CULTIVATING AN INTEGRATED LEARNING APPROACH TO EARLY CHILDHOOD MATHEMATICS: A TEACHER EDUCATOR'S SELF-STUDY

Dimakatso Kortjass

Student number: 204523782

A thesis submitted in fulfilment of the requirements of the degree of

DOCTOR OF PHILOSOPHY

TEACHER DEVELOPMENT STUDIES

School of Education: College of Humanities

University of KwaZulu-Natal

South Africa

Supervisor: Professor Kathleen Pithouse-Morgan

2020

DECLARATION

I, Dimakatso Kortjass, declare that:

(i) The research reported in this dissertation/thesis, except where otherwise indicated, is my original work.

(ii) This thesis has not been submitted for any degree or examination at any other university.

(iii) This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

(iv) This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

a) their words have been re-written but the general information attributed to them has been referenced;

b) where their exact words have been used, their writing has been placed inside quotation marks, and referenced.

(v) Where I have reproduced a publication of which I am author or co-author, I have indicated in detail which part of the publication was actually written by myself alone and have fully referenced such publications.

(vi) This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged and the source being detailed in the thesis and in the References section.

Signed: 

Dimakatso Kortjass

As the candidate's Supervisor I agree to the submission of this thesis.

Signed:

Professor Kathleen Pithouse-Morgan

ABSTRACT

To improve my practice as a newly appointed teacher educator at a South African university, I conducted a self-study project focused on exploring an integrated learning approach (ILA) in early childhood mathematics teacher education. I wanted to become a change agent by assisting pre-service teachers in developing a genuine interest in mathematics and seeing it within their reach. I hoped that they would then be inspired to do the same for their prospective learners. My primary research question was: *How can I cultivate an integrated learning approach to Early Childhood Mathematics in my teacher education practice?* I used four self-study methods to address the research aim: personal history, arts-based explorations, a developmental portfolio, and memory work. I recalled how I learnt mathematics from a young age and my experiences of teaching mathematics to young children and pre-service teachers. I engaged four groups of pre-service teachers to explore an integrated learning approach using arts-based methods to enhance mathematical concepts and pedagogical content knowledge. By embedding my study within a sociocultural perspective, I was motivated to acknowledge my pre-service teachers' lived experiences and cultural backgrounds to strengthen their mathematical knowledge and pedagogy. Various critical friends helped me gain confidence in myself, and their compassionate critiques enhanced my understanding of my purpose and my ability to work. Having completed this project, I now add my voice to other South African scholars in mathematics integration conversations, especially in early childhood mathematics teacher education. This study also contributes to the hitherto limited body of research conducted by mathematics teacher educators in the early childhood discipline. Moreover, I have brought mathematics and the arts together through hands-on arts-based activities. This manuscript is presented in a colourful, engaging and unique way using collages and metaphors that embody early childhood mathematics practices in teacher education. The thesis itself is an artefact of the integrated approach to mathematics teaching in early childhood and in teacher education.

ACKNOWLEDGMENTS

It is with deepest gratitude that I convey my appreciation to all the exceptional people who have helped me on this doctoral journey:

- My heartfelt thanks go to Professor Kathleen Pithouse–Morgan. Your reassurance, perceptive guidance, motivation and the supportive feedback during this learning experience are much appreciated.
- I am thankful to my late parents, Moses and Smangele who would have been very proud of my achievement.
- I am so grateful to my daughter, Lerato, for your love, patience and inspiration. You have been my beacon of hope throughout my study.
- To my brother, Cedric and my nephews, Londa and Aphelele whom I neglected, thank you for being there for me.
- Thank you to my friends Nonhlanhla Mthiyane and Lulu Nkonzo-Mtembu for your wise advice and encouragement.
- I am grateful to my students for their willingness to participate in this study.
- To my critical friends, thank you for your advice and the constructive feedback.
- Thank you to the University Teaching and Learning office (UTLO) for the research grant.
- Thank you to the University Capacity Development Programme (UCDP) office for the staff support grant.
- My sincere gratitude goes to Almighty God for giving me health and strength to complete this study.

ABBREVIATIONS AND ACRONYMS

B.Ed. - Bachelor of Education
CAPS - Curriculum Assessment Policy Statements
CFP - Critical Friends Portfolio
DBE - Department of Basic Education
DEC - Department of Education and Culture
DET - Department of Education and Training
DHET - Department of Higher Education and Training
DoE - Department of Education
ECA - Early career academic
ECM - Early childhood mathematics
FET - Further Education and Training
PGfUM - Playing games for understanding mathematics
TGfU - Teaching games for understanding
FP - Foundation Phase
FLBP - Funza Lushaka Bursary Programme
GPS - Global positioning system
HP - Higher primary
HoA - House of Assembly
HoD - House of Delegates
HoR - House of Representatives
IL - Integrated learning approach
KZN - KwaZulu-Natal
LANS - Learning Area Network System
LP - Lower primary
LZ - Learning zones
MAA - Mathematical Association of America
MRTEQ - Minimum Requirements for Teacher Education Qualifications
NAEYC - National Association for the Education of Young Children
NCTM - National Council for the Teaching of Mathematics
NDP - National Development Plan
NELDS - National Early Learning and Development Standards
NPDE - National Professional Diploma in Education

NSC - National Curriculum Statement

PBL - Phenomenon-based learning

QPA - Quality Promotion and Assurance

SAERA - South African Educational Research Association

SARAECE - South African Research Association of Early Childhood Education

SFPTEP - Strengthening Foundation-Phase Teacher Education Programme

SIG - Special interest group

SPN - Scholarly Personal Narratives

SSA - Sub-Standard A

TRIS - Teacher Rural Incentive Scheme

WIL - Work integrated learning

TLIQEG - Teaching and Learning Innovations and Quality Enhancement Grant

UKZN - University of KwaZulu-Natal

UNIZULU - University of Zululand

UTLO - University Teaching and Learning Office

ZPD - Zone of Proximal Development

PRESENTATIONS AND PUBLICATIONS EMANATING FROM MY STUDY

My doctoral journey has been long and, at times, challenging. However, it has been academically fulfilling. I have grown and developed tremendously. True to the principles of self-study, I have made my work public through presentations and publications. I have travelled this journey with my critical readers, my colleagues, and my self-reflexive support group. I have received feedback and input from critical friends and various stakeholders in the South African and international research community to whom I have presented my work. What is in this thesis has been put under vigorous scrutiny. Below is a list of presentations and publications. I indicate which of the thesis chapters are informed by these presentations and publications.

PRESENTATIONS

Presentations	Chapters
Henning, E., **Kortjass, M.**, Mphahlele, R., Webb, L., van der Haar, H., Mathews, C. (2020). *Pedagogic standards for primary mathematics teacher education: Towards a signature pedagogy for numeracy teaching*. Paper presented at Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE), held at the Nelson Mandela University, Port Elizabeth, 16 January 2020.	Ten
Kortjass, M. (2019). *Going beyond boundaries by creating collages in my self-study doctoral journey*. Paper presented at the South African Education Research Association (SAERA) Conference, held at the Southern Sun Elangeni/Maharani Hotels, Durban, South Africa, 22 October 2019.	One, Three, Five, Six, Seven, Eight, Nine and Ten
Kortjass, M. (2018). *Making an integrated learning approach to early childhood mathematics tangible: A teacher educator's self-study.* Paper presented at the South African Education Research Association (SAERA) Conference, held at the Saint George Hotel and Conference Centre, Pretoria, South Africa, Sun Elangeni/Maharani Hotels, Durban, South Africa, 23 October 2018.	Four, Five and Six
Kortjass, M. (2018). *Enriching teaching through artefacts: An early childhood mathematics teacher educator's self-study project.* Paper presented at the South African Association for Early Childhood Education (SARAECE) Conference, held at the Forever Hotel Centurion, Pretoria, South Africa, 11 May 2018.	Six
Kortjass, M. (2016). *Innovative strategies: Putting into practice an integrated learning approach in early childhood numeracy teacher*. Paper presented at the South African Education Research Association (SAERA)	Four, Five and Six

Conference, held at the Cape Sun Hotel, Cape Town, South Africa, 25 October 2016.	
Kortjass, M. Ndlovu, B., Madonda, N., & Mzimela, J. (2015). *Taking a 'selfie' into our practice: A collaborative self-study in early childhood teacher education*. Paper presented at the UKZN Teaching and Learning Conference, held at the Elangeni/Maharani Hotels, Durban, 22 September 2015.	One
Masinga, L., Kolobe, L., Singh-Pillay, A., **Kortjass, M.** Chirikure, T., & Ndlovu, B., (2015). *Re-Imagining higher education policy implementation: Can policy learn from practice? Complexities, Challenges and Possibilities*. Paper presented at the UKZN Teaching and Learning Conference, held at the Elangeni/Maharani Hotels, Durban, 22 September 2015.	Nine and Ten

PUBLICATIONS

Publications	Chapters
Kortjass, M. (2020). Re-Envisioning early childhood mathematics education: Learning through memory drawing. In C. Edge, A. Cameron-Standerford, & B. Bergh (Eds.), *Textiles and Tapestries* (pp. 1-14). EdTech.	Three and Seven
Kortjass, M. (2019). Enriching teaching through artefacts: An early childhood mathematics teacher educator's self-study project. *Educational Research for Social Change, 8*(2), 70-85.	Six
Kortjass, M. (2019). Reflective self-study for an integrated learning approach to early childhood mathematics teacher education. *South African Journal of Childhood Education*, *8*(2), 1-11.	Three and Four
Dhlula-Moruri, M. N., **Kortjass, M**., Ndaleni, T., & Pithouse-Morgan, K. (2017). A stove, a flask, and a photograph: Learning together through object inquiry in self-study research. In D. Pillay, K. Pithouse-Morgan & I. Naiker (Eds.), *Object medleys: Interpretive possibilities for educational research* (pp. 81-89). Rotterdam, Netherlands: Sense Publishers.	Three
Masinga, L. Myende, P., Marais, A., Singh-Pillay, A., **Kortjass, M.,** Chirikure, T., & Mweli, P. (2016). "Hear our voices": A collective arts-based self-study of early-career academics on our learning and growth in a research-intensive university. *Educational Research for Social Change, 5*(2),117-135.	Nine and Ten
Kortjass, M. (2016). 'I think I can teach': The preparation of mathematics early childhood education teachers. *Journal of Education Studies*, *14*(1), 1-19.	Five and Six

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

TABLE OF ANNEXURES

CHAPTER ONE: THE FIRST STEPS INTO UNKNOWN WATERS

Teachers can be the change agents in schools, countries,
and states when they take their first steps in unknown waters

Anastasia Samaras

1.1 Introduction

To improve my practice as a teacher educator, I decided to embark on a self-study project focused on exploring an integrated learning approach (ILA) in early childhood mathematics teacher education. As a recently appointed lecturer working with Foundation Phase (Grade R to Grade 3) pre-service teachers in the Bachelor of Education (B.Ed.) programme at a university in KwaZulu-Natal, South Africa, the primary purpose for my research was to enhance my own pedagogical practices. I thus employed various self-study methods. The first chapter of this thesis is titled, *The first steps into unknown waters*, because I attempted an approach to early childhood mathematics teacher education that was new for me. This self-study project was a journey into the unknown. The opening quotation, "Teachers can be change agents in schools, countries, and states when they take their first steps in unknown waters" (Samaras, 2002, p. 149), resonates with my first tentative steps towards becoming a change agent.

This chapter offers my motivation for embarking on this self-study research project. I also provide background information on the integration of subjects in the Foundation Phase. Next, I briefly elucidate the methodological approach that I followed and the self-study methods that I employed, and I explain why these were appropriate for my research. To follow, I present the research questions that guided the study. I then explain the key concepts and the theoretical perspective that helped me understand these concepts differently. I conclude the chapter with an overview of the thesis chapters as a whole.

The chapter headings of this thesis are metaphors for the various self-study research activities that I undertook. They offer a creative image of my self-study research experiences and my engagement with other scholars' work. Also, as Badley (2018) advises academics to use titles that will engage and inform the envisioned readers, I intended to draw the readers' interest by using metaphors in chapter headings.

It is noteworthy that I have chosen not to have a distinct literature review chapter in this thesis. Instead, I have integrated discussion of literature throughout, using it in places relevant to the

narrative as a whole rather than a separate discourse. This is because I have chosen to use a "scholarly personal narrative [writing] style" (Nash, 2004, p. 6). This means that, as advised by Nash (2004), I have intentionally put myself, my voice, and my personal and professional stories into my scholarship. I have interlaced my voice and my accounts with what Nash (2004, p. 66) describes as "proof texts", which enrich and complement the writer's text. Nash (2004, p. 7) articulates the value of integrating discussion of "scholarly background references" into the storyline of the writer's scholarly personal narrative "only when they are directly applicable". I anticipated that adopting a scholarly personal narrative style would allow my voice as a researcher and a teacher educator to ring true throughout this thesis. I also wanted my voice to resonate with the respected voices of those who came before me and those who may wish to build on this study.

1.2 Motivation for the Study

In 2015, I was hired as a lecturer in the early childhood education discipline at the university where I am currently working. One of my employment conditions was that I had to register for and complete my doctoral studies within five years. In my first year of employment, I taught two modules in the B.Ed. Foundation Phase programme: Curriculum Development in Early Childhood Education and Issues and Perspectives. I also taught Mathematics Teaching in the Foundation Phase in the Post Graduate Certificate in Education (PGCE) programme. This programme was subsequently suspended at the end of 2015. Then in 2016, I registered for doctoral studies. In the same year, I also started teaching the Early Childhood Mathematics module in the B.Ed. Foundation Phase programme when my colleague who taught this module went on sabbatical leave. In the beginning, I just taught mathematical concepts such as subitising, place value, additive relations, and so on, by introducing them, explaining what they meant, and giving examples.

Starting to teach early childhood mathematics to student teachers[1] at the university was really challenging for me. The transitioning process to becoming a university-based teacher educator was fraught with some difficulties, especially regarding mathematics content. I lacked confidence in my understanding because I had not studied mathematics in high school. And as

[1] I refer to the students in the Bachelor of Education (B.Ed.) programme as 'student teachers' and 'pre-service teachers'.

a pre-service teacher at the tertiary level, I had only learnt teaching methods. And, according to Dinkelman, Margolis, and Sikkenga (2006), as much as the teacher and teacher educators' work is similar, these roles are considerably different in significant ways. I felt that I needed to develop my identity and competency as a teacher educator. Dinkelman, Margolis, and Sikkenga (2006) note that a teacher educator's professional identity and knowledge are built over time. Thus, I became conscious that I needed time to learn more.

I wanted to learn to assist pre-service teachers in gaining content knowledge and pedagogical content knowledge of mathematics. Shulman (1986) identified the different knowledges that teachers need to have to teach well. In 1987, Shulman defined seven categories of teacher knowledge: "knowledge of content; knowledge of pedagogy; knowledge of curriculum; knowledge of learners and learning; knowledge of contexts of schooling; pedagogical content knowledge; and knowledge of educational philosophies, goals and objectives" (Shulman, 1987, p. 127). A number of researchers (Adler, Slonimsky & Reed, 2002; Grossman, 1990; Morrow, 2007; Turner-Bisset, 1999) have generated models of teacher knowledge based on this.

As a teacher educator, I need to guide pre-service teachers in developing various kinds of knowledge: pedagogical content knowledge, content knowledge (or subject matter knowledge), and knowledge of "mathematics-for-teaching" which encompasses both subject content knowledge and mathematics-specific pedagogical knowledge (Pournara, Hodgen, Adler, & Pillay, 2015, p. 2). On this point, Schuck and Brandenburg (2020) highlight that pre-service teachers need to acquire ways of teaching mathematics content successfully. Additionally, Pournara et al. (2015) assert that some agreement exists that the knowledge teachers require for teaching mathematics goes beyond sound content knowledge. For example, the use of concrete materials when teaching mathematical concepts to young learners[2] is vital. When preparing pre-service teachers, teacher educators should thus highlight the distinction between "the use of a resource to *demonstrate* to a class and the use of a resource for children to *engage* with subject content" (Delaney, 2010, p. 72). Delaney (2010) argues that the former approach highlights resources as a support for *teaching,* whereas the latter emphasises the resource as a support for *learning*.

[2] 'Learners' in this study refer to those who are still at school (Grade R to Grade 12).

Thames and Ball (2010, p. 223) claim that, in examining their teaching regularly, teacher educators discover that "teaching well requires an abundance of mathematical skills and of *usable* mathematical knowledge – [thus] mathematical knowledge in and for teaching". This sentiment is shared by Schuck and Perreira (2011), who state that mathematics teacher educators should not only focus on abstract mathematics content, but also on the pedagogy of mathematical processes. Therefore, to benefit my students in acquiring knowledge and pedagogy, I needed to reflect on how *I* was teaching.

I was also motivated by successful teachers and teacher educators who used an integrated approach to teaching. For example, teacher Matonhodze, based in the Mpumalanga province in South Africa, was awarded the honour of "best Mathematics teacher" for using an integrated approach in her classroom. She explained how she linked mathematics to learners' everyday experiences and interactions by using examples that they could relate to. This helped them appreciate mathematics as an essential part of life (Public Sector Manager, 2018). Further motivation came from an Accounting teacher educator from the University of KwaZulu-Natal, Dr Msizi Mkhize, who provided learners and students with opportunities to show how mathematics can be used in their daily lives and in other subjects such as History and Geography (UKZNndaba Online, 2018). Reading about these two educators made me wonder how it would be possible to adopt a similar approach in my own lecturing and make it work.

I anticipated that by adopting an integrated learning approach, I could assist pre-service teachers in improving their understanding of mathematical concepts and how to teach them in the Foundation Phase (Pradhan, 2018). This phase's fundamental purpose is to lay a solid foundation for young learners to acquire knowledge, skills and values. I thus embarked on this project to improve my practice to assist pre-service teachers who should, in turn, help their prospective learners acquire age-appropriate mathematical knowledge, skills and values.

As shown in Chapter Three of this thesis, my formal learning experiences as a schoolchild made me regard mathematics as something nebulous that is disconnected from everyday life. However, as a newly appointed university teacher educator, I wanted to become a change agent by assisting student teachers in developing a genuine interest in mathematics and seeing it within their reach (National Association for the Education of Young Children, 2002). I hoped that they would then be inspired to do the same for their prospective learners.

According to Nicol, Archibald and Baker (2013), the prescribed Mathematics curriculum can exclude some learners because of inaccessible word problems and inappropriate examples. These authors further call attention to how unproductive teaching strategies can alienate learners and make them believe that mathematics is difficult and unattainable (Nicol et al., 2013). Conversely, I think that approaches that foster practical and exploratory activities across a range of relevant contexts may offer learners and pre-service teachers opportunities to experience mathematics in a more user-friendly manner. They can thus develop the ability and insight to solve mathematical problems (Alderton, 2008). Lovin et al. (2012) highlight that teachers should always strive to use developmentally appropriate strategies for learners as they progress to become competent in their thinking and doing. This can propel them in a direction where they will understand and apply mathematical concepts at various levels and across many disciplines.

In light of the above, I felt that I could – and should − positively influence early childhood mathematics among pre-service teachers. I recognised that I should try out an integrated learning approach with the pre-service teachers to learn from my practice and facilitate the learning and teaching of mathematics in an accessible and comprehensible way.

1.3 Background Information

According to the Revised Policy on Minimum Requirements for Teacher Education Qualifications in South Africa, the B.Ed. programme has the fundamental purpose of providing "a well-rounded education that equips graduates with the required subject content knowledge base, educational theory, and methodology that will enable them to demonstrate competence and responsibility as academically and professionally qualified beginner teachers" (Department of Higher Education and Training, 2015, p. 20). B.Ed. Foundation Phase programmes must prepare pre-service teachers to teach from Grade R to Grade 3.

My decision to undertake this self-study project was influenced by reflections on my prior experiences as a Foundation Phase teacher. As explained in Chapter Three, I clearly recall how, as a schoolteacher, I employed teacher-centred methods such as telling and question and answer methods to teach mathematical concepts and how frustrated both the learners and I would become. I taught abstract concepts, and I made my learners recite the times tables mindlessly. I can recall that I taught mathematics in an integrated manner only during a theme week when everything we taught had to be underpinned by a particular theme. I also remember

that my Standard 1 (Grade 3) classroom layout was conventional, with the learners' desks in rows and my desk and cupboard in front.

1.3.1 Integration of subjects

Combining disciplines and pedagogical approaches in higher education is not a new phenomenon. Mathison and Freeman (1997) state that an interdisciplinary approach to teaching and an integrated curriculum first appeared in the 1920s, which was the time when they were first connected with the progressive education movement. According to Samaras (2002, p. 58), "integration of the curriculum is an excellent way to enable pre-service teachers to embrace the bigger picture of learning". Similarly, Van Laren (2014) argues that pre-service teachers need integrative structures to apply in their classrooms when teaching their learners. Therefore, I understood that integration of subjects in teacher education could play a pivotal role in providing student teachers opportunities to integrate different learning areas during their teaching.

The integration of subjects can afford students a deeper understanding of how different concepts relate to one another. Mathison and Freeman (1997, p. 1) perceive integration as "the horizontal connections necessary for a coherent curriculum". Combining subjects and/or courses using different approaches can provide students with more meaningful experiences as they learn. A deeper understanding can occur through merging topics and concepts and utilising their interconnectedness across major strands (Hunting, 2010). I thus chose to explore the methodologies and applications of an *integrated learning approach* in this study. Humphreys, Post, and Ellis (1981) define an integrated learning approach as "one in which children [or students] broadly explore knowledge in various subjects related to certain aspects of their environment". Shoemaker (1989) offers the following definition of an integrated curriculum:

> "[It is]education that is organised in such a way that it cuts across subject matter lines, bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of study. It views learning and teaching in a holistic way and reflects the real world which is interactive."

The term 'integrated curriculum' is often used synonymously with 'interdisciplinary curriculum' (Lake, 1994). Because Foundation Phase teachers in South Africa teach the three primary learning areas (Mathematics, Language/s and Life Skills) to an allocated group of

learners for an entire year, they must take into account the "social, personal, intellectual, emotional and physical growth of learners and the way in which they are integrated" (Department of Basic Education, 2011a, p. 8). Foundation Phase teachers should allow themselves ample time to interact and gain in-depth knowledge of their learners and their circumstances (van Laren, 2014). The Curriculum Assessment Policy Statement[3] (CAPS) stipulates that Foundation Phase teachers also need to know how to stimulate and sustain an integrated approach across learning areas in an age-appropriate manner. Furthermore, Brandt and Chernoff (2015) note that subject integration is significant in mathematics lessons in primary teaching as it stimulates learning while promoting problem-solving opportunities. Therefore, equipping pre-service teachers with the knowledge and hands-on experience of how integration across learning areas should occur is essential. As a teacher educator in the Foundation Phase, I thus felt the need to improve and extend my pedagogical practice by bringing an integrated approach into the early childhood mathematics module.

1.3.2 Integration in the Foundation Phase

The Department of Basic Education (2011a) foregrounds integration in the Foundation Phase in all the learning areas (Languages, Mathematics and Life Skills). The National Curriculum Statement[4] (NCS) stipulates that the Life Skills learning area is "a cross-cutting subject that should support and strengthen the teaching of other core Foundation Phase subjects, namely Languages (Home and First Additional Language) and Mathematics" (DBE, 2011a, p. 8). The Languages learning area thus cuts across all other disciplines through oral work and reading and writing. Listening and speaking should accordingly be developed within the Mathematics and Life Skills disciplines. These are made up of various subjects such as "Creative Arts and Beginning Knowledge, including Personal and Social Well-Being, Natural Sciences and Technology, and the Social Sciences" (DBE, 2011a, p. 13). Themes and topics can be selected from these subject areas to provide contexts for the teaching of language. In the Mathematics learning area, integration is strongly accentuated in the Grade R classroom by the DBE (2011a, p. 13):

[3] Foundation Phase Curriculum and Assessment Policy Statement (CAPS) provides teachers with a definition of each subject, specific aims, specific skills, focus areas, and weighting of the areas recommended resources for the Foundation Phase Mathematics lessons, suggested guidelines on supporting learners with barriers to learning, and enhancing the teaching and learning in this phase.

[4] The *National Curriculum Statement Grades R - 12* is a policy statement for learning and teaching in South African schools and comprises the National Curriculum and Assessment Policy Statements for each approved school subject.

> All aspects of Grade R, including the classroom environment and teaching and learning practice, should promote the holistic development of the child. Development that is an integral part of emergent Mathematics includes cognitive development (problem-solving, logical thought and reasoning), language development (the language of mathematics) and perceptual-motor as well as emotional and social development.

Similarly, the Revised Policy on the Minimum Requirements for Teacher Education Qualification in South Africa foregrounds this approach. It stipulates that the combination of knowledge for Foundation Phase teaching must include "disciplinary, pedagogical and practical learning to enable teachers to work competently with Grade R learners" (Department of Higher Education and Training, 2015). Thus, teachers in the Foundation Phase need to draw from a wide range of knowledge to implement the national school curriculum.

The South African government views the early childhood education sector as one of the most critical nodal points for the country's social and economic transformation and development. According to the National Early Learning and Development Standards[5] (NELDS), the vision of children's holistic development as expounded in South African policies can be realised (Department of Basic Education, 2009). In this context, the South African National Development Plan (NDP) calls for universities to be innovative and improve the quality of teaching and learning in higher learning (National Department Commission: Department of Presidency, 2012). In line with the NDP, higher education institutions are mandated to develop the capacity to provide quality undergraduate teaching and to ensure flexibility and innovation throughout the system (Department of Basic Education, 2009). Universities are also urged to assist students in coping with the demands of higher education learning. Therefore, I hoped to guide and capacitate pre-service teachers to explore innovative teaching through active involvement in understanding and enacting an integrated learning approach.

I found that Finland is an excellent example of a country where an integrated learning approach is successfully used. This country is regarded as a world leader in education as a result of its innovative teaching methods. Finland's pioneering pedagogic approach is "phenomenon-based

[5] The National Early Learning Development Standards is a South African curriculum-related policy initiative focusing primarily on the early learning needs of children from birth to four years. It provides early learning standards expressed as desired results, indicators and competencies of expected learning achievements for young children in a designated age range.

learning" (Halinen, 2015, p. 3). Instead of concentrating on segregated subject areas such as mathematics and science, the phenomenon-based learning policy expects schools to integrate various components based on learning about a single topic by approaching it from the perspective of several disciplines (Halinen, 2015). According to Strauss (2015), phenomenon-based learning is not aimed at replacing conventional subject-based teaching. Instead, it is aimed at broadening children's view of the world and their understanding of themselves. In applying this approach, teachers choose project topics that connect to their learners' background knowledge and personal experiences (Strauss, 2015). Against this background, I approached the self-study project of cultivating an integrated learning approach by selecting concepts (or topics) that were relevant and age-appropriate, that would encourage integration among subject areas, and that built on prior knowledge and experiences in the teaching of early childhood mathematics.

1.3.3 Teacher educators in the early childhood education discipline

In preparing for my self-study project, I collaborated with two of my colleagues in the early childhood education discipline to explore and illuminate possibilities for an integrated learning approach. One was a language specialist who taught all the language modules, and the other was a life skills specialist. After receiving the approval to conduct my doctoral study in January 2017, I presented the purpose of my research to my colleagues. We then created collages to explore an integrated learning approach. Dinkelman (2003) observes that, as educators work together to achieve the same objectives in a teaching and learning area, they bring particular knowledge and understandings to the group. Thus, it was crucial for us as early childhood teacher educators to work collaboratively and note how the integration process could occur across the learning areas. I learnt that we could accomplish more when we worked collaboratively to improve the programmes we offered in this discipline. It made me realise that I could not take our collaboration for granted. I understood that collaboration has to be something that we consciously choose to do and facilitate in the discipline.

Our interaction focused on cultivating an integrated learning approach in the early childhood mathematics module that I taught. I presented what I had planned to do regarding integration to my colleagues, and we discussed the importance of integration in all early childhood education modules. We agreed that we needed to look at this approach's value in all the modules we offered our pre-service teachers.

Following the collage technique presented by Van Schalkwyk (2010), we created a collage (Figure 1.1.) that illustrated how the Life Skills and Languages learning areas can be integrated with the Mathematics learning area. Van Schalkwyk (2010) explains that photographs, pictures, and cuttings, including text from magazines and other media, can represent experiences when creating a collage. We noted how integration can occur across all learning areas and worked collaboratively to cut out pictures, symbols, and words from magazines representing the integrated learning approach. Again, following Van Schalkwyk's example, we then wrote transcripts of these images to indicate how integrated learning can occur.

Figure 1.1: The collage we created as early childhood teacher educators

Table 1.1: Summary of the collage transcript

Themes	Categories	Integration
Celebrations	Birthday Celebration	Life-Skills: Celebration of a birthday Maths: Years and ages Language: Reading and viewing; writing number names
	A woman wearing traditional attire	Life-Skills: Cultures, heritage, diversity Maths: Patterns, colours, counting, shapes Language: discussion, listening, colouring
Places I know	SABC Tower	Life-Skills: Buildings and structures (Places I know) Maths: Man-made patterns, numbers, shapes Language: Reading and viewing – SABC (letters)
	African map	Life-Skills: Geographical location – Personal and social well-being Maths: Sequencing, colours (black, white, red) Language: Reading, listening writing, handwriting, comprehension
Time	Clock	Life-Skills: Time - seasons Maths: Time Language: Speaking
Health	Eggs	Life-Skills: Food, nutrition Maths: counting, basic operations, measurement Language: Listening and speaking – Shopping
	HIV Ribbon	Life-Skills: Health & safety, HIV awareness Maths: shape, colour, statistics (data handling) Language: Discussion, storytelling, dramatisation
Growth	Arno	Life-Skills: Developing fine motor skills, eye-hand co-ordination Maths: Space and shape, number, colours Language: Picture story, child's name
	Sums	Life-Skills: Eye-hand co-ordination, fine motor skills, Maths: Basic operations, drawing Language: Writing of word problems
	Cars	Life-Skills: Road transport, colours Maths: counting, multiplication, comparison, ordering Language: Speaking – language vocabulary

We used the transcriptions to develop themes from the categories (Table 1.1) that we had identified using the pictures and texts in our collage. We then discussed these in connection with the integrated learning approach. For example, we linked the theme "celebrations" with birthdays and cultural events. These were illustrated by the caption "Birthday Celebrations" and the image of a woman wearing a traditional outfit. We pointed out that there was integration with mathematics regarding patterns, colours, shapes, and life skills relating to cultures and diversity. The language aspect was captured in our discussions and by listening to one another.

Working with these colleagues deepened my understanding of the concept that "together we can achieve more". As Schuck and Russell (2005) proposed, we shared common values regarding early childhood teacher education. It was also interesting to observe how passionate we were about our roles in early childhood teacher education. Schuck and Russell (2005) highlight that teacher educators working together gain insights about taking positive actions that would not have been possible had they not collaborated. Further, working with my colleagues in the discipline engendered shared respect (Lovin et al., 2011). I acquired some ideas from my colleagues for improving my teaching practices. I was motivated to plan my lessons for the early childhood mathematics module, using innovative methods to explore an integrated learning approach.

1.4 Methodological Approach

This study employed a self-study research methodology. I chose the self-study approach because, according to Samaras (2011), self-study research allows the researcher to examine her own lived experiences and practices. I thus employed this approach to improve my teaching of the early childhood mathematics module by cultivating an integrated learning approach. I anticipated that this study would help me better understand and enact my role as a change agent in teacher education.

According to Samaras (2011), self-study research comprises a framework that has five main foci: "personal situated inquiry, critical collaborative inquiry, improved learning, a transparent and systematic research process, and knowledge generation and presentation" (Samaras, 2011 p. 70). I provide a brief description of each of these main foci.

Personal situated inquiry

Personal situated inquiry refers to the importance of personal, contextualised experience as a

valued source of knowledge (Loughran, 2004). Situated inquiry means that self-study "begins with your inquiry and is driven from your questions situated in your particular context" (Samaras & Freese, 2006, p. 40). A focus on the personal (or the self) in context is fundamental to self-study. By undertaking this self-study project, I recognised the personal 'situatedness' of this research as I strove to study and improve my practice. I give a detailed account of my personal situated inquiry in Chapters Four, Five, Six and Seven.

Critical collaborative inquiry

Samaras (2011) argues that, although self-study involves personal inquiry, "it is also interpersonal, interactive, and collaborative" (p. 75). In this self-study project, I drew on my personal experiences as a teacher educator and involved my colleagues in critical and collaborative inquiry processes. Thus, working with others created a support system that enhanced my research (as illustrated in Chapters Eight and Nine).

Improved learning

Improved learning encompasses understanding how to enhance one's teaching in the interests of students' learning (Samaras, 2011). Because my goal was to improve my practice and support my pre-service teachers' learning, I reviewed an integrated learning approach. I used various methods to enhance my teaching of early childhood mathematics. I also engaged my pre-service teachers in arts-based learning and reflection practices as my confidence grew (see Chapters Four, Five and Six).

Transparent and systematic research process

According to Samaras (2011, p. 80), a transparent and systematic research process "involves transparency of your procedure and analysis, which you share with your critical friends and validation team". I understood that I should be open-minded and honest when I shared and reflected on my work. I also had a plan and schedule when I showed my work to others. I kept an audit trail of the data, and I shared these data and my analyses with evidence of my claims with my critical friends, as proposed by Samaras (2011).

Knowledge generation and presentation

Self-study researchers produce knowledge which they make public through presentation and publication (Samaras, 2011). LaBoskey (2004) also asserts that teachers and teacher educators employ self-study research methods and practices derived from knowledge and learning

concepts. Hence, I was aware that I must share and explore the outcomes and significance of my self-study research by presenting the findings on different educational platforms and in various research spaces (as indicated on pages viii and ix of this thesis in the list of presentations and publications).

I anticipated that employing a self-study methodology would allow me to use different approaches to allow my pre-service teachers to understand the integrated learning approach concept for teaching mathematics and improve my own teaching practice. As a teacher educator, I accepted that I had pedagogical imperatives and was responsible for my pre-service teachers and their prospective learners (LaBoskey, 2004). I sought to stimulate my pre-service teachers through innovative approaches to learn and do the same with their learners one day. I employed different self-study methods such as the *personal history self-study,* an *arts-based self-study,* and a *developmental portfolio of self-study methods* (Samaras, 2011) to respond to the research questions. These are discussed in depth in Chapter Two.

1.5 Research Questions

My primary research question was: *How can I cultivate an integrated learning approach to Early Childhood Mathematics in my teacher education practice?*

From my primary question, I developed three more focused research questions to direct a dynamic approach to the study:

1. What can I learn about cultivating an integrated learning approach (ILA) from working with my memories? (See Chapter Three)

2. What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers? (See Chapters Four, Five, Six and Seven)

3. What can I learn about cultivating an integrated learning approach (ILA) from working with critical friends? (See Chapter Eight and Nine)

1.5.1 Research Question 1

What can I learn about cultivating an integrated learning approach (ILA) from working with my memories? (See Chapter Three.)

To respond to this research question, I recalled my earliest experiences of learning mathematics as a young child up to my school years and as a mathematics teacher. I used photographs, objects, and drawings from memory to stir and refresh my reflections and illustrate my personal history. I recalled my experiences, and I remembered how I acquired various mathematical concepts during my early childhood (Chapter Three). This journey prompted an understanding that mathematical concepts can be established and strengthened by childhood games, particularly those that entrench basic mathematical concepts and content. I came to understand that the value of numbers, my counting skills, and my addition and subtraction competencies had been developed and enriched through childhood games. I was brought to the realisation that my informal learning of mathematical skills during my early childhood started even before I went to school. As my memory became more acute through persistent and deliberate reflection, I clearly recalled my primary school mathematics struggles. Moreover, by writing about my experiences, I could more clearly remember the strategies, activities, and resources we applied as children. I understood that eliciting what and how I learnt as a child could enable me to use an integrated learning approach more effectively in the early childhood phase.

1.5.2 Research question 2

What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers? (See Chapters Four, Five, Six and Seven)

I addressed this question as my purpose was to implement an integrated learning approach while working with pre-service teachers in the early childhood programme. In Chapters Four, Five Six and Seven, I explain how I engaged pre-service teachers in various activities to understand using an integrated learning approach in the Foundation Phase. These pre-service teachers developed learner activities, created collages and concept maps, engaged in memory work, explored artefact retrieval activities, participated in extramural activities, and played various board games. They also did multiple exercises and responded to questions about their understanding of the integrated learning approach. Having undertaken all these activities with the pre-service teachers, I learnt more about the integrated classroom environment and how to make learning even more attractive, challenging and learner-centred. These experiences made me more aware of how I learn by working with pre-service teachers to develop the knowledge and hands-on experiences of an integrated approach to teaching and learning mathematics in the early childhood development phase.

1.5.3 Research question 3

What can I learn about cultivating an integrated learning approach from working with critical friends? (See Chapter Eight and Nine)

I addressed this question by discussing my experiences with friends and colleagues. I refer to these others as 'critical friends'. Schuck (2011) regards critical friends as colleagues or peers who offer honest and valuable opinions about improving our teacher educator practice. I presented my self-study research at workshops and national education conferences to others whose feedback was reflective, critical and guiding. I learnt that I needed to have an open mind while working with these colleagues as their feedback might be critical, yet constructive. I appreciated that receiving feedback from colleagues should be seen as an exciting opportunity for learning rather than a harmful or threatening experience. My defensive responses might have derailed this worthy project. I had thought that I was on the right track as a mathematics teacher educator in the early childhood development phase. Still, in listening to others' feedback, I recognised that I needed to move beyond what I had applied and practised earlier. In their role as critical friends, my colleagues played an essential part in the development of my authentic self-study project because their contributions enhanced the reflective nature of my study.

1.6 Key Concepts that Informed the Study

I focused on key concepts: a) an integrated learning approach; b) Early Childhood Mathematics; and c) teacher educator learning. To begin exploring my understanding of these concepts, I created collages. Butler-Kisber and Poldma (2010, p. 2) describe the process of creating a collage as "using pieces of images or materials and gluing them to a chart or a flat surface to portray a phenomenon". The collages that I produced helped me think conceptually and clearly articulate the concepts (Butler-Kisber, 2008). The following section presents my initial understanding of the central ideas that informed the study. Each one is illustrated with a collage. The meanings that transpired when these collages were created and re-examined are discussed.

1.6.1 Concept A: An integrated learning approach

At the heart of the study was an integrated learning approach as I wanted to understand this approach and develop opportunities for its implementation.

Figure 1.2: Collage representing the concept 'integrated learning approach'

Exploring integrated learning through collage making enabled me to begin to understand this concept and the implications for my practice as an early childhood mathematics teacher educator. The collage (Figure 1.2) shows how Mathematics learning happens all the time, whether we are playing, shopping, or engaging in everyday activities. For instance, the picture of a handbag suggests that mathematics is all around us and integrated into our lives. The embroidered patterns that appear on this bag are in various shapes that are an integral part of mathematics. The caption, "A breath of fresh air", is a metaphor for my desire to do things differently in my practice. Thus, instead of using my typical teaching methods to teach mathematics in teacher education, I opted to try a new approach to make learning exciting and relevant. I also hoped to avoid a situation where the pre-service teachers would feel bored, and this is depicted by the woman who is yawning. I thought it would be essential to give pre-service teachers opportunities to reflect on their learning experiences. This is shown by the picture of the students who are looking back. However, they are also moving forward (by, for

example, using more advanced technology), and they thus create new things and ideas and build on what they have learnt.

Scholars use a variety of terms to define an integrated learning approach. For example, Mwakapenda (2008, p. 191) uses the expression "making connections", whereas Lake (1994) and Adamu (2003, p. 1) refer to it as "curriculum integration". Björklund and Ahlskog-Björkman (2017, p. 98) use the term "thematic work" to describe an approach that enables learners to experience mathematics in their daily lives and connect their lived experiences to the mathematics learnt at school. Adler, Pournara and Graven (2000, p. 3) identified three levels of integration, namely: (i) integration of the various components of mathematics; (ii) integration between mathematics and everyday real-world knowledge; and (iii) integration across learning areas. In terms of Mathematics as a subject or learning area, I conceptualised four aspects of integration in the Foundation Phase teacher education programme. These were: i) integration of concepts within the Mathematics learning area; (ii) integration of Mathematics with the Language learning area; (iii) integration of Mathematics with the Life Skills learning area; and (iv) connection-making (which refers to a holistic view of learning areas and subject content).

1.6.1.1 Integration of concepts in the Mathematics learning area in teacher education

Many concepts in Mathematics as a school subject cut across different content areas. For example, the Department of Basic Education (2011b) prescribes the following content areas for Mathematics in the Foundation Phase:

- Numbers, operations and relationships;
- Patterns, functions and algebra;
- Space and shape (geometry);
- Measurement; and
- Data handling.

The figure below from the collage illustrates this integration of mathematical concepts.

Figure 1.3: Image of the dining area in a restaurant

In the above picture, the floor tiles represent tessellation (a tiling pattern) and 2-D shapes, thus illustrating how mathematical concepts are unconsciously integrated into everyday life. For example, the content area of patterns, functions and algebra links with the space and shape content area. If Foundation Phase teachers understand how mathematical concepts are integrated into everyday life, they can consciously guide learners to embrace and use mathematics as part of their lived experiences. According to the Teachers' Guide for the Development of Learning Programmes (Department of Education, 2003), "…integration must support conceptual development rather than being introduced for its own sake" (p. 6). The content areas thus depend on and thoughtfully support one another. For example, learners can develop number concepts in measurement and data handling lessons (DoE, 2003).

Because learning through play is an essential focus of learning in the Foundation Phase, teachers can plan structured play activities to ensure that content areas in the Mathematics learning area are not only taught independently. Hughes (1986) asserts that playing simple games helps stimulate and motivate young learners. For example, exciting shapes and arrangements can reinforce learners' understanding of multiplication number facts. Playing games with dice or cards can help them acquire necessary skills in contexts and through meaningful and enjoyable way (Hughes, 1986). When teaching fractions, teachers can use concrete objects such as 3-D and 2-D shapes to reinforce geometry. Number patterns are also an excellent example of how integration can help learners develop the concept of numbers naturally. Making associations among various illustrations associated with mathematics and shifting between representations, words, drawings and objects are crucial activities for learners in the Foundation Phase (Delaney, 2010). Therefore, as a teacher educator, I needed to enhance connection-making among different mathematics representations.

1.6.1.2 Integrating Mathematics with the Language learning area in teacher education

The Language learning area forms the basis of other learning areas because it is the vehicle that facilitates learning (DoE, 2003). The use of language in all the learning areas helps learners grasp the concepts communicated to them. For example, Hughes (1986) conducted research to explore language use in solving mathematical problems. The findings revealed that when learners were asked hypothetical "shopping" questions, they could provide correct answers. However, the learners "experienced problems when words and phrases such as 'make', 'take away', 'difference', and 'goes into' were used" (Hughes, 1986, pp. 42-43). Therefore, learners should be supported to apply reasoning skills using language. This will enable them to be more efficient in using language as "a tool for working on mathematics problems together" (Mercer & Sams, 2006, p. 509). Thus, it is vital that in my teacher education practices, I encourage Foundation Phase pre-service teachers in using appropriate language to mediate the learning of early childhood mathematics.

A useful tool in achieving integration is theme work, as illustrated in Figure 1.5.

Figure 1.4: Image of stones and the word "themes"

The word 'themes' depicted in the above picture illustrates how thematic work can facilitate mathematics learning. I wanted to encourage pre-service teachers to participate in activities where they could express themselves aesthetically and linguistically while mathematics formed an integral part of these activities. Björklund and Ahlskog-Björkman (2017) show that making sense of the surrounding world is an essential objective of learning and should be facilitated by integrating knowledge areas in thematic work. The writing on the wall in Figure 1.5 depicts the integration of language and mathematics. This is how young learners view the world, and therefore I was conscious that I should make this viewpoint visible to pre-service teachers.

1.6.1.3 Integrating Mathematics with the Life Skills learning area

The Life Skills learning area in the Foundation Phase is concerned with the holistic development of the child. It includes study areas such as "beginning knowledge and personal and social wellbeing; creative arts; and physical education" (DBE, 2011a, p. 9). The CAPS

document for the Foundation Phase prescribes that "the formal application of one or more of the art elements should be incorporated into each visual art lesson" (DBE, 2011a, p. 9). For example, teachers can help learners discuss lines, shapes, and colours in a visual art activity. This enhances the integration of the Languages, Mathematics and Life Skills curricula as learners get opportunities to talk about and explore 2-D shapes and 3-D objects. Young learners can also use their bodies in physical education lessons when playing games such as hopscotch. To execute this game, square and circular shapes are drawn on the ground and children hop and skip from one shape to the next. While playing, their counting competences can also develop.

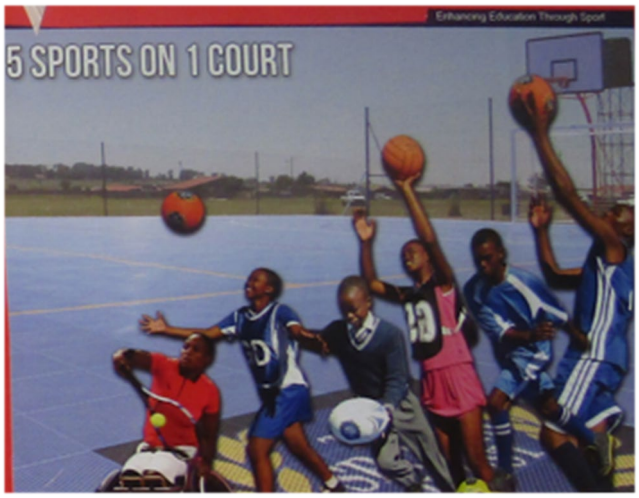


Figure 1.5: Image of learners playing sport

The picture above of the learners at play (Figure 1.5) suggests how, while they are playing, children learn and develop knowledge and abilities. In the Foundation Phase, it is imperative that teaching and learning address the holistic development of children. Gordon and Browne (2014) note that it is essential for young learners to grow physically, socially, emotionally and cognitively (intellectually). I believe that Foundation Phase learners can acquire language proficiency by engaging in games in developmentally appropriate contexts. I realised that I should bring this awareness into my practice for pre-service teachers to see the value of the skills and competencies that young learners acquire through play. The Foundation Phase curriculum emphasises physical health and gross and fine motor development skills to ensure young learners' overall well-being. To allow their motor skills to develop, children need to experience new opportunities to explore and investigate the world around them (Sigelman & Rider, 2006). To reflect on this requirement, the caption that I attached to the above figure, namely "Sowing seeds", is a metaphor for how I planned to engage my pre-service teachers in

experiencing appropriate pedagogical approaches. The "seeds" would be "sowed" by using different techniques and resources.

Figure 1.6: Illustration of the phrases: "sowing seeds" and "dignity and development"

In the context of an integrated learning approach, the phrase "dignity and development" underscores the need to acknowledge the dignity of children. Teachers should appreciate the diverse contexts from which children come and be aware of what they bring to the classroom. Likewise, I needed to acknowledge my student teachers' dignity by treating them as knowledgeable and valuable human beings rather than as "empty vessels that need to be filled". A solid foundation for future learning can be established by acknowledging experiences and perceptions significant to learners and pre-service teachers. For example, hands-on activities that link prior knowledge and experiences to the prescribed curriculum can enhance learning.

1.6.1.4 Making connections holistically

In our interaction with objects in our environment, the world we live in is connected to our everyday lives. Schuck and Pereira (2011) point out that mathematicians do not regard school mathematics as a set of rules detached from physical objects and everyday life. On the contrary, mathematics is substantially tangible and attached to our daily experiences.

Figure 1.7: Illustration of the phrase "The right blend"

The caption "The right blend" signifies how mathematics can be connected to learners' and pre-service teachers' everyday lives. Mwakapenda (2008) argues that making connections of mathematics with everyday life experiences can be accomplished through mathematical modelling. I recognised that I needed to assist pre-service teachers in developing and building "awareness of the important role that mathematics plays in real-life situations, including the personal development of the learner" (Department of Basic Education, 2011b, p. 9). According to Adamu (2003, p. 3), "curriculum integration focuses on making *learning reflect life* so that students see the value of what they are being taught". Adamu (2003) notes that, as human beings, we learn through making connections. Therefore, we need to teach by making

connections. I appreciated that it was thus vital for me as a teacher educator to encourage an understanding of making connections in early childhood mathematics teaching and, in this process, to harness my pre-service teachers' everyday experiences.

1.6.2 Concept B: Early Childhood Mathematics

Mathematics is often viewed as a complicated subject that is not easily accessible. Schuck (2002, p. 331) articulates that pre-service teachers often believe that one has to have a "mathematics brain" to be able to do mathematics and that mathematics is for "clever" students. Similarly, Lee (2014) contends that learning "difficult" subjects such as mathematics is affected at varying levels by the sociocultural backgrounds of learners and teachers. Pre-service teachers' and Foundation Phase learners' understanding of mathematics, their ability to solve problems and their attitude towards mathematics are all shaped by their encounters inside and outside the mathematics classroom. Therefore, I needed to raise pre-service teachers' awareness of the different sociocultural factors that could affect how they teach and respond to learners and how they see themselves in mathematics (Naudé & Meier, 2016).

Teacher educators of Foundation Phase pre-service teachers may consider diverse ways of representing mathematics concepts in their teaching. Human, van der Walt, and Posthuma (2015) note that pre-service teachers should appreciate how learners can be supported to construct mathematical concepts that broaden their knowledge and appreciation of mathematics. These authors argue that pre-service teachers "should recognise the social conditions in which learners grow up, be able to promote holistic development in the mathematics classroom, and have a thorough knowledge of learners and how they learn mathematics in the Foundation Phase" (Human et al., 2015). There is thus "widespread agreement that the knowledge teachers require for teaching mathematics is more than a sound content knowledge of mathematics itself" (Pournara et al., 2015, p. 2). Hence, it is fundamental to prepare pre-service teachers adequately to teach young learners mathematics by encompassing social knowledge and mathematical knowledge in my pedagogic practice.

In South Africa, the Foundation Phase curriculum highlights the competencies that young learners need to acquire in each of the five mathematics content areas: numbers operations and relationships, patterns, functions and algebra, space and shape, and measurement and data handling (DBE, 2011). As noted by Tsamir, Tirosh, and Levenson (2011), early childhood mathematics teachers' "knowledge and conception of number operations, measurement, and

patterns" call for development. Therefore, pre-service teachers should understand this content and be able to use it appropriately. Tsamir et al. (2011) acknowledge that teacher educators should include all these essential aspects when preparing young children's prospective teachers. Pre-service teachers should understand that, before young learners enter formal school, they have already acquired various concepts relating to numbers, patterns, space and shape. For example, focusing on the logic of patterns lays the foundation for developing algebraic thinking skills. Thus, consideration of learners' natural curiosity as an opportunity to make them aware of patterns in their natural surroundings is vital, as is illustrated by the picture of the building in Figure 1.9 below. In my teaching of mathematics content areas, I also needed to consider what pre-service teachers already knew and enhance their interests, to model what they would have to do for their learners one day.

Figure 1.8: Collage representing the concept of Early Childhood Mathematics

Figure 1.19: Image of the shape of windows in a building

Understanding fundamental mathematical concepts is an essential foundation for teachers of mathematics. Schuck (2002) contends that pre-service teachers must understand the concepts underlying any of the activities they will develop for their learners when they start teaching. The concepts of space and shape are depicted in Figure 1.10, where two children help each other build a structure using blocks. This is a vital play activity, as playing with blocks "can contribute to children's spatial reasoning, knowledge of geometric shapes, numerical knowledge, and problem-solving skills" (Ramani & Eason, 2015 p. 29). Affording learners opportunities to engage in activities that involve multi-sensory experiences such as physically touching objects, creating movement with their bodies and playing outdoors can stimulate their thinking and help them grasp mathematical concepts (Samaras, 2002). For example, teachers can let learners climb into boxes when teaching the difference between 2-D shapes and 3-D objects. This may help them easily remember that a 3-D object has space or dimensions in which you climb or put something. Figure 1.10 below also depicts activities for teaching the concept of 3-D objects. I needed to challenge myself to work with pre-service teachers to physically engage learners in grasping mathematical concepts.

Figure 1.10: Image of children playing with building blocks

Co-operative learning can facilitate an understanding of mathematics. Alderton (2008) suggests that pre-service teachers need to work collaboratively in groups to practically explore and cultivate a personal sense of mathematics. Alderton (2008) also argues that pre-service teachers "require experience in problem-solving and open-ended mathematical activities across a range of relevant contexts that offer prospects for decision-making and communication". Therefore, I recognised that I should continuously think about affording my pre-service teachers opportunities to work in groups and develop mathematics problem-solving skills.

Figure 1.11: Illustration of the phrases "Playing games" and "Taking it outside"

In my efforts to improve my teaching practice, I wanted to be an agent of change and design approaches that would give my pre-service teachers formative mathematics experiences. Pereira (2005) believes that the initial step that mathematics teacher educators need to take is to reform their teaching practices. This can change the way pre-service teachers experience and learn mathematics. I saw that one way to do this could be to incorporate play into early childhood mathematics teacher education. When teaching mathematics, making connections by playing games can maximise the learning of mathematical concepts, and this learning can occur in a fun, relevant and meaningful way. Dockett and Perry (2010, p. 717) claim that "teachers who facilitate children's play and who are aware of the nature and complexity of that play are well positioned to build on children's existing knowledge and understandings – another tenet of childhood curriculum and pedagogy". Figure 1.11 ("Playing games" and "Take it outside") signifies the importance of playing games for young children's learning. Pradhan (2018) claims that games help learners and students develop quick decision-making skills and logical thinking and reasoning, which are the foundations of mathematics learning. I aimed to involve pre-service teachers in different play activities and games to strengthen mathematics education in Foundation Phase classrooms (Ramani, Siegler, & Hitti, 2012). On the point of stimulating learners' mathematics learning, Harris (2007, p. 151) argues that early childhood teachers "need to be playful teachers" who can think creatively. I aspired to become a more playful teacher educator.

1.6.3 Concept C: Teacher educator learning

By taking a self-study stance during this research, I anticipated encountering both challenging and rewarding experiences. Human, van der Walt and Posthuma (2005) draw attention to how professional development activities can support teachers' life-long learning. Figure 1.12 illustrates my understanding that teacher educators should also be life-long learners.

Figure 1.12: Collage depicting teacher educators as life-long learners

Figure 1.12 visually illuminates what I understood about teacher educators as life-long learners who seek to enhance their idea of self. By engaging in a self-study project, I anticipated that I would learn about myself while working with pre-service teachers who were also on a self-discovery journey. Henderson (2012) describes 'self-concept' as an idea that incorporates efficiency and adeptness. I saw it as essential to reflect on my thoughts and practices and learn from my teaching experiences while constructing knowledge about teaching pre-service teachers (Goodell, 2011). Figure 1.13 depicts that the focus of the self-study approach was on me and that I had taken the first step in becoming an agent of change. According to Samaras (2011), self-study endorses the practitioner's experiences by validating that a researcher's personal and professional voice matters. This is contradictory to the more conventional and largely impersonal manner in which education research is often conducted and reported (Nash, 2004). Thus, as discussed in Chapter Two, I saw that employing novel modes of research and writing could advance my self-study.

Figure 1.13: Image of a red arrow representing "self" and the phrase: "Take the next step"

Teacher educator learning and self-study require collaboration with and learning from others. Samaras (2010) highlights the value of collaborative work among colleagues who bring knowledge and competences with them when they explore phenomena that they want to understand better through collective activity. An illustration of this view is exemplified in Figure 1.14. Likewise, in her attempts to improve her practice, Alderton (2008, p. 100) recognised that "collaboration with others was a fundamental aspect of the methodology of self-study", particularly as a teacher educator. I thus regarded myself as a learner who needed to learn from and with others.

Figure 1.14: Image of a teacher assisting students

While I was reflecting and reading about the need for teacher educators to learn, I realised that such a journey would be difficult, but I also discovered that I would not be alone as a "learner". It was heartening to note how teacher educators engaged with other self-study researchers who played the role of critical friends. Samaras (2011) contends that self-study researchers work with others through critical collaborative inquiry in a supportive and safe environment to enhance their teaching practices. Similarly, McGlynn-Stewart (2010) points out that critical

friends offer emotional and practical support for others to grow. I saw how critical friends could provide invaluable support and feedback and contributed to each other's development. In Chapter Eight and Nine, I describe the significance of critical friends in detail and demonstrate how they contributed to my learning as a self-study researcher.

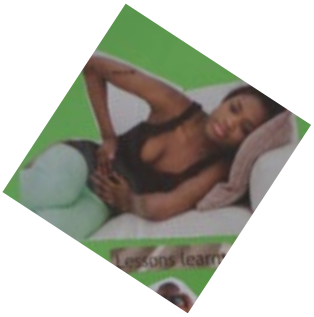


Figure 1.15: Image of a girl lying on a couch feeling discomfort

My reading about others' self-study experiences clearly revealed that it may not be easy to expose your ideas and practices to others. You may develop feelings of discomfort when being challenged or critiqued. This discomfort is depicted in Figure 1.15. As Schuck (2011) notes, critical friendship does not have to be easy and comfortable all the time for it to be useful so that the reframing of practice and assumptions can occur. However, critical friends can support and encourage one another. Clarke and Erickson (2003, p. 5) contend that teacher educators who inquire into their practice with others receive "benefits from the support of colleagues engaged in similar enterprises and the scrutiny of the wider education community". Thus, it is valuable and beneficial to have collaborative spaces where we can grow together to improve our practice. As a teacher educator and self-study researcher, I saw that I should work with colleagues to reflect on our practices and embrace critical advice to change for our students' benefit.

Because I had chosen a self-study project, I needed to focus on my own self-concept as a teacher educator. One of the prominent self-efficacy researchers, Roy Baumeister (1999), defines self-concept as the individual's belief about oneself, including understanding one's attributes and knowing who and what the self is. Therefore, I saw that building and understanding my own self-concept would have implications for my learning. I could not help enhancing my pre-service teachers' self-concept if I did not develop my own. Schwarz and Ray (2018, p. 52) maintain that "teachers need to take a critical look at what they are doing … to improve their own practice and sense of self-efficacy". Thus, I needed to unpack some personal

baggage of learning mathematics to improve my teacher education practice. This is elucidated in Chapter Three.

1.7 A Sociocultural Theoretical Perspective

To foster meaningful learning experiences, teacher educators must articulate their knowledge of teaching practice informed by theory and firmly grounded in particular contexts (Goos, 2014). They must exhibit expertise and embrace uncertainty as they explore new ideas and methods in their teaching (Samaras, 2011). According to Lake (1994), the drive towards an integrated curriculum is embedded in learning theorists' arguments that promote a sociocultural view of learning. In moving towards an integrated learning approach, I began by exploring Vygotsky's sociocultural perspective (as shown in Figure 1.16). John-Steiner and Mahn (1996) explain that Vygotsky's sociocultural perspective is based on "the concept that human activities take place in cultural contexts, are mediated by language and other symbol systems, and can be best understood when investigated in their historical development" (p. 191).

Figure 1.16: Collage depicting a sociocultural theoretical perspective

Figure 1.17 and Figure 1.18 depict the notion that it is vital to consider learners' contexts and cultures because social and cultural influences shape their development (Samaras, 2002).

Dimitriadis and Kamberelis (2006) note that Vygotsky's sociocultural theory also suggests that "…parents, caregivers, peers and the culture at large are responsible for developing higher order functions" (p. 192). This means that children's thinking is shaped by their knowledge of and from the social community. As such, Vygotsky's sociocultural view of learning emphasises a requirement for more knowledgeable other people at home, in schools, and in communities. These could be parents, adults, teachers, coaches and even children's friends (Dimitriadis & Kamberelis, 2006). In changing my practice, I needed to incorporate how social and cultural contexts could stimulate early childhood mathematics learning.

Figure 1.17: Image of a child learning from an adult

"How long will it take you to walk around the world?"
Figure 1.18: Images of learners learning together

Figure 1.18 (right) depicts how children learn from one another through experience. Early childhood teacher educators must note the knowledge that pre-service teachers and young learners bring into the classroom. Likewise, Alderton (2008, p. 97) states: "I am an advocate of the view that children and students actively construct knowledge rather than passively receive it from the environment and that *coming to know* is a process of adaptation that is constantly modified by a learner's experiences of the world". To improve my practice, I wanted to get pre-service teachers actively and vigorously involved in the processes of coming to know.

The picture of a boy with the caption: “Little kids, big questions” (Figure 1.19) denotes how schoolchildren can pose helpful questions and solve problems. Goos (2014) alludes to Vygotsky’s sociotheoretical approach: it involves higher mental functions’ social origins. Vygotsky introduced the idea of the proximal development zone that explained how the interaction of a child with an adult arouses cognitive functions that are still developing (Goos, 2014). Thus, educators need to allow learners to talk, ask questions, and engage in activities to develop cognitive functions. Opportunities may be provided for them “to participate and regulate problem-solving activities, but [this should occur] within a level of cognitive understanding in relation to the difficulty of the task” (Samaras, 2002, p. 81). I appreciated that I should offer preservice teachers experience in problem-solving and open-ended activities that would provide possibilities for questioning and decision making (Alderton, 2008).

Figure 1.19: An image of a boy wearing big glasses

A distinctive feature of a sociocultural theoretical perspective is that it does not separate individuals from their cultural settings. According to Samaras (2002), Vygotsky argued that culture is an integral part of each person’s makeup and that individual learning and development are “connected to the social and cultural world in which individuals grow up” (p. 41). To illustrate this point, women wearing traditional attire in Figure 1.20 embody cultural heritage as a learning resource. Gerdes (1988b) comments on how student teachers develop mathematical ideas and practices in and about their own and their prospective learners’ cultural environments. Further, Björklund and Ahlskog-Björkman (2017, p. 101) state that “the communication and mediation of meaning intended by teachers in pedagogical activities are key features of the inquiry whereby cultural tools are considered to shape cognitive processes”. Teachers and teacher educators need to consider cultural tools for teaching as they are fundamental in the teaching and learning process. Therefore, in preparing pre-service teachers

to understand how young learners learn, I needed to engage them in experiencing how learning is mediated through tools.

Figure 1.20: Image of women wearing traditional attire

A sociocultural theoretical perspective highlights the fundamental role of working together and collectively making sense of personal experiences (Taylor, 2014). Put simply, this is based on the principle that understanding is socially motivated by the people that we come into contact with (Dimitriadis & Kamberelis, 2006). Therefore, as a teacher educator, I needed to be consciously thinking of the means I could employ to ensure that pre-service teachers would get ample opportunities for working together and drawing on each other's experiences.

1.8 Conclusion and Overview of the Thesis

Chapter One: In this chapter titled '*First steps into unknown waters',* I provided an overview of the study. The heading is a metaphor for the first tentative steps that I took when I embarked on this self-discovery journey. I explained why I was interested in undertaking this research, and I discussed the focus and purpose of the study. As a teacher educator, I intended to learn as much as I could about implementing an integrated learning approach for teaching mathematics in the early childhood phase. To orientate the reader, I explained the background of the integration of subjects in the Foundation Phase. I then briefly introduced the methodological approach that I followed, and I explained why the self-study research approach was appropriate for my study. Furthermore, I presented the research questions that guided the study. I also explained my initial understanding of the three main concepts that underpinned this study, namely: (i) the integrated learning approach, (ii) early childhood mathematics, and

(iii) teacher educator learning. I introduced and discussed the sociocultural theoretical perspective that informed my thinking about the study.

Chapter Two: This chapter is titled '*Time to Start Paddling'.* The chapter elucidates the research methodology that I used to explore the integrated learning approach for teaching and learning mathematics in a pre-service context, focusing on the Foundation Phase (FP) as the entry phase in education. The chapter delineates the start of my doctoral journey and maps out how I intended to execute this project. I elaborate on why I chose a self-study methodology and then describe the research setting and the research participants. I emphasise my dual position in this project as a researcher and a participant. I explain how I worked with pre-service teachers and describe the steps that I took to cultivate an understanding of the integrated learning approach for teaching mathematics in early childhood. I also explain my critical friends' role and describe their contribution to my growth as a teacher educator throughout the research process. Next, I describe the research practices that I used to generate data such as artefact retrieval, collage making, journal writing, taking and analysing photographs, memory work, audio recorded lesson presentations, and audio recorded presentations to my colleagues (i.e., my critical friends). I also explain what I learnt by working with critical friends, fellow doctoral students, and my supervisor. I describe how this helped me respond appropriately to the research questions and make meaning of the data. Then, I explain how I addressed ethical issues in the study. In conclusion, I highlight the challenges that I encountered during the study process and explain how I overcame these.

Chapter Three: I titled this chapter '*The Echoing Sea',* a metaphor for my history as an early childhood mathematics teacher. I use this metaphor to describe my life history and illuminate my reflections on how I learnt mathematics. I address the first research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with my memories?* I commence the discourse by tracking my personal experiences of early mathematics as I grew up in a township. I then reflect on and record recollections of my experiences of acquiring mathematical concepts as a child. I recall my experiences of learning mathematics when I was in primary and high school through memory drawings. I also describe and analyse the photographs that I took to make meaning of my childhood memories of developing mathematical concepts. When reflecting on my memories, I contemplated their influence on my educational journey and what I had learnt about myself as a learner, teacher and teacher educator.

Chapter Four: This chapter is titled '*Getting my Feet Wet',* a metaphor describing my initial attempts to trial an integrated learning approach to teaching early childhood mathematics. I address the second research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* I describe how I worked with a pre-service teacher class in a pilot project at the inception of my self-study project. I show how I used arts-based methods such as creating collages and concept maps to pilot the integrated learning approach. I reflect on the participating pre-service teachers' evaluation of their experiences and understanding of an integrated learning approach. I also deliberate on encouraging pre-service teachers to use an integrated learning approach to teach mathematics in the Foundation Phase. I conclude this chapter with my thoughts on what I learnt in trying this approach for the first time. I acknowledge that I had to abandon my comfort zone and learn from a vulnerable position, a new and frightening experience.

Chapter Five: The title of this chapter is '*Keeping my Head Above Water'.* This metaphor underscores the challenging encounters I experienced in implementing the integrated approach concept when teaching a second, larger pre-service teacher class. I describe the second research question's outcomes, and I elaborate on the dynamics that impacted the findings when I worked with a larger group of pre-service teachers. I realised that the journey on which I had embarked was not smooth sailing. Still, I acknowledge that the choice of using an arts-based approach was an advantage because my pre-service teachers relished the challenges. It made learning mathematics and methods of teaching fun and accessible.

Chapter Six: This chapter's title is '*Boarding a boat and drifting out to luminous seas'*. This metaphor reflects how I came to an understanding of the impact of the integrated approach on my pre-service teachers. Based on my observations of their successful knowledge of basic mathematical concepts and processes, I was able to broaden the cultivation of an integrated approach for teaching and learning mathematics in early childhood teacher education. I explored the use of cultural artefacts with a third group of pre-service teachers. I give an account of the pre-service teachers' feedback and evaluations, as well as my learnings. Their ability to recognise and apply mathematical concepts based on diverse cultural objects was inspiring.

Chapter Seven: The title for this chapter is '*Watching the Ebbing Tide'.* This metaphor

characterises my growing confidence in exploring an integrated learning approach using arts-based methods. I explain how I extended my teaching practice by engaging my pre-service teachers in extramural activities. During this time, pre-service teachers and I made drawings that represented our early childhood mathematics learning. To enhance this learning and illumination process, we also played various board games, which allowed me to get to know my pre-service teachers at a more personal level. The sociocultural theoretical perspective allowed me to venture into self-study methods that sought to evoke my memories and students' learning and improve my practice as a teacher educator. I learnt that focusing solely on pre-service teachers' cognitive development is insufficient.

Chapter Eight: The title of this chapter is '*Putting my Head Under the Water'.* I recall the unpleasant feelings that I experienced initially when I received feedback from my critical friends. I recount how I addressed the third research question: *What can I learn about cultivating an integrated learning approach from working with critical friends?* I commence the discourse by clarifying the role that my critical friends played throughout the study, and I demonstrate how I presented my data and findings to them at different times during the project. I then evaluate the discussions that I had with my critical friends. The conversations with critical friends gave me another way of looking at myself and my work. I conclude this chapter by reflecting on what I learnt from my engagement with these critical friends and presenting the collage that I had created. I found that this process was always worthwhile. I deeply appreciated the feedback that I received from my critical friends, and I shall be grateful for their inputs for as long as I live. All in all, I was fortunate in that I could learn from and with others.

Chapter Nine is titled '*Swimming the Tide'.* This metaphor symbolises my appreciation of the opinions and ideas that my fellow doctoral candidates shared as self-study researchers in teacher education. I addressed the third research question again: *What can I learn about cultivating an integrated learning approach from working with critical friends?* I give an account of my fellow doctoral candidates' and our supervisor's engagement and clarify the different activities we engaged in. Through this process, I acquired assistance to develop my writing as a self-study scholar. I gained confidence through working with my colleagues, who gave me honest and constructive feedback.

Chapter Ten is titled '*Watching the Rainbow After the Rain'.* This metaphor epitomises the

feelings of accomplishment and gratitude that I experienced in this study and upon completing the thesis. The chapter presents the main conclusions, summarises the thesis, and offers reflections on the lessons learnt. I conclude that an integrated learning approach is critical in teaching mathematics and is vital in allowing pre-service teachers, and ultimately their future learners, to make various connections between experiences to learn meaningfully. I acknowledge that my exploration of this innovative approach was a liberating experience because it gave me a different outlook and illuminated exciting new prospects for me as I continue on my journey of teaching early childhood mathematics teacher educators. I reflect on the educative value of creating and presenting my thesis using collages and metaphors. I position the thesis itself as an artefact of the integrated approach to mathematics teaching in early childhood and in teacher education.

CHAPTER TWO: TIME TO START PADDLING

Learning entails a number of steps and requires diligence in addressing those steps

Karran Thorpe

2.1 Introduction

This study aimed to advance my teacher education practice by exploring an integrated learning approach towards teaching mathematics to Foundation Phase (FP) pre-service teachers. As a teacher educator, I examined my teaching practice involving pre-service teachers in an undergraduate programme. I also aspired to contribute to teaching practices in general and to enrich the discourse on teacher education.

In the previous chapter (Chapter One), I explained why I was interested in undertaking this self-study project. I offered an initial explanation of pivotal concepts: "integrated learning approach", "early childhood mathematics", and "teacher educator learning". I also discussed the sociocultural theoretical perspective that assisted me in understanding the findings of this research study.

The title of this chapter, 'Time *to Start Paddling',* is a metaphor representing the process of this undertaking and embodies all the research activities that I executed. Thorpe (2004, p. 339) proclaims, "Learning entails a number of steps and requires diligence in addressing those steps". This quotation is appropriate as it captures how my journey unfolded. These words validate that, no matter how long the voyage was, I needed to be inspired to soldier on, embrace the astonishments and unexpected moments, and welcome the lessons I gained. Paulo Freire's words, "I research because I notice things, take cognisance of them" (Freire, 1998, p. 35) also inspired me to learn from my research and to welcome the unforeseen predicaments on this journey.

This chapter (Chapter Two) provides a detailed description of the self-study methodology that I employed and highlights why I found it appropriate. I explain how I applied the practices, procedures, and guidelines of a self-study project. I also explain how this methodology assisted me in responding to the research questions. I also describe the research setting, my dual position as a research participant and doctoral student engaged in learning, as well as the participants involved in my study. I explain the data generation, data analysis and interpretation methods. I

also illuminate the ethical considerations and how I attended to this study's trustworthiness. The last section of this chapter deals with the challenges that affected my research.

2.2 Research Methodology

A research methodology is about 'how we come to know'. Thus, Henning, van Rensburg and Smit (2004) affirm that methodology involves particular ways that we can use to understand our world better. Similarly, Cohen, Manion, and Morrison (2009) explain that research methodology aims to describe approaches to the study and the paradigms of an investigation. My study was located in an interpretive research paradigm with a focus on personal inquiry. Bertram and Christiansen (2015) argue that interpretivists seek to understand the meaning that informs human behaviour. This study was in line with this proposal as it aimed to enhance my understanding and practices of an integrated learning approach.

Appropriate methodological processes to drive a scholarly investigation are crucial. I chose the self-study approach to interrogate educational practices in this study. LaBoskey (2004) defines self-study methodology as "a stance that a researcher takes towards understanding or explaining the physical or social world" instead of a way of knowing or doing research (p. 1173). According to Samaras and Freese (2006, p. 56), the self-study methodology incorporates "a body of practices, procedures and guidelines used by those who work in a discipline or engage in an inquiry". For Pinnegar and Hamilton (2009), self-study is a research methodology that allows researchers and practitioners to use different kinds of methods that provide the needed evidence and context to understand their practice. I aspired to improve my approaches to strengthen my work in this self-study research. Hence, the self-study methodology was best suited for me because it allowed me to pay attention to my experiences as I explored the integrated learning approach. Moreover, these experiences helped me better understand how I could improve to enrich my students' learning. I hoped that this would equip them to teach mathematics to make sense to their prospective learners.

Self-study methodologies benefit 'the self' in a research project by acknowledging that focusing on the self can be a factor in our understanding of teaching and teacher education (Pinnegar & Hamilton, 2009). This sense of self underpinned my endeavours of examining and improving my practices in teacher education. Additionally, as Dinkelman (2003) states, through this self-study research, I was able to illuminate how I acquired new knowledge about

enriching the integrated learning approach and how the research process enhanced my understandings of how teacher education works to enrich professional learning.

2.2.1 Self-study research

My understanding of self-study research was informed by various scholars' seminal work (LaBoskey, 2004; Samaras & Roberts, 2011; Samaras, 2011; Pithouse, Mitchell & Weber, 2009). These scholars all assert that self-study research allows the researcher to examine her own lived practice while working collaboratively with other colleagues. They acknowledge that even though the self is central, self-study researchers endeavour to involve students and colleagues in the study process (LaBoskey, 2004; Samaras & Roberts, 2011). Self-study researchers' main objectives are to "analyse and improve their practice" (Lovin et al., 2012, p. 53), and also to add knowledge to the field. Similarly, Samaras and Roberts (2011) emphasise that "in self-study, teachers critically examine their actions and the context of those actions as a way of developing a more consciously driven mode of professional activity" (p. 43). As a result, self-study focuses on how individual practice can be enhanced for teacher education (Schuck, 2002). In choosing a self-study approach, I sought to improve my practice by interrogating the integrated learning approach towards early childhood mathematics teaching. The statement below by Hamilton and Pinnegar (1998, p. 236) appropriately captures my undertaking of this self-study project:

> The study of one's self, one's actions, one's ideas, as well as the 'not self'. It is autobiographical, historical, cultural, and political and it draws on one's life .... Self-study also involves a thoughtful look at texts read, experiences had, people known and ideas considered. These are investigated for their connections with and relationships to practice as a teacher educator.

One way of comprehending the ethos of self-study is by understanding its characteristics. As mentioned in Chapter One, my understanding of self-study research was informed by Samaras' (2011) assertion that a five foci framework was designed, enhanced and broadened by self-study scholars to be applied in self-study projects. This framework comprises the following methodological components: (a) personal situated inquiry; (b) critical collaborative inquiry; (c) improved learning; (d) a transparent and systematic research process; and (e) knowledge generation and presentation (Samaras, 2011, p. 70).

Next, I elaborate on how these methodological components framed my study.

2.2.1.1 Personal Situated Inquiry

Personal situated inquiry indicates that self-study researchers initiate their investigation and apply self-study methods to be linked with that inquiry (Loughran, 2004). Because self-study is self-initiated, the focus is on the self with the goal of self-improvement (LaBoskey, 2004). I thus considered the research questions as well as the context of the study within this frame. Samaras (2011) notes that undertaking this step means the research project originates with a self-initiated inquiry. Given that personal experience is regarded as an essential foundation of self-study knowledge, my voice would count. As a teacher educator, I had the opportunity to integrate my research into my teaching practice setting, my classroom. Samaras and Freese (2006, p. 40) state that situated inquiry "begins with your inquiry and is driven from your questions situated in your particular context". Therefore, I discussed the classroom context and the strategies I used to enact an integrated learning approach with my pre-service teachers. Bullough and Pinnegar (2001, p. 15) assert :

> While self-study researchers acknowledge the role of the self in the research project, … such a study does not focus on the self per se but on the space between self and the practice engaged in. There is always a tension between those two elements, self and the arena of practice, between self in relation to practice and the others who share the practice setting.

Correspondingly, LaBoskey (2004) reminds teacher educators that they have a pedagogical responsibility to continuously monitor their progress and justify the pedagogies they use. By undertaking this approach, I strived to link my pedagogy and my self-study research methods.

2.2.1.2 Critical collaborative inquiry

Learning through various interactions with others in self-study is essential. In their intentions to improve practice, self-study researchers work with an intellectually safe and supportive community (Samaras, 2011). Pithouse-Morgan and Samaras (2017, p. 35) note that "learning, thinking, and knowing arise through collaboration and re-appropriating feedback from others and a willingness to learn with and from each other". As shown in Chapters Eight and Nine, learning from colleagues through collaboration helped me as a self-study researcher. Nicol (2011) uses the term "multi-party collaborative self-study" for teacher educators who frequently meet to deliberate on their perceptions, questions and understandings of their

practices. During my study, I worked together with colleagues from different disciplines who encouraged and supported me throughout the research process. Schuck (2002, p. 328) maintains that various perspectives "are brought to the situation by students and colleagues". In some instances, I found that my colleagues' critical views were upsetting, but this was part of my growth as I reflected on the truth of what they said. This view is also highlighted by Schuck (2011), who claims that to improve our teaching, we must go beyond the comfortable. The conversations in critical collaboration have ultimate advantages considering that the researcher values constructive feedback that comes with them. The conversations I had with my colleagues assisted me in implementing new ideas to improve my pedagogy.

Scholars worldwide work together towards a common research goal. Lovin et al. (2012) found it interesting that a group of mathematics teacher educators from different contexts who collaborated in research found all their students grappled with similar problems at various levels. This highlights the imperative role of collaborative self-study concerning best practices in mathematics teacher education. Dinkelman (2003, p. 14) notes that, by sharing "mutual goals in the same teaching and learning space, all members of a teacher education programme bring knowledge and understandings [that are] unique to their own experiences". In their project entitled "*Thinking in space*", Pithouse-Morgan and Samaras (2017) shared the challenges and rewards of e-learning and found that they encountered similar dilemmas regardless of discipline. Therefore, collaborative self-study helps teacher educators move beyond the individual towards the group by exemplifying the power of examining and reflecting on other teacher educators' beliefs and practices (Lovin et al., 2012). In this study, I worked collaboratively with scholars in my discipline − scholars from different higher education institutions grappling with mathematics projects and scholars from other fields. Together we formed an interdisciplinary self-reflective research support group and also collaborated in different spaces such as national conferences.

2.2.1.3 Improved learning

The culture of improved learning ought to be maintained by self-study practitioners in their quest to develop as self-study scholars. Samaras (2011) asserts that self-study researchers question their teaching and the broader belief systems to improve and influence learning for themselves, their students and the education domain. As noted above, the collaborative element of self-study enables researchers to concentrate on self, and thus, by interacting with their colleagues, they improve their learning (Hamilton et al., 2008). Additionally, Chisanga and

Meyiwa (2020) assert that the self-study methodology brings novelty to research and possibly helps more researchers improve their practices. As a teacher educator, I embarked on this study to attempt a new approach to early childhood mathematics teaching.

In my endeavours, it was essential to consider that learning does not merely involve the cognitive domain. For example, Schuck and Perreira (2011) reveal that we need to recognise that both the teaching and learning of different subjects have an emotional side. Our understanding is shaped and affected naturally by our environment – "a network of social, cognitive, psychological, emotional, and physical factors" (Samaras, 2011, p. 79). Hence, to improve my learning, I acknowledged my pre-service teachers' backgrounds and the roles played by their families and communities in enhancing their education. Hamilton et al. (2008) emphasise that self-study researchers focus on practice and improvement of practice while other methodologies might focus on relation or culture. I, therefore, focused on how to improve the quality of my teaching for enhanced learning. For instance, in Chapter Six, I discuss how I incorporated cultural artefacts in the implementation of the integrated learning approach to improve my practice and learn from it.

Bullough and Pinnegar (2001) note that the questions that motivate the creativity of those who engage in self-study work are centred around how their practice as teacher educators could be improved. Although there has been much conversation about the importance of improving teaching, there has been relatively little discussion about how teachers and teacher educators are motivated to improve their practice quality to improve student learning (Samaras & Roberts, 2011). Therefore, self-study teacher research is intended to encourage teachers and teacher educators to be agents of their reform initiatives while working collaboratively with their colleagues (Samaras & Roberts, 2011). Thus, I needed to show my pre-service teachers how mathematics exists in an integrated web of various disciplines and experiences to embrace this sociocultural perspective in their teaching. The concept of the integrated learning approach thus offered me an opportunity to learn and improve my practice.

2.2.1.4 A transparent and systematic research process

Self-study researchers employ research methods and practices derived from conceptions of knowledge and learning (LaBoskey, 2004). I thus kept an audit trail of the data I generated and analysed, and I shared the findings and evidence of my claims with my critical friends (Samaras, 2011). According to Samaras (2011, p. 80), self-study research calls for a

"transparent research process that clearly and accurately documents the research process through dialogue and critique". To engage in this kind of process requires researchers to be genuine and sincere about their work. I thus demonstrate in Chapter Eight how the discussions I had with my colleagues and their role as critical friends during the different stages of my research obliged me to be transparent in the research process.

Undertaking a self-study project requires researchers to continually check their work with others. Loughran (2007) asserts that self-study scholars have an entrenched responsibility to review data and interpretations with colleagues to increase possibilities and encounter viewpoints that will improve their work's credibility and validity. I developed a plan and schedule to show my work to others. This was encouraged by Samaras' (2011) notion of being systematic in research. In terms of teacher educator research, Grossman (2005) states that "close attention must be paid to the circumstances under which data are collected, the relationship between research and students, and the manner in which data [are] analysed" (p. 449). Likewise, Bullough and Pinnegar (2004) assert the significance of transparent methods to uphold good quality self-study research. Thus, I had to be mindful that the processes I used would be transparent and systematic throughout the research project.

Bullough and Pinnegar (2004, p. 340) argue that "like any good research, self-study must present rigorous data gathering and analysis". Moreover, I was conscious that self-study researchers need to articulate and thoughtfully develop a methodology to counter those who question self-study research (Hamilton, Smith, & Worthington, 2008). This is also important because the self-study research methodology entails a process that is not straightforward and sequential − instead, it is cyclical and involves going back and forth. Similarly, Samaras (2011, p. 81) proclaims that self-study involves "an open-ended research process" that gives rise to a changing journey of questioning, discovery, structuring, restructuring, and revisiting. Therefore, throughout this research process, I went back and forth while learning, implementing and reflecting on the integrated learning approach and the successes and disappointments I experienced.

Throughout this research journey, I realised that I would need to incorporate reflection in exploring the integrated learning approach in early childhood mathematics. Dinkelman's (2003) position is aligned with the one I adhered to: self-study is not the entire teaching, but it reflects and systematises that part of pedagogy that is a reflection. If we do not reflect, then we

will not be able to learn from our experiences. Bullough and Pinnegar (2004) explain that, as we commit to doing self-study, part of that process is "progressing from critical reflection to creating and sharing an account of that reflection" (p. 321). Thus, continuous critical reflection was a constant feature of my self-study research, and I learnt and gained knowledge from sharing my work and thoughts with critical friends.

2.2.1.5 Knowledge generation and presentation

Self-study scholars disseminate the knowledge generated through various research methods. Dinkelman (2003) argues that teacher educators who employ self-study methodology cultivate knowledge production and development and that this contributes to the transformation of programmes and pedagogy. As I explored the integrated learning approach with my pre-service teachers in the early childhood mathematics classroom, I generated more understandings of how I improved and continued to improve my teaching practices. As I was reflecting and reporting on my study in progress, self-study helped me to produce knowledge. For example, I presented my work at national conferences and published articles in South African journals (see pages viii and ix of this thesis). Dinkelman (2003) affirms that, as teacher educators learn about their work in advancing practice through reflective self-study, they construct knowledge that is valuable in improving teacher education programmes. By cultivating an integrated learning approach and by reflecting on and writing about it, I was driven to improve my teaching practices in the module that I taught. According to Samaras (2010, p. 722), "self-study teachers generate knowledge for investigating and developing new knowledge about teaching with evidence that is immediate, personal and of significance to others" (Samaras, 2011, p. 82). In presenting my work publicly to validate and question my self-study project's value, I moved beyond the self to assist others. I appreciated the critiques, insights and recommendations that were offered to improve my work that was in progress at the time.

2.2.2 Self-study methods

Self-study researchers use a wide range of methods when executing their projects. According to LaBoskey (2004, p. 859), "self-study employs multiple, primarily qualitative methods" that help researchers gain various and extensive perspectives on the educational processes under study. Pithouse-Morgan and Samaras (2017) argue that self-study methodology is signified by using different methods to develop multifaceted and distinctive understandings of the research phenomenon. This sentiment was earlier expressed by Schuck (2002, p. 328), who stated that "various methods may be used in self-study, but the focus in all cases is on how personal

practice in teacher education can be improved and [this has] implications … for teacher education in general". I thus employed four self-study methods to respond to my research questions. I used the *personal history, arts-based self-study, developmental portfolio,* and *memory work self-study* methods.

2.2.2.1 Personal history self-study method

Samaras (2011) describes the personal history self-study method as a "self-study method to explore how personal experience, culture, history, and learning experiences can inform one's teaching" (p. 284). Likewise, Russell (2009, p. 72) terms this approach "the method of personal experience". Through this self-study method, I could explore how my lived experiences influenced myself and my practice as a teacher educator. Samaras and Freese (2006) claim that the personal history self-study method permits teachers and teacher educators to provoke thinking about teaching and practice as it entails contextualised thinking. Samaras (2011, p. 95) notes that it is most beneficial in examining "who you are as a teacher, your teacher identity, the motivations behind your teacher goals, and the constraints and supports you have experienced in reaching those goals". Thus, I aimed to be more aware of my development as a teacher educator and how this influenced my practice. Samaras, Hicks and Berger (2004) provide persuasive evidence that "the connection between personal reflection and action is also a vital ingredient in the growth of personal history self-study" (p. 7). Correspondingly, Vygotsky (1978) believed that cultural and historical influences shape our development and knowledge about education. Nash (2004, p. 22) calls the personal history self-study method, "the scholarly personal narrative" (SPN), which he claims can inspire other people when executed well. I was empowered by studying my personal experiences of learning about early childhood mathematics and how they shaped me as a teacher educator. I hope that my stories may resonate with other researchers who reflect on early childhood mathematics teacher education (see Chapter Three).

I recorded my personal history and early childhood mathematics education experiences in writing (see Chapter Three). I tracked my personal development in mathematics education by drawing from my personal experiences of learning mathematics as a child growing up in a township. I explored my learning experiences of mathematics in primary and high school. I also delved into my encounters with mathematics in different teacher education contexts. Nash (2004, p. 36) asserts that "the stories we construct then turn around and construct us, and we use them forever". In line with Nash's (2004) assertion, the personal history self-study method

enabled me to tell stories about my learning and teaching of mathematics throughout the years and reflect on how my experiences influenced my thinking and practices. Reflection caused me to understand the changes I wanted to see in myself and my pre-service teachers' perceptions of early childhood mathematics teaching.

2.2.2.2 Arts-based self-study method

In my self-study project, I used another inventive method, referred to as the arts-based self-study method. According to Samaras and Freese (2006, p. 73), arts-based self-study "promotes and provokes self-reflection, critical analysis, and dialogue about improving one's teaching through the arts". I was drawn to the arts-based self-study method as I aimed to improve my practice using unconventional methods. I describe in detail in the subsequent chapters how I used the arts-based approach in my study. In brief, I explored the use of different artefacts (such as photographs) as reflective prompts to look into the events that influenced my educational experiences. Tidwell and Jónsdóttir (2020, p. 25) argue that "a photo is a visual artefact as well as an object". Further, Weber (2014) proclaims that photographs compel us to take a step back and look at our practice from another standpoint presented by the medium itself. This increases the potential for in-depth self-analysis (Weber, 2014).

I extended the photographic exploration by creating collages, concept maps and the use of other artefacts during the research process. Van Schalkwyk (2010, p. 678) describes the collage as "a visual representation in which the participant makes use of photos, pictures and cuttings (also text) from magazines and other media" to portray phenomena. Samaras (2011, p. 209) defines a concept map as "a technique for visualising the relationships and complex ideas among the big ideas or concepts and the dynamics and connections between them". Pithouse-Morgan and van Laren (2012, p. 418) describe an artefact as "an object that has cultural and/or historical significance". In early childhood mathematics, the manipulation of objects aids in facilitating learning and understanding of concepts. These arts-based tools enabled comprehension of the integrated learning approach among my pre-service teachers. As noted by Richards (2013), art has the potential to provide a situation for students to convey their feelings and ideas that may otherwise be difficult to express.

Art as a medium for exploration and reflection can allow individuals to look deep into themselves and gain new insights. Richards (2013, p. 5) notes that "arts construction, as an aesthetic and emotional endeavour, can heighten conscious inquiry into the self". Thus, the

arts-based self-study method helped me engage in self-reflection as I critically analysed my practice in authentic contexts to improve it. Samaras (2010) emphasises that the arts-based self-study method can personalise meaning-making and enhance critical analysis and interpretation. Moreover, it inspires dialogue about improving one's practice through the arts.

2.2.2.3 Developmental portfolio self-study method

Samaras and Freese (2006) explain how the use of a developmental portfolio self-study method documents the process of self-study research to allow teachers or teacher educators to discover aspects of their practice that may not always have been evident. It can be in the form of "reflective journals, lessons, projects, papers, and [one's] work with critical friends who help validate [one's] findings" (Samaras & Freese, 2006, p. 68). This self-study method also supports meaning-making during personal inquiry and peer reviewing (Samaras, 2011). Thus, by employing this method, I could document and store the data I had generated during my research process in a retrievable format. The portfolio is a useful self-study tool, especially when studying one's growth and development as a teacher (Samaras & Freese, 2006). Utilising the portfolio self-study method helped me explore and progress as a teacher educator (as demonstrated in Chapter Eight).

2.2.2.4 Memory work self-study method

The memory work self-study method serves to "uncover the ways in which individuals build their identities … what we remember and how we remember the events in our lives to form the basis of who and what we are today" (O'Reilly-Scanlon, 2002, p. 74). I thus used drawings from memory to recall my childhood experiences of learning mathematics. I also involved my pre-service teachers in memory recall in eliciting their narratives of how they learnt mathematics in their early years. Pereira (2005) argues that many pre-service teachers believe that mathematics is a subject that entails a collection of unconnected skills and techniques. In contrast, it is significant in the manner that it relates to our everyday activities and lives. The drawings helped me to gain a better understanding of my negative experiences with mathematics so that I could reflect on how I could create positive ones. By engaging in memory recall activities, I encouraged my students to think positively about mathematics and make them feel excited about the prospect of teaching it to young learners one day. I provide a description of the use of memory work in Chapters Three and Seven of this thesis.

2.3 Research Setting

This study was conducted in the School of Education at a South African university in KwaZulu-Natal. The School of Education in this institution specialises in undergraduate and postgraduate teacher education programmes. It accommodates pre-service teachers and in-service teachers from diverse socio-economic backgrounds and race groups. The pre-service teachers had different social demographics and came from both rural and urban areas. This cohort's enrolment figures usually range between 800 and 1 000 students in the undergraduate programme per year and between 200 and 300 students in the post-graduate programme per year. Undergraduate degrees are offered full-time, whereas post-graduate degrees are offered both full- and part-time. The student ratio per module ranges from 40 to 400. The classrooms and lecture halls accommodate about 80 to 400 students. Recently, enrolment in undergraduate programmes has increased, which has posed various challenges for delivering content, especially in method modules. Some classes are overcrowded, making it challenging to conduct interactive activities with the students, such as group work. All the lecture halls and classrooms are equipped with audio-visual systems that facilitate PowerPoint presentations.

The South African Constitution[6] recognises 11 official languages as well as sign language. It also acknowledges the right of every individual to obtain instruction in their language of choice. The language of teaching and learning at the university has historically been English. Because most of the students are IsiZulu speakers, pre-service teachers learn in their first additional language (English) and not in their mother tongue. However, a newly introduced B.Ed. programme in the Foundation Phase specialisation will offer instruction in both IsiZulu and English as of 2020. This is per the university's language policy, which states: "The University will continue to use English as its primary academic language but will activate the development and use of IsiZulu as an additional medium of instruction together with the resources (academic and social) that make the use of the language a real possibility for interaction by all constituencies in the University" (The University of KwaZulu-Natal Language Policy, 2014, p. 1). This was a positive initiative on the institution's part to ensure that all students are accommodated and abiding by the Constitution.

[1]The Constitution of the Republic of South Africa, Act 108 of 1996, is the supreme law of the country and no other law or government action can supersede the provisions of the Constitution.

2.4 Research Participants

As a self-study researcher, I was the primary participant in this project. I am a middle-aged Black female teacher educator who has been in the education field for 30 years. My experience spans from teaching at primary schools both in rural and urban contexts, to teaching at a college of education and universities as a lecturer in both rural and urban contexts. My position in this self-study research was two-fold: I was both the researcher and a participant. Dinkelman (2003) argues that self-study's dual purpose helps foster reflective teaching and serve a teacher educator's functional goal. The researcher's positionality is integrated, not objectified, from a research study grounded in the lived experiences of one's practice (Dinkelman, 2003). Of absolute importance is that the researcher should focus intensely on the self and the connections between the self and the phenomenon under study − thus, the focus is on the self and teaching practice.

The study involved three different groups of pre-service teachers enrolled in the B.Ed. Foundation Phase (FP) programme who were in their first year of study. The FP programme prepares pre-service teachers to teach learners in Grade R up to Grade 3. The ages of these young learners range from five to eight years.

2.4.1 Pre-service teachers

The secondary participants in the study were pre-service teachers enrolled for the early childhood mathematics module. The first group comprised 34 first year pre-service teachers who participated in the pilot study in 2016. The second group involved 141 students in the following year in 2017. In the third year (2018), a group of 111 participated in the self-study project. The ages of the participating students ranged from 18 to 28. They came from different contexts such as rural, semi-rural and urban areas.

In recent years, there has been an increase in male pre-service teachers' intake in the Foundation Phase programme in South Africa compared to earlier years when only female pre-service teachers enrolled for this course. Warin (2019, p. 306) believes that teacher education programmes should strive to address gender equality, as it is necessary for young learners "to witness men in roles with young children". Moosa and Bhana (2019) concur and note the importance of addressing men's underrepresentation in the early childhood domain in the South African context. Additionally, they argue that many studies have acknowledged the capabilities of men teaching in the early years of schooling (Moosa & Bhana, 2019). Having male pre-

service teachers is a milestone for the early childhood education discipline. It challenges gender stereotyping and the prevalent view that the Foundation Phase is only for female teachers.

The institution where I teach accommodates students from all races, and thus the participating student cohorts were comprised of different races. Historically, South African people were categorised according to race, which meant that race groups lived and were schooled separately. Carrim (1998) states that schools were segregated during the apartheid years, and schooling was provided disproportionately based on race. The Group Areas Act of 1966[7] was designed to separate the races geographically in South Africa. It was this law that mandated separate areas of development for each race/tribe/ethnic group. The Act has subsequently been amended many times and was repealed (along with many other discriminatory laws) in June 1991. This law had cultural connotations as segregation was enforced based on race, culture, and language differences. The pre-service teachers in this study were schooled in the 2000's in the post-apartheid era. Table 2.1 presents the demographic details of the study participants.

Table 2.1: Research participants

B.Ed. Foundation Phase pre-service teachers				
Year	**Module**	**Number of Participants**	**Gender**	**Race**
2016	Early Childhood Mathematics	34 students	31 females 3 males	1 White 3 Coloured 4 Indian 26 African
2017	Early Childhood Mathematics	Group 1 – 56 students	48 females 8 males	3 Coloured 3 Indian 42 African
		Group 2 – 85 students	71 females 14 males	3 Indian 83 African
2018	Early Childhood Mathematics	Group 1 – 54 students	34 females 23 males	1 Coloured 3 Indian 50 African

[7] Act to consolidate the law relating to the establishment of group areas, the control of the acquisition of immovable property and the occupation of land and premises and matters incidental thereto (South Africa, 1966).

		Group 2 – 57 students	39 females 18 males	1 Indian 56 African

2.4.2 Pre-service teachers involved in extra-curricular activities

Due to time constraints caused by a very full prescribed curriculum, I could not complete everything that I wanted to accomplish with my pre-service teachers to cultivate an integrated learning approach towards mathematics teaching. Semesters are very short, and there is a lot to cover in each semester. Hence, in the second semester of 2018, I invited my pre-service teachers to participate in extra-curricular activities to enhance my practical approach to integrated learning. Twelve pre-service teachers volunteered to participate in these activities from a group of 57 students. The group involved 10 females and two males, of which 10 were Black, and two were Coloured students. The activities took place over 8 weeks. I met with these students once a week for 2 hours (see Chapter Seven).

2.5 Critical Friends

During my self-study journey, I shared my work with colleagues and scholars using various platforms. Schuck (2002, p. 336) supports the idea that "the presence of colleagues who are able to act as critical friends is important in the development of authentic self-studies that genuinely study practice rather than confirm existing beliefs". As detailed in Chapters Eight and Nine, my critical friends played an essential role in my self-study research. Self-study entails the formalisation and dissemination of the work to other professionals for deliberation, examination and evaluation (LaBoskey, 2004). Because self-study has to be interactive, I presented my research to colleagues representing multi-disciplinary groups in various contexts. Table 2.2 below illustrates the platforms in which I offered my work.

Table 2.2: Engagement with critical friends

Date	Presentation
18 May 2016	University of Zululand (UNIZULU) Teaching and Learning conference
24 June 2016	Self-reflective research support group
22 October 2016	South African Education Research Association (SAERA) national conference

24 March 2017	Supervisory support group
26 May 2017	Self-reflective research support group
23 June 2017	Supervisory support group
1 September 2017	Supervisory support group
11 May 2018	South African Research Association of Early Childhood Education (SARAECE) national conference
18 May 2018	Self-reflective research support group
23 October 2018	SAERA conference
10 May 2019	Self-reflective research support group
24 October 2019	SAERA conference

2.5.1 Colleagues in the self-reflective research support group

The self-reflective research support group comprised colleagues and self-study postgraduate students from the university's College of Humanities. It also included postgraduate students from other local universities. The numbers of colleagues in the self-reflexive support group fluctuated. There were generally about 20 people in a session. At the time of this study, it had been running for almost a decade. The convenor, a professor at the institution, worked with two other professors and a senior lecturer and supported academics and postgraduate students. My critical friends in this group provided invaluable support to me practically and emotionally. The research support group met once a month, and I shared my work with lecturers from different disciplines who were also conducting self-study research regularly. I received feedback from this group, and I audio recorded the discussions.

2.5.2 Colleagues in the supervisory support group

The supervisory support group included my colleagues who were my fellow PhD candidates and our supervisor. They also played the role of critical friends. The number of colleagues in the supervisory support group varied between seven and eight people. We had lunchtime meetings that generally took place before the self-reflective research support group meeting with the wider critical friends group. The colleagues in this supervisory support group learnt from one another in a comfortable intellectual space. We engaged in various activities which were facilitated by our supervisor.

2.5.3 Dissemination of my work at national conferences

I also presented my project at national education conferences. During these interactions, I received positive and beneficial feedback that engendered new ideas and illuminations about my research. As a result, I was able to interrogate my own teaching education and practice in-depth. It was essential to view my colleagues' role as critical friends whose contributions were considerate rather than confrontational (Alderton, 2008, p. 101). I reflected on what my critical friends had said and proposed. I valued and interpreted their comments, and this "led to some changes in my practice", as suggested by (Schuck & Russell, 2005, p. 115). For example, I had to reconsider my lesson plans and embark on techniques geared explicitly towards teaching pre-service teachers about mathematics teaching in the Foundation Phase through an integrated learning approach. I did this in the hope of enabling and enhancing teaching and learning of this subject not only for the benefit of my students, but also in the interest of the pedagogics they were expected to adopt as teachers in the Foundation Phase. In the process of presenting my research, I established new insights about critical friendship.

2.6 Data Generation

An essential element in achieving quality self-study research is that the data should be derived from multiple sources and perspectives to respond to research questions from more than one viewpoint (Samaras, 2011). In this study, qualitative data were generated. As explained earlier in this chapter, I drew on four self-study methods to respond to my research questions: personal history, arts-based self-study, memory work, and a developmental portfolio. Table 2.3 below illustrates the research practices I engaged in to generate the data for my study.

Table 2.3: Data generation and data sources

Research Questions	Self-Study Methods	Data generation activities	Data sources
1. What can I learn about cultivating an integrated learning approach (ILA) from working with my memories?	• Personal history self-study	• I wrote my personal history about my experiences of Early Childhood Mathematics (ECM) education.	• Reflective journal entries

	• Arts-based self-study • Memory work self-study	• I collected objects that elicited my memories of my personal history about experiences of childhood mathematics education. • I created collages and concept maps to reflect on my past experiences of ECM education. • I drew pictures representing my learning of Early Childhood Mathematics	• Artefacts retrieval • Collages and concept maps • Memory drawings
2. What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?	• Arts-based self-study • Developmental portfolio self-study • Memory work self-study	• Pre-service teachers created collages and concept maps to represent their understanding of integrated learning approach in 2016, 2017 & 2018 • Made notes on 4 lessons in the ECM module in 2016 • I audio recorded 8 lessons in the ECM module in 2017 & 2018 • I kept a journal for my reflections of the lessons I presented in the classroom with pre-service teachers in 2017, 2018 & 2019 • I audio recorded extramural sessions in 2018 • I drew a picture that portrayed my learning of ECM in 2018	• Pre-service teachers' - Collages - Concept maps • Notes on the 4 lessons • Audio recordings of 8 lessons • Lesson plans • Material and resources that I developed • My journal entries • Audio recordings of extramural sessions • Memory drawings

		• Students drew pictures representing their learning of ECM in 2018 • Students and I played boardgames in 2018 • Pre-service teachers compeleted the questionnaire on their reflections on the integrated learning approach in 2017. • Pre-service teachers filled in the module evaluations forms in 2016, 2017 & 2018.	• Photos of playing boardgames • Pre-service teachers' questionnaires on their reflections on the integrated learning approach • Pre-service teachers' module evaluations forms
3. What can I learn about cultivating an integrated learning approach to Early Childhood Mathematics from working with critical friends?	• Developmental portfolio self-study	• I developed a critical friends' portfolio (CFP) • I had meetings with my critical friends to examine the data I generated • I engaged critical friends in the analysis and interpretation of the data.	• Audio recorded meetings with colleagues • Critical friends' portfolio • Audio recorded meetings with critical friends

According to Schuck and Pereira (2011), self-study encourages researchers to ponder and restructure their practices and approaches. These data generation practices were used to stimulate reflection on my personal history and my current self and practice as a teacher educator. I used a reflective journal to reflect on: my past; the collages and concept maps that I created; the pre-service teachers' collages, concept maps, learner activities and reflective activities; and on the collages my colleagues and I made and the discussions that we had during meetings. The pre-service teachers created collages and concept maps and they also developed learner activities, reflected on activities, and evaluated the module. I audio recorded myself teaching eight lessons (see lesson plans Annexure B) in the early childhood mathematics module involving pre-service teachers. I also recorded the presentations of my work in progress to my critical friends.

2.6.1 Artefact retrieval

Using authentic objects and photographs as artefacts helped me reflect on my journey as a teacher educator. Allender and Manke (2008) argue that the use of artefacts opens evocative methodological paths and brings strong images and memories to mind. Hence, using artefacts allows us to reflect on the past to understand it and then change the present and influence the future. Furthermore, Allender and Manke (2008) claim that "self-study research in teacher education has a history rich in the use and analysis of artefacts, often providing tangible evidence of the realities of teaching and learning" (p. 20). Therefore, generating data using artefact retrieval enabled me to engage with my personal history and review my practice to improve it. Pithouse-Morgan and van Laren (2012) explain that the objects that self-study researchers choose to assist them with their reflections are usually not newly bought but already exist in researchers' living environments. So, I used items that I already had to stimulate my thoughts. For example, I used a photograph of pre-service teachers to reflect on my teaching experiences in a rural context. The use of objects and artefacts is described in Chapters Three and Six .

2.6.2 Reflective journal writing

Continuously recording my reflections in my journal involved writing about my personal life history, elucidations of concrete information, and an account of my research process. Hamilton et al. (2008) note that reflection occurs in different ways, including journaling and thinking intensely about teaching problems to explore possible solutions. My journal entries were also written reviews of my interactions with my pre-service teachers and planned activities such as collages and concept maps and learning activities. These entries were unrestricted, but I also tried to focus on my research questions. This was particularly useful as I examined who I was as a teacher educator and my motivation and teaching goals. I also wrote about the constraints and support I experienced in achieving my educational goals (Samaras, 2011).

I provide some examples of my journal entries. In the beginning, I tended just to explain what had transpired in the lessons I had presented in class. For instance, one reflection reads as follows:

> *Today I am reflecting on the lesson I presented yesterday. I started with the slides on 'Planning mathematics teaching in the Foundation Phase'. The students were attentive, making notes as I was talking. They seemed to grasp what I was presenting.*

(18 April 2017)

In a bid to articulate my thoughts more clearly in my journal, I began to reflect critically and express how I was feeling over time. For example, I wrote:

> *I was very angry with one group of students in class when no one from the group was coming forward to present their artefacts. Afterward, I felt that I was hard on them. I felt terrible for not considering that maybe they were shy and not confident to present in English. There could have been other reasons for that matter. I did not think about their battles, especially because this was their first year at the university. I would need to be considerate next time.*
>
> (19 April 2017)

As I wrote my reflections in my journal, I realised how challenging this process was. Thorpe (2004) suggests that reflection is more than merely presenting your current knowledge, as it involves detailed thoughts on your experiences that allow for inclinations about emotional, cognitive and behavioural changes. Initially, my challenge was that I was only presenting and not engaging with how I was feeling as I was reflecting. During the supervisory meetings, my supervisor encouraged me to think about what I was learning as I presented my lessons according to integrated learning approach guidelines.

The reflections were vital as they informed me of the changes I needed to make to improve my practice. I could consider what I was learning about my lived experiences and interactions with my pre-service teachers and my learning through engagement with colleagues in different spaces. For example:

> *Today at a meeting with my early childhood education colleagues, we created a collage to show how mathematics integration with the languages and life skills learning areas took place. I felt good during this exercise because we were all passionate about teaching in this phase. I did not need to defend the importance of the early childhood phase with my colleagues, as I have done in other spaces where people sometimes did not understand early childhood education.*
>
> (25 April 2017)

I also reflected on what emerged in meetings with my supervisor. For instance, I wrote:

> *After my supervision meeting yesterday, I thought deeply about my work as a teacher educator and a self-study researcher. Some of the things that my supervisor said are now sinking in. For example, in our discussion, I said that we are always looking, reflecting, and trying to do better as self-study researchers. My supervisor indicated that with self-study, the more you do it, the more you realise that you don't have to be the perfect teacher educator.*
>
> (29 March 2019)

Retrospective reflections

In addition to recording my daily reflections in my journal, I also engaged in retrospective reflections. As my study progressed, I felt that it was essential for me to reflect back on the experiences recorded in my journal. I wanted to deepen my understanding of what I was learning when working with pre-service teachers and how I could improve my practice. This decision is supported by Hiralaal (2017), who states that retrospective reflection helps in developing a richer and more self-reflective perspective. I became more analytic when I reflected retrospectively (see Chapters Five, Six and Seven).

2.6.3 Collages

I regularly used collages in this research project. According to Van Schalkwyk (2010, p. 678), the collage is a pictorial illustration that involves the "use of photos, pictures and cuttings [also text] from magazines and other media" to represent situations or events and feelings to tell a story about development. Lahman et al. (2020) note that collages have been in existence for ages in producing visual media to express meaning that may be unattainable otherwise. Similarly, Gerstenblatt (2013, p. 294) explains that collage representations offer "the opportunity to include marginalized voices and encourage a range of linguistic and non-linguistic representations to articulate authentic lived experiences". Thus, the use of collages in this study allowed for different pathways to understand the phenomenon under study.

I created collages throughout the research process, and I used them as "a form of elicitation" that allowed me to provoke "inner and unconscious thoughts" to come to light (Butler-Kisber & Poldma, 2010, p. 4). The collages also helped me envision and articulate critical concepts, methodology, and theoretical perspectives that narrated my teacher education development. This was illustrated in Chapter One. Furthermore, as shown in subsequent chapters, I used the

collage as an analytical tool to make sense of my data. Butler-Kisber and Poldma (2010) suggest that, by using collages, the researcher acquires understandings that may not have been attained otherwise.

The pre-service teachers also created collages in class, which was an activity aimed at representing an integrated learning approach. I engaged my pre-service teachers in creating collages to understand the use of an integrated learning approach in the Foundation Phase. These collages are depicted in Chapters Four, Five and Six. The interactive collage-making process encouraged the student teachers to reflect, plan, and deliberate on how integration could occur across the Foundation Phase's learning areas. This was in keeping with Butler-Kisber and Poldma's (2010) advice that collaging can also help stimulate ideas to understand a phenomenon.

In addition, I created a collage with my colleagues in the early childhood education discipline. This collage illuminated how integration can occur among the Mathematics, Languages and Life Skills learning areas. In Chapter One, I discussed how the collage that I created with my colleagues motivated group conversation to improve integrated learning practices in the Foundation Phase. Overall, the collage provoked the emergence of our inner thoughts that might otherwise have remained hidden. When creating our collage, many pictures were available, and we selected those that best represented the integration of the learning areas in the Foundation Phase.

2.6.4 Concept maps

Samaras (2011 p. 174) defines concept maps as "visual displays that highlight connections and links of 'big ideas' and [tools to] document your understanding of a phenomenon by visualising the relationships and complex ideas among concepts and the dynamics and connections between them". Concept maps are regarded as artistic and cognitive tools that permit the researcher to uncover and display links between and within concepts in a self-study (Samaras & Freese, 2006).

My pre-service teacher participants created concept maps to transpose the meaning or message of the collages they had created (Van Schalkwyk, 2010). The concept maps enabled them to make connections across the learning areas to understand an integrated learning approach's

functionality. The concept maps created by the pre-service teachers are presented as illustrations in Chapters Four, Five and Six.

2.6.5 Audio recordings of lessons and discussions

The data generated among the pre-service teachers included audio recordings of lessons that were conducted in the early childhood mathematics module. Masinga (2012) notes that recordings are beneficial in self-study research because they help the researcher gain more insight into what is happening in a specific situation for further analysis. The recordings helped me gain insight into how I presented my lessons to cultivate an understanding of how my students engaged with the integrated learning approach. These audio recordings also gave me access to the perspectives of my pre-service teachers. They helped me to obtain information on questions related to their understanding of the integrated learning approach. Thus, I made inferences using the information I received and assessed how I could improve my practice. A significant advantage of recording the lessons was that I could repeatedly listen to them, which helped me look at my performance more critically (Schratz, 1992). Additionally, I audio recorded the discussions with 12 pre-service teachers during extramural activity sessions. I used the quotes that were pertinent to my own learning. These recordings gave me a different perspective on how pre-service teachers learnt to understand and teach mathematics.

2.6.6 Audio recordings of the discussions with colleagues

I audio recorded the meetings and discussions with my colleagues in the Early Childhood Education discipline (as discussed in Chapter One). I also recorded my presentations and discussions with colleagues who took the role of critical friends (see Chapter Eight). The conversations I had with critical friends helped me gain an in-depth understanding of my teaching and study.

2.6.7 Audio recordings of supervisory support group

I audio recorded the discussions I had with my fellow doctoral candidates organised and facilitated by our supervisor (Chapter Nine). We held these discussions once a month and were somewhat informal. In this group, all of us were employing self-study methodology in our studies. We developed an excellent mutual relationship and learnt from each other.

2.6.8 Audio recordings of the supervision meetings

I audio recorded all the meetings I had with my supervisor. In the first year of my study, these meetings took place once a month, but we met once every two weeks in the following years. I would then transcribe the audio recordings and refer to them as I proceeded with my study.

2.6.9 Developmental portfolio

Samaras (2011) explains that the developmental self-study method offers a structure to support and understand one's research and provides a platform for sharing one's ideas with other people. Samaras and Freese (2006) note that the portfolio is valuable when studying one's growth and improvement as a teacher. A developmental self-study portfolio "typically spans a considerable period of time so you can examine the longitudinal nature of your professional development either broadly or with a specific focus" (Samaras & Freese, 2006, p. 69). I developed my portfolio of the early childhood mathematics module for three consecutive years.

I documented my reflections on my engagement with my pre-service teachers. I also recorded my lesson plans and the resources that I used when presenting my lessons on an integrated learning approach. By creating this developmental portfolio, I researched and documented my practice simultaneously (Samaras, 2011). Organising the portfolio was a challenge as I presented lessons and held meetings in many different spaces. I sometimes misplaced some of my audio recordings because I did not save them immediately. I then developed a better system by creating folders.

Samaras (2011) maintains that including critical friend data in a portfolio allows researchers to discover unique elements of teaching and that it is a "great fit for a semester-long self-study teacher research project" (p. 90). For example, I documented how I shared with my critical friends why I was curious about my research topic and who could benefit from my inquiry (Samaras, 2011). I audio recorded discussions with my critical friends throughout the research process.

2.6.10 Pre-service teachers' evaluation forms

At the end of the semester, the pre-service teachers filled in questionnaires to evaluate the module. These questionnaires were developed by the university's Quality Promotion and Assurance (QPA) unit. The responses are anonymous and can be accessed by the lecturer. I

then accessed the students' feedback online. I presented and analysed pertinent feedback from the module evaluation forms in Chapters Four, Five and Six.

2.6.11 Pre-service teachers' reflections on an integrated learning approach

In 2017, I developed a one-page questionnaire to explore the pre-service teachers' views on an integrated learning approach. Most of their reflections were positive, which encouraged me to continue exploring this approach. I elaborate on the pre-service teachers' reflections in Chapter Five.

2.7 Data Representation

Almost all qualitative studies will contain data about the participants' activities and attitudes in a study (Yin, 2011). This information needs to be presented using different formats. Yin (2011) observes that many researchers who employ qualitative research limit themselves to a narrative presentation. However, Richardson (2000) notes that a linear, straightforward narrative can constrain what is known and has been narrated. She suggests that researchers engage in innovative writing practices and express "evocative representations [that] are a striking way of seeing through and beyond social scientific naturalisms" (Richardson, 2000, p. 11). I employed various ways to represent the data, including some evocative forms to create images in my mind that made the data clearer. For example, I represented data using tables, extracts from transcribed recordings, photographs, collages and a poem.

2.7.1 Tables

Yin (2011) contends that tables typically present two elements: rows and columns. In qualitative research, a table usually contains words and not numbers. Tables help readers easily see the information in rows and columns and quickly interpret it (Yin, 2011). I used tables to capture the research practices I engaged in to generate the data for my study and present the analytical framework. As shown in subsequent chapters, I also summarised the themes that emerged and what I had learnt in tables.

2.7.2 Transcribed recordings

According to Santori, Ven, and Hennessey (2019), educators need to record and transcribe their teaching recordings as this may benefit them in the analysis of what unfolds when they teach. This practice enables educators to use a critical lens to view how well and in what ways

they can facilitate interactive teaching (Santori et al., 2019). Self-study necessitates a disposition of openness to outside views, questions and critique (Samaras & Freese, 2006, p. 58). As a participant researcher, I audio recorded and transcribed the lessons I presented in class and the conversations I had with the students, critical friends, and supervisor. This provided me with rich data, and I was thus able to analyse my data from multiple perspectives (Brandenburg, 2011, p. 81). As I listened to all these recordings, I gained insightful views about my strengths and weaknesses as a teacher educator. I use verbatim quotations in this thesis to represent my critical friends' authentic voices (see Chapters Eight and Nine).

2.7.2.1 My voice

Many voices need to be considered in self-study research. Bullough and Pinnegar (2001, p. 16) argue that "in self-study, the researcher is one of the voices in the conversation". In this study report, my voice is represented as the researcher, the leading participant, and a teacher educator. In Chapters One and Two, my voice as a self-study researcher is represented by how I am telling my story, explaining my motivation for embarking on this study, and describing the research process. In Chapter Three, my voice is that of the primary participant as I represent and narrate my personal history. In Chapters Four, Five and Six, my voice is that of the teacher educator reporting on the lessons I presented in class while exploring an integrated learning approach. My voice is also depicted in Chapters Eight and Nine, through my engagement with critical friends, my fellow doctoral candidates and my supervisor. It is important to note that my voice did not stay static through the research process, it grew and changed over time. In the beginning I was hesitant to use my voice. As I presented my work throughout my study, it became more clear, strong and self-reflexive. Badley (2017, p. 5) is of the view that having strong personal voices assist us "develop epistemological, intellectual, and professional voices". I also note that my voice is represented in words and visually in collages, memory work, and photos.

2.7.2.2 Pre-service teachers' voices

My pre-service teachers' voices are represented as secondary participants in this study. I audio recorded and transcribed my conversations with the pre-service teachers in class and during the extramural activity sessions. This was important as I needed to understand how they were grasping the concept of integrated learning approach. I also needed to understand their views on teaching mathematics to be accessible to learners. I found that, as the study progressed, the

pre-service teachers became more confident in voicing their understanding of the integrated learning approach.

2.7.2.3 Critical friends' voices

I present quotations from the conversations with my critical friends that I audio recorded and transcribed in Chapter Eight and Nine. Engaging with critical friends proved invaluable as they always kept me on my toes, as proposed by Schuck and Russell (2005). It was challenging and motivational to be critiqued, as I learnt and infused my critical friends' ideas in my practice. Initially, I struggled to take feedback from critical friends in a constructive way. I soon realised that for me to learn and grow, listening to critical friends' advice was instrumental. Schuck (2002) maintains that critical friends' voices are essential in developing authentic self-studies that genuinely study practice. My critical friends' voices served to support and challenge me, thus enhancing my growth.

2.7.2.4 My supervisor's voice

During my doctoral journey, I constantly liaised with my supervisor. I audio recorded and transcribed our conversations during our supervision meetings, which took place biweekly. The journey to obtain a doctorate degree is an intellectually demanding undertaking that requires candidates to be on top of their game (Trafford & Leshem, 2009). The conversations I had with my supervisor stimulated my thinking and enabled me to articulate the notions I had about my study. Moreover, my supervisor's ideas motivated and encouraged me to reflect vigorously on my research, and I was able to incorporate these ideas and recommendations into my thesis. In Chapter Nine I detail the conversations I had with my supervisor. I use verbatim quotes to capture the essence of some of these conversations.

2.7.3 Photographs

Using photographs is a useful mode of displaying qualitative data. According to Yin (2011), photographs used in a study may depict participants or other artefacts and features of the relevant environment. Mitchell (2011) notes that photographs can be used to visually represent the significance of the research. Visual representations, together with oral descriptions, help in deepening understandings of people's memories (Mitchell, MacEntee, Cullinan, & Allison, 2019). Furthermore, Mitchell (2011) claims that we can learn a lot about life and people's characters, how they dress, their hairstyles and their attire from looking at photographs. I took most of the photographs presented in this thesis, while some were taken by the students. I also

used one old family photograph to illustrate my personal history and memories and to enhance my understanding of how I learnt mathematics in my early childhood. The photographs are presented in Chapters Three, Four, Five, Six, Seven and Nine.

2.7.4 Collages

I illustrate the data using collages to represent my learning. Creating collages helped me to express my feelings and emotions visually. Butler-Kisber and Poldma (2010) state that collage work is always an engaging process. Furthermore, Butler-Kisber and Poldma (2010, p. 13) explain that "a collage represents ideas by creating links between fragments that represent emergent feelings first, and then ideas". Cancienne and Snowber (2003) assert that representing the educational research process through collages affirms the place of an arts-based inquiry in this field of study. Therefore, collages were the visual artistic tools used to represent the data (see subsequent chapters).

2.7.5 Poetry

I used poetry as another art form to represent my data. I created a pantoum, which is a French poem based on a Malaysian poetry format. The pantoum poem is a "powerful form that can create a haunting effect through the repetition of lines throughout the poem" (Furman, Lietz, & Langer, 2006, p. 26). The poem represents my emotional responses to some of the findings and offers a profoundly personal understanding of the study's focus. Furman et al. (2006) acknowledge that the most popular application of poetry in research includes its use as a tool of data representation and presentation. I also used the Kyrielle poem, which is a French poetic style. This type of rhyming poetry is written in quatrains with a refrain of each stanza's last line. Representing data in this way enabled me to convey my message and what I was learning succinctly, but also with the deep emotional undertone that only poetry can provoke (see Chapters Nine and Ten).

2.8 Making Meaning (data analysis and interpretation)

According to Samaras and Freese (2006, p. 87), self-study generally involves qualitative data, but quantitative data may also be used. The researcher should commence the analysis process by engaging in systematic and thoughtful analyses that require immersion in the data (Samaras & Freese, 2006). Cohen et al. (2009) explain that "qualitative data analysis involves organising, accounting for and explaining the data; in short, making sense of the data … while noting patterns, themes, categories and regularities" (p. 41). In addition, Samaras (2011, p. 198)

believes that qualitative research involves a repeated application of a process that needs a re-examination of the data and reconsideration of any initial findings. Considering that data analysis does not follow a linear process, I engaged in the following procedures that required going back and forth.

2.8.1 Getting to know the data

To better understand the data, I read and re-read the texts I had generated. I thus repeatedly scrutinised data sources such as my journal entries, the transcriptions, and students' reflections on their activities and evaluations. During this process, I took notes on matters that stood out or that were repeated or patterned (Samaras, 2011). As I discovered any significant sections, I coded them. According to Nieuwenhuis (2010), the coding process allows the researcher to immediately retrieve and gather all the text and other information that the researcher has linked with a particular idea. Because I was analysing the data inductively, various codes emerged from the data. I then developed categorising and connecting strategies. However, this process was not linear and involved going back and forth to make meaning of the data.

2.8.2 Categorising the data

According to Maxwell and Miller (2008), methods of categorising and connecting entail analysing data according to "relationships based on similarity (categories) and ... continuity (connections)" (p. 462). Nieuwenhuis (2010) notes that categories are developed from the data when the researcher works inductively. I constructed categories, read through the identified codes, and identified themes related to the data's recurring parts. These themes and patterns developed in response to my research questions, and I colour coded them. For example, one comment that frequently occurred in the students' evaluations was that particular things they did in class made them remember the work more efficiently when writing tests. This comment was categorised under the theme "hands-on experiences". I reviewed my notes and journal entries using the same process to study whether my perceptions of the module were similar to those of the pre-service teachers.

2.8.3 Focusing on analysis

Considering the questions I wanted to address, I engaged in a logical and deeply reflective analysis of the data (Samaras & Freese, 2006). I thus analysed the data inductively using the learning zones (LZ) and zone of possibility (ZOP) (Samaras, 2011). Learning zones are "organic and diverse communities of expertise where learners co-mediate, negotiate and

socially construct an understanding of a shared task" (Samaras & Freese, 2006, p. 51). I reread the items I had gathered and considered what I was learning about implementing an integrated learning approach together with my pre-service teachers. For example, I read and reread the evaluation forms, listened to my audio recorded lesson presentations, and reflected on the pre-service teachers' activities in class. I paid attention to "any repeated statements, behaviours and actions across my data set" (Samaras, 2011, p. 199). I gained more understanding about the integrated learning approach. (As illustrated in Chapters Four, Five and Six.)

Kravtsova (2006, as cited in Samaras, 2011) claims that a zone of possibility occurs when the teacher and learners learn by acquiring others' perceptions in their discussions. This process occurred when the pre-service teachers talked about their understanding of an integrated learning approach, during my observations of the students' activities, in my journal entries, in the transcriptions of my meetings with my supervisor, and in the comments of my critical friends.

2.8.4 Interpreting and reporting on my learnings

Samaras (2011) points out that, in reading and re-reading, the researcher already begins to make meaning of the data. I adhered to this process and constructed tables that distinguished the themes, described the activities and presented my learnings. I wanted to understand what I was learning from my pre-service teachers' experiences to improve my practice.

I chose to use what Richardson (2000, p. 9) refers to as "creative analytical practice", namely the collage. I thus created collages to discover what I was learning through a process of "zooming in and zooming out" (Chang, 2008, p. 128). Some of the collages I created comprised cut-out texts only, whereas the other collages contained texts and pictures from magazines. According to Butler-Kisber and Poldma (2010), this form of visual inquiry is used to generate insights and understand phenomena. By interpreting the collages holistically, I constructed categories and codes and created themes that recurred in the data. These interpretations are illustrated in Chapters Five, Six, Seven, Eight and Nine.

I also used the collages to understand how working with artefacts could enrich an integrated learning approach in early childhood mathematics in teacher education. Using the collages evoked novel ideas and revealed new connections and understandings that had previously been unexplored (Butler-Kisber & Poldma, 2010). For example, I explained how one of the images

helped me understand the work I had done with my students and how it identified the milestones we had reached. I allowed the pictures from the magazines to say how I was feeling. As I was cutting and pasting the pictures, my feelings and emotions were enhanced through the illustrations. Even though I was reflecting on myself, the illustrations merged in the collage. One image illustrated the success that we, as a team of early childhood teacher educators, were beginning to achieve (Chapter One). I understood the image of falling seeds in the collage as a metaphor for my successes that would allow others to grow and develop (Chapter Six).

2.9 Ethical Considerations

Yin (2011) notes the importance of upholding a self-critical perspective and having a strong sense of ethics in conducting qualitative research studies. In research, this is especially pivotal because "it is our obligation and responsibility to ensure that, in the process of research, we do not bring harm to others − to students, families, colleagues, or the school community" (Samaras, 2011, p. 145). Ellis (2007) pointed out that ethical issues in self-reflective research are complex, and there is no general principle that applies to all cases. Therefore, in relentless efforts to improve professional practices in teacher education, researchers are obliged to ensure that they protect their students and colleagues (Samaras, 2011). Addressing ethics was crucial in this self-study research project, mainly because I was both a researcher and a teacher educator with a pedagogic responsibility towards my students who helped me work towards my goal. Samaras (2011) notes that one has to be aware of these two roles' delicate position to ensure that one's positionality does not negatively affect the students. For example, when working with the students, I did not give them anything extra to do that was not directly related to my teaching. Everything that I did in class, was first and foremost in the interest of their learning. I was recording the lessons, but I did not burden the students by asking them for long interviews or surveys. Therefore, I never lost sight of my role as a teacher educator. I tried to make the lessons fun and beneficial to them rather for it to be a research activity. The extramural activities were an exception as that was by invitation and students participated voluntarily.

Conducting research ethically improves the study's quality and contributes to its trustworthiness (Samaras, 2011). Therefore, ethical clearance to conduct this study was obtained through the appropriate channels from the tertiary institution involved. Proper procedures were followed, and ethical approval was granted (Annexure F). The attainment of consent is based on the research link and procedure, as this displays respect for the individual

research participant's dignity (Graham, Powell, & Taylor, 2015). I explained to the pre-service teachers what my study involved, and they agreed voluntarily to sign consent forms and commit to the study (Annexure C). I informed them that they could withdraw at any time and their confidentiality was assured through pseudonyms. It was made clear to the participants that the information they provided would only be used for research purposes. I elaborated on what a PhD meant by giving them examples of different educational qualifications. I asked them which qualifications they would register for when they completed the B.Ed. programme. I proceeded with the questions on the following qualifications: Honours, Masters and PhD. I also indicated that the lecturers who were titled Doctor had a PhD and that I was pursuing to obtain a PhD qualification.

During my study, the student teachers' activities mostly formed part of their classwork for the early childhood mathematics module. In our reflections on how we learnt about mathematics for early childhood education, I tried to create an atmosphere where the students could speak openly (Mitchell, Magubane, Burkholder, & Saloojee, 2019). I concur with Ellis (2007, pp. 210-211) that "relational ethics requires us as researchers to act from our hearts and minds, to acknowledge our interpersonal bonds to others, [and to] initiate and maintain conversations". When I was writing, I thought about the students connected to this study and considered how they would feel if they read this work. Moreover, the "ethically important moments" (Guillemin & Gillam, 2004, p. 262) that I experienced occurred when I became aware of my pre-service teachers' challenges. For example, when the students shared their memories of schooling was emotional at times. It resonated with me when I heard their stories of being beaten as children as I experienced the same thing. I tried to hide my astonishment, because I thought that it did not happen in their era. Still, I had to maintain a professional stance at all times. I also learnt that I had to be careful not to incite emotional pain and cause my pre-service teachers embarrassment in my reporting. I responded by highlighting that we have a responsibility as Foundation Phase teachers to provide supporting learning experiences for young children.

Therefore, as a teacher educator and a self-study researcher, I needed to interact with others ethically. Samaras (2011) raises the urgency for self-study researchers to intensify their commitment to checking data and understanding with colleagues to increase their work's integrity and validity. Similarly, Samaras and Freese (2006) highlight the significance of self-study researchers to be vigilant in ensuring that their work is known to others as they strive to

better understand their practice. Therefore, I presented my work to critical friends throughout this research project and shared my challenges and accomplishments. I asked the critical friends for consent to record the conversations.

I had planned to share my findings with the students in 2020, but due to the Covid-19 pandemic and the lockdown restrictions I have postponed this meeting to the second semester of 2021. I am planning to do it in a way that is student friendly and appropriate. I will have a conversation with them in a language that is accessible to them.

2.10 Trustworthiness

Pinnegar and Hamilton (2009) argue that in our endeavours to understand and improve our practice as researchers, teacher educators and practitioners, the knowledge that we gain from our self-studies needs to have trustworthiness. Then it can guide us in our practice and be useful to others who want to understand and improve their practice. As discussed above, conducting research ethically enhances the quality of research and contributes to its trustworthiness. Furthermore, Samaras (2011) advises that, for a self-study project to be trustworthy, the data must be generated from varied sources and viewpoints. Samaras (2011) also urges that transparency, honesty and reflective engagement are essential. I thus established trustworthiness by presenting clarifications and descriptions of the data sources I used and explain how I generated, represented and interpreted the data (Feldman, 2003). For example, I use tables in this thesis to show which data sources I used and how I generated, represented, and interpreted the data. I followed the self-study research practices with care, which is vital in asserting the authority of the claims one is making (Bullough & Pinnegar, 2001). Furthermore, I elaborate on these in this thesis by presenting in-depth descriptions and evidence.

Fletcher (2012) asserts that other ways of checking the trustworthiness of qualitative findings involve "triangulating the data from different sources and using member-checking when gathering and writing up data" (p. 90). I thus shared my findings with the pre-service teachers whom I worked with during extramural activity sessions. I also presented my work while it was in progress with critical friends, and I understood how we could "broaden each other's zone of possibility in understanding [our] practice" (Samaras, 2011, p. 77). Therefore, I learnt to be open-minded when I received criticism from my colleagues. This was vital in developing this authentic self-study project because their contributions enhanced my study's reflective

nature. I learnt that unfavourable or critical comments might not have been pleasant, but they had to be viewed as constructive and enhancing my learning opportunities.

2.11 Research Challenges

At the beginning of this research process, I struggled to position myself in the centre and focus on myself and what I was trying to learn. I battled to use the first-person perspective and use 'I' when I conceptualised the study, and I found myself shifting focus to the students. However, my critical friends would bring me back and remind me that the research was about me. This was a learning process as I needed to be aware that my position was pivotal to the study.

Using the collages personalised my position and allowed me to talk about my feelings and emotions as I had tended to downplay how I felt, thinking it was not significant. For example, in one of my presentations to the research support group, I explained how the collages helped me articulate my feelings. I described a picture in the collage representing the teacher educator concept. I was talking about myself and delving into my own perceptions and experiences using this collage. It was a challenging process, but with time, it became easier.

I had to learn that the process of engaging in self-study research is not as straightforward as it may appear. It entails questioning and challenging oneself and visiting and revisiting what one has been discovering. It requires openness and deep reflection but is also rewarding at the same time. It was important to reflect critically on my practices and perceptions and think about improving what I had always done so naturally.

I acknowledged that inspiring my students to use alternative teaching methods could achieve positive outcomes. Still, to do this, I had to abandon my comfort zone and learn from a position of vulnerability, which was new and frightening. It is also undeniable that it was a challenge to implement an integrated learning approach in a large class of pre-service teachers. However, I had to improvise and use creative methods. This self-study project also illuminated shortcomings in the curriculum, particularly as I became aware of time constraints in the prescribed curriculum that prevented me from including other pedagogies such as playing games to understand and master mathematics. I thus created learning opportunities outside the classroom by providing extramural activities. This was important, not just for mathematical learning but also for the pedagogy of mathematics. However, only 12 of a large class of students

were exposed to these additional activities, which was restrictive as I would have preferred to inspire the entire group (see Chapter Seven).

2.12 Conclusion

This chapter emphasised the significance of self-study research and the value of personal experiences. The context in which the inquiry was situated was also described. I illuminated the research methods I employed and explained that I used personal history, arts-based self-study, developmental portfolio and memory-work as the self-study methods of choice. I explored how these methods enhanced the potential for deep reflection as they compelled me to take a step back and look at my practice from a new perspective.

I acknowledged that I had learnt the significance of the critical collaborative inquiry entrenched in each step of the self-study research process. I thus became aware of the importance of sharing my work with critical friends as it evolved because this necessary support helped me grow as a teacher educator. Through my engagement with critical friends, my fellow PhD candidates and my supervisor, I developed as a self-study researcher.

This chapter highlighted reflection as a valuable tool in a self-study project. I found that reflecting on my practice encouraged me to be open about my research process experiences. By adopting a transparent and systematic research process, I meticulously document the procedures I followed (Samaras, 2011), contributing to the study's trustworthiness. Additionally, this chapter illuminated both negative and positive encounters that affected my self-study research and my dual position as a researcher and a participant. However, even though it was difficult for me to put myself at the centre of my study, scholarly self-study principles as expounded in the literature helped me focus on myself, my growth, and my development.

In the following chapter, titled '*The Echoing Sea'*, I demonstrate how I utilised the personal history self-study method to help me explore how my lived experiences influenced my teaching and cultivating an integrated learning approach in mathematics in the Early Childhood phase. I describe how I engaged with photographs, objects, artefacts and memory drawings to call up memories of how I acquired mathematical concepts during my early childhood and develop an awareness of my growth as a teacher and a teacher educator.

CHAPTER THREE: THE ECHOING SEA

Your stories will teach, but only if you have the courage to put them into words − to narrate them with pride and enthusiasm

Robert Nash

3.1 Introduction

In narrating my personal history as a component of this self-study project, I focused on my mathematics learning from a young age until my experiences of teaching early childhood mathematics as a teacher educator. I embarked on this study to understand my lived experiences and how I could embrace these experiences to explore and cultivate an integrated learning approach in teaching early childhood mathematics while improving my practice as a teacher educator in an undergraduate programme.

In the previous chapter, I discussed the methodological approach that I employed. I explained why it was appropriate and how it helped me to respond to the research questions, and I elaborated on the framework of five foci as proposed by Samaras (2011). The methodological guides that informed this self-study were: personal situated inquiry, critical collaborative inquiry, improved learning, a transparent research process, and knowledge generation and presentation. I also described each research practice that I used to generate data and explained why and how each one helped me respond to my research questions. I then clarified the issues of trustworthiness and ethical considerations and the challenges I encountered in this study's implementation.

This chapter was titled '*The Echoing Sea'* because I associated the repetitive sound of waves crashing on the shore with the reflective process that I employed to recall my earlier learning mathematics experiences. Nash (2004, p. 54) states: "They [your stories] will teach, but only if you have the courage to put them into words ... narrate them with pride and enthusiasm", and these words echo the purpose of why I narrate the stories of my learning and teaching of mathematics intending to improve my practice in teacher education. I ultimately hope to encourage and influence other teacher educators who anticipate using the personal history self-study method.

In this chapter, I address the first research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with my memories?* In responding to this question, I utilised the personal history self-study method to study the influences my lived experiences had on me as a teacher and teacher educator. I also focus on my progress as a teacher educator and what I did to continually improve my practice. As Pinnegar and Hamilton (2009) explain, self-study researchers often explore their past, which stimulates their recollections of their experiences, examining how these past experiences informed their practice. In my opinion, this process allows self-study researchers to be mindful of who they are and how they may improve their practice. This sentiment is also expressed by Samaras (2011, p. 95), who states that "the personal history self-study method is one way to begin to develop an awareness of your development as a teacher and [to understand] what current beliefs and values you bring into your practices". I found that exploring my personal history was rewarding, as I could understand my experiences and think about my learning in a more focused manner.

I followed Nash's (2004) suggestion that scholars should make an effort to understand their personal experiences through narrative writing. Cole (2011) argues that connecting "current practices with childhood memories" is critical for teachers' reformation as these memories encompass emotional and personal issues that richly inform scholarly investigation. Memory enables us to uncover positive and negative emotions (Cole, 2011).

The first memory I relate is of how we played games as we grew up. I thus commence my narratives by describing memories of my childhood experiences of mathematics as a Black South African child growing up in a township. I discuss how the acquisition of mathematical concepts happened before we started school and how it continued in primary school through the games we played when we were growing up. I then discuss my mathematics learning experiences in secondary school. Next, I reflect on my memories of teaching mathematics at primary school level. Finally, I deliberate on my encounters as a teacher educator at higher education institutions, where I worked with pre-service teachers in rural and urban contexts.

My learning journey involved objects and artefacts. Recalling these helped me reflect on my experiences of childhood when I acquired mathematical concepts. I recorded the data in a reflective journal and stimulated my memory through artefact retrieval and photographs. These processes enabled me to reflect on my personal history and review my practice to improve it.

3.2 My Childhood Experiences

My memory of my childhood experiences goes back to when I was about three years old, which was well before I entered formal schooling. I still recall my primary school years until when I was about 12 years of age. I grew up in Umlazi township near Durban in KwaZulu-Natal. In South Africa, a township is a suburb that is predominantly occupied by Black people. These areas were formerly officially designated for the occupation by Black people by apartheid legislation. Mampane and Bouwer (2011, p. 114) explain that "township residential areas in South Africa originated as racially segregated, low-cost housing developments for Black labourers to remain closer to their places of employment within cities and towns". We usually used the informal term 'location' to refer to a township.

Townships were usually developed on the periphery of towns and cities. Nowadays, townships are characterised by large surrounding informal settlements as many people who flock to cities for a better life do not find accommodation in already overcrowded townships (Mampane & Bouwer, 2011). Most of the houses in the township where I grew up had four rooms. There were very few big houses called *omazakhela* (meaning people have built them independently). As children living in four-roomed homes, I remember how we were envious of the people who lived in these bigger houses. We desired the lifestyle of rich people, and we associated their lives with warmth and luxury.

Each four-roomed house had a kitchen, a dining room/ lounge, two bedrooms (a small one and a larger one) and a toilet/bathroom. They were built of red bricks and roofed with asbestos and no ceiling boards. People who were doing well financially made some renovations to make these houses beautiful. For example, they would plaster them, paint the bricks and put in ceiling boards. Our house was one of the beautifully renovated homes in our section. For example, I recall that the radio speakers were mounted in the ceiling and you could not see them, while the radio was operated in the bedroom. I now realise how modern and advanced my parents were.

Such houses still exist, but most people have extended their homes by adding more bedrooms. There was no electricity in any of these houses, but a few houses were equipped with electricity as time went by. Now all the houses in the township where I lived have electricity. There were electrified streetlights outside our homes. All the houses in Umlazi township had running water. Most of the four-roomed dwellings were occupied by large families. Sometimes there were as

many as eight children in one household. Some slept in the dining room and even in the kitchen. A positive result of this tight living space was the spirit of union and closeness in families who earned a limited income. However, it would appear that the Black South Africans' human rights were denied, as there was a lack of adequate housing and electricity (Atmore, 2013).

We were a family of four: my mother and father and my younger brother and me. My mother was a nurse and my father was a clerk who worked for the Department of Works. We were the only family in my neighbourhood with only two siblings. My brother and I used to envy our friends who were members of large families. For us, this meant that they had more fun when playing with their siblings.

The social structure (the family, school and community) played a significant role in children's rearing. Looking back, I remember how much respect we had for our elders. It did not matter if an older person was not your parent. Madondo, who also recalls his childhood (Madondo, Mkhize, and Pithouse-Morgan (2019, p. 17) affirms that "every elderly person you met was your parent and [had] as much right as your biological parents to discipline you if you were behaving in an unacceptable way". That is precisely what happened in our community. According to Madondo et al. (2019), in rural KwaZulu-Natal in the 1980s when Madondo was growing up, the Zulu culture was influential. Specific values, such as respect and *ubuntu*[8], were instilled in the young generation.

We attended junior primary and senior primary schools that were close to our home. We referred to them as LP for a lower primary or HP for a higher primary school. The lower primary school started at sub-standard A (SSA), which was equivalent to Grade 1 and continued up to Standard 2, equivalent to Grade 4. The higher primary schools started from Standard 3 (Grade 5) up to Standard 6 (Grade 8) and the secondary school started at Standard 7 and 8 (Grades 9 and 10) while the high school was Standards 9 and 10 (Grades 11 and 12). Learners could exit school after Form 3 (Grade 9) to pursue a professional qualification such as teaching, nursing or policing. These were the only three options that we had as we grew up. My mother wanted me to become a nurse. However, I did not like nursing and opted for teaching.

[8] Ubuntu is a shared belief system within the community which promotes humanistic characteristics such as caring and respect for another person's dignity (Reddy, Meyer, Shefer, & Meyiwa, 2014).

The classes in the township's primary schools were not heavily overcrowded, with each class accommodating 30 to 40 learners. Ndimande (2016, p. 33) notes that "in the South African context, township schools are an equivalent of urban schools in the United States". However, in the apartheid era, large Black urban schools were under-resourced (Ndimande, 2016). They were vastly under-funded and the apartheid government spent very little per Black learner compared to other races. For example, Christie (1986) states that between 1982 and 1983, the government paid the following to educate each child per year: R149 for Blacks, R498 for Coloureds, R711 for Indians R1 211 for Whites. According to Ndimande (2016, p. 36), township schools, mostly in poor neighbourhoods, "that served Black children remained entirely racially segregated and lacked educational resources". Nowadays, township schools are mostly overcrowded and some still lack infrastructure. This is because of the development of informal settlements near townships and the influx of learners from rural areas.

Table 3.1 illustrates the structure of the schools in Black education during the apartheid and post-apartheid eras. It must be noted that there were variations in this structure.

Table 3.1: Illustration of the apartheid (old) and post-apartheid (new) structure of schooling

Primary schooling (Old)		**Secondary schooling (Old)**	
Lower Primary	***Higher Primary***	***Secondary***	***High school***
SSA - Std 2	Std 3 – 6	Std 7 – 8	Std 9 - 10
Primary schooling (New)		**Secondary schooling (New)**	
Foundation Phase	***Intermediate Phase***	***Senior Phase***	***Further Education and Training (FET) Phase***
Grades R –3	Grades 4 - 6	Grades 7 – 9	Grades 10 - 12

In tracing my memories to compose this personal history, I recalled the names of the schools we attended in the township as they had positive and encouraging connotations. For example, the primary schools I attended were *uMgijimi*, meaning a runner, *Umzwilili*, meaning a hummingbird, and *Zimisele,* meaning to be determined. I associate these words with the lessons we learnt for life. Each of us ran our own race to the finishing line in our earlier lives. We were motivated by passionate educators to run the race with a song in our hearts and achieve a better life. The schools were symbols of hope − we had to be diligent and aspiring and believed that we would accomplish something one day. Even though the educators were

very strict and exercised harsh punishment when we made mistakes, we pursued a positive future and persevered.

3.2.1 The lived experiences of childhood games

Informal Learning of Mathematics

Before we went to school, most of us were looked after by our grandmothers or carers while our parents went to work. We did not go to a crèche or preschool during those days, as we immediately started schooling in Grade 1, which was called Sub-Standard A (SSA). Padayachie et al. (1994) report that, before 1994, Black South African children could not access early childhood development programmes and services. I recall playing different games in our backyards and on the streets in the township. We also used school playgrounds for playing other games because the houses in the township were close to one another without much space for playing. Areas for recreation were limited as there were no parks in our neighbourhood. We played games after school and during weekends and holidays. We organised these games ourselves and no adults were involved. Older children facilitated the games that involved teams competing with each other. During play, we had fun and enjoyment. There was a sense of belonging. Reminiscing about these games gives me such delight, even now. We were never bored as we always had something to do to entertain ourselves.

Some of the games[9] we played were *amagende* (this game was played with stones), three tins, hopscotch, *ushumpu, arigogo,* and many others. A few of the games we played are described in the next sub-sections.

[9] The description of the games *amagende* and *three tins* have been published in an article: Kortjass, M. (2019). Reflective self-study for an integrated learning approach to Early Childhood Mathematics in teacher education. *South African Journal of Childhood Education, 9*(1), 1-11.

3.2.1.1 Amagende (stone game)

Figure 3.1: Representation of the stone game

This game was played with stones and was popular in the late 1960s and early 1970s among township children. We did not have enough toys, but stones were readily available in our township and were much fun to play with. Figure 3.1 depicts the stone game we used to play when we were around 3 or 5 years old. I took this picture at my current home as I reminisced about this game. When playing the stone game, we sometimes had to count the stones. For example, a person who won received a big pile of stones that was counted to determine the magnitude of the win. The counting ability we learnt also enabled us to count other prized objects, like the number of sweets we could buy every now and then. As we grew older, we were able to count with understanding.

Two to six players could play the stone game. We would sit in a circle with a big pile of stones (or pebbles) in front of us. We would draw a circle around the stones called *isibaya* (meaning kraal). Each player would pick one stone (*ingede*) to play with and would toss it into the air while dragging a portion of *amagende* (stones) from the circle. The player had to grab *ingede* as it came down, throw it up again and push *amagende* simultaneously into the circle (*isibaya*), leaving out one. The one left outside now belonged to that player. If the player dropped *ingede*, then it was the next player's turn. The same pattern continued until no more *amagende* were left in the circle. The following levels of the game involved the players leaving two, three, or four stones, and so on. The winner of each level was the player who had collected all the stones first. The stones were thus counted to see who had managed to collect the most, which was a significant learning experience in acquiring mathematical concepts.

3.2.1.2 Three tins

Figure 3.2: Illustration of the 3-tins game

Another popular game that we played was called "three tins". We played this game in the street because it required space to run. We would stack three tins, one on top of the other, starting with the big tin and the smallest tin on top, as depicted in Figure 3.2. We would then draw a circle around them and draw a line a few metres away from the circle. Two teams would be involved – the attacking and defending teams. The attacking team would throw a tennis ball and try to hit the tins so that they would come tumbling down. The thrower would then run towards the circle and reset the tins within the circle. Each player had three attempts to hit the tins. While this was happening, the defending team would run to retrieve the ball and then throw the ball, aiming to hit the attacker. A hit would mean that the attacker was out, just like hitting a cricket player's wickets. If the attacker was able to reset the tins without getting hit, a point was scored. All the team members were given a chance to attack, while the defenders were placed strategically around the tins (again, almost like a game of cricket). The idea was to aim and throw the ball as hard as possible at the tins, allowing the ball to bounce far away and giving the attacker a chance to reset the tins. Mathematical concepts were strengthened when hits were scored and counted.

I took this picture (Figure 3.2) recently to illustrate how we played the game. We would collect empty tins of baked beans, fish, jam, peas, etc. I also recall the food we used to eat during those days. Linked with this, we sometimes played "home". We would make small fires using twigs and cook food using the tins. We would sneak into our homes and "steal" some vegetables to cook. This sounds so unhealthy, just thinking about it now. But we never got sick. We would compete and decide whose food tasted most delicious.

3.2.1.3 Hopscotch

Figure 3.3: Illustration of the hopscotch game

Hopscotch was another popular game that we played when we were young. We would draw three circles, two squares and one circle on the concrete floor in our yard or on the road. The first player would throw a token (usually a pebble) into the first circle, hop on one leg into the three circles, and then land with both legs on the two squares and on the last circle, the home area. The player would then turn around and hop on one leg back to the starting position in the same way and pick up the token. After picking up the token, the player would hop into the space where the token was and continued hopping into the rest of the spaces. The next player then took a turn. The idea was not to touch any of the lines.

3.2.1.4 Playing with tyres

There were many other activities that we engaged in for recreation, which were not necessarily games. For example, we played with old car tyres. A photograph of this (Figure 3.4), was found in my family album. This photo was taken in the late 1960s. In this regard, Mitchell (2011, p. 43) asserts that "family albums are full of history and address stories". Two of the boys in the photograph are my cousins and the other was their friend. They were about 4 and 5 years old at the time. Looking at this photograph reminded me how we played with tyres, rolling them down the street and jumping inside or over them. When rolling the tyres, it was essential to roll them smoothly so that they stayed steady. We would put water in the tyres and use hard sticks to roll them as if we were driving a car. It was convenient to play in the streets because of the space and there were not many cars around. Sometimes we would go to a nearby school playground to play. It was the boys who played with tyres the most, but sometimes girls also played with them.

Figure 3.4: My cousins playing with tyres

3.2.1.5 Reflections about the games we played

My recollections of childhood games made me realise how influential these games were in my mathematics learning. For example, when we played with tyres, I was not aware that I was learning geometry. Now, I can teach geometry using the games we played and link them with mathematics. Because mathematics was entrenched in our environment and in the activities that we engaged in, I can draw on examples of readily accessible objects in our communities. Bishop (1988) argues that mathematics may be regarded as a result of cultural activities practised in various communities. Bose and Seetse (2016) argue that play and games are strongly connected to childhood and offer children opportunities to be imaginative and develop their intellectual thinking. Consequently, the reflections about the games we played when we grew up motivated me to incorporate them in teaching my pre-service teachers. They will be teaching young learners themselves one day.

Primary school teachers could use such examples by drawing on learners' cultural experiences when they teach mathematics. Nkopodi and Mosimege (2009) highlight that it is vital to expose learners to opportunities that associate mathematical concepts and principles with what they encounter in everyday life. Therefore, I believe it is essential in the early childhood mathematics module to emphasise the significance of the sociocultural knowledge that young learners bring to the classroom.

3.2.2 My experiences of learning mathematics in primary school

Formal learning of mathematics

For me, Mathematics was the most challenging subject in primary school. One stumbling block was that we were compelled to memorise times tables.

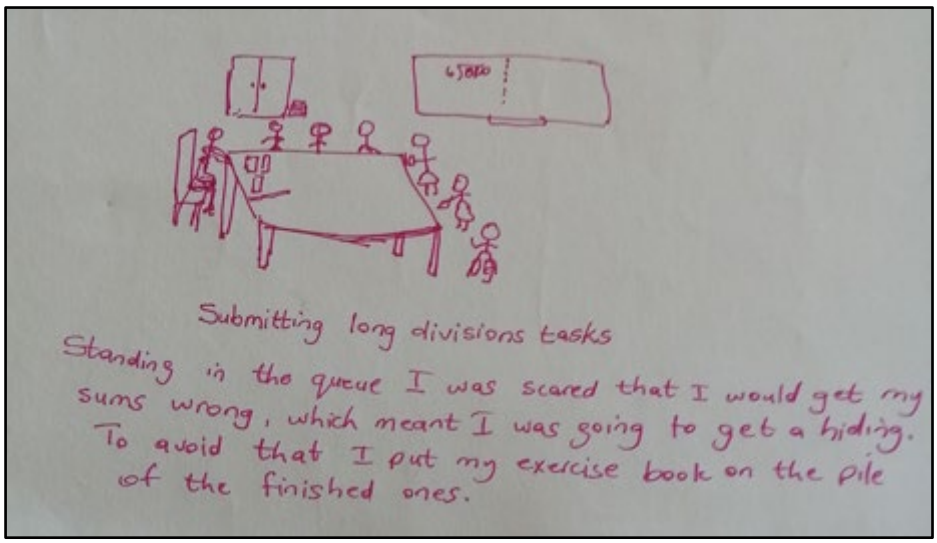


Figure 3.5: Submitting long division tasks

Figure 3.5 is a drawing from memory as I recalled my childhood experiences of learning mathematics. This memory drawing represents my struggles with long division when I was in primary school. According to Tahir (2010), some teachers believe that teaching long division is a mammoth task and that the learners do not understand it. Further, Tahir (2010) claims that one obstacle that makes it hard for young learners to solve long division problems is not knowing their times tables well. I recall one day when our Grade 1 teacher gave us some long division exercises. She sat at her desk in front of the class next to the cupboard and we had to queue to submit these exercises one by one. If you did not get the answers right, you got a hiding with a cane. I was really scared as I knew that I had not performed well. So, to escape the beating, I decided to put my exercise book on the pile of the exercise books she had finished marking. Remembering this experience, I am reminded of the fear that some children may experience if we do not show compassion.

As a teacher educator, I aspire to use inventive methods to explain potentially problematic mathematics concepts. Introspectively, had I not reflected on this frightening memory, I would not have realised how I might have failed to meet my pre-service teachers' needs. As I prepare pre-service teachers to teach mathematics to young learners, I need to be aware of making mathematics accessible and creating a learning environment where my students will feel safe.

Allender and Allender (2006) emphasise that teachers need to be humanistic and prioritize their learners' needs. When creating a humanistic environment, learners are not scared to fail and try again. Mathematics is a subject that often inspires fear, and it is even worse when it is associated with punishment when you are still a young learner.

3.3 My Experiences of Learning Mathematics in Secondary School

As alluded to earlier, our teachers and we made no connections between mathematics learning in school and informal learning at home or during play. My memories of mathematics in secondary school are unpleasant. I remember that we were always beaten for getting the wrong answers. For instance, there was a time when we were asked to buy graph paper for geometry activities. One of the learners in class did not have any, as his parents did not have the money. The teacher always scolded him, and he was so embarrassed that he ended up dropping out of school. Many learners left school for different reasons, such as avoiding being beaten as they struggled with mathematics while others had special needs that were not met. The schooling system was rigid, and the teachers were very strict.

Another incident I remember is when I was in Standard 8 (Grade 10). It was early in the year when we were taught theorems, which I did not understand. In mathematics, a theorem is a statement that has been proven based on previously established statements, such as other theorems, and generally accepted statements, such as axioms (Luneta, 2014). Although they can be written in an entirely symbolic form, for example, within the propositional calculus, theorems are often expressed in an academic language such as English. Unfortunately, to me, it sounded like Greek. My mathematics teacher did not clarify the theorems in a way that we could understand them. Very few learners understood mathematics in his class.

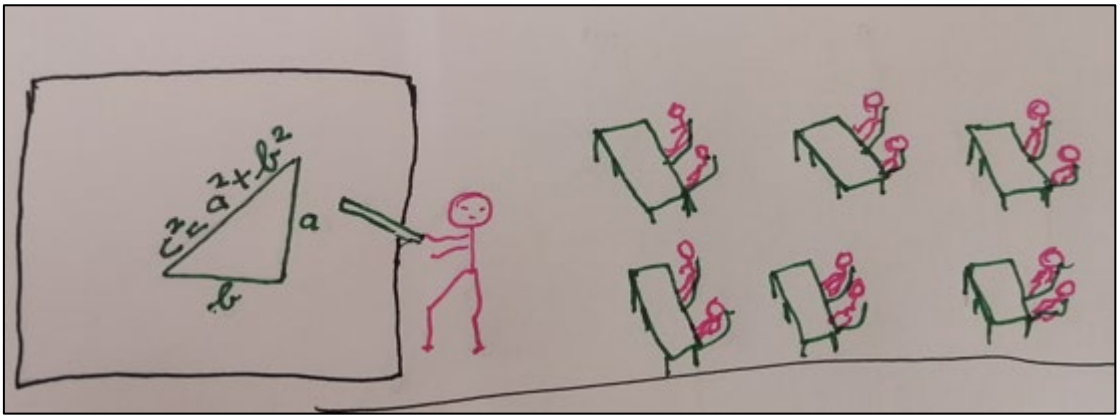


Figure 3.6: A drawing of the classroom in secondary school

Figure 3.6 depicts my Grade 8 mathematics classroom. The classroom was arranged in rows and two learners would share a desk. The teacher would explain the sums on the board and then give us exercises to do. Most of us would get the sums wrong and we would be beaten for that. My negative attitude towards mathematics learning escalated to a point where I decided to drop out of the Mathematics class and take Functional Mathematics instead. Functional Mathematics of those days is very similar to the current Mathematical Literacy. Mathematical Literacy involves the mastery of fundamental mathematical skills and was included in the South African Further Education and Training (FET) curriculum in 2006 (Houston et al., 2014).

During the apartheid era, the curriculum was structured in three streams in Black schools: the general, the science and the commerce streams. There were very few schools that offered commercial subjects. Therefore, most schools offered general and science subjects. The subjects in the general stream included subjects such as IsiZulu (for IsiZulu home language speakers), English, Afrikaans, Biology, History and Agricultural Science. Thus, in Standard 9 and 10 (Grade 11 and 12), learners had the option of dropping Mathematics entirely. I decided to take the general stream subjects. (Currently, the revised South African National Curriculum stipulates that all learners should do mathematics − either Mathematical Literacy or 'pure' Mathematics.) My choice of the 'easier' mathematics stream negatively affected my self-concept as my belief that I could not do mathematics proliferated. Failing to do mathematics in secondary school made me believe that I would never succeed in mathematics in my life, let alone teach it.

As an adult, I now realise that many adults have negative mathematics memories because of their school experiences. Many adults who reminisce about their days at school declare that mathematics was the most difficult of all the subjects they learnt (Dewah & Van Wyk, 2014). The widely used teacher-centred approaches to teaching mathematics had detrimental effects on learners and caused many to drop out of school. In these approaches, class activities were centred on the teacher and involved drilling, memorisation, lecturing, and corporal punishment (Kunene, 2009; Pithouse-Morgan, Makhanya, Downing, & Phewa, 2019). I know of learners in my Grade 8 class who dropped out of school because of their difficulties with mathematics and the harsh, unforgiving teachers.

My personal experiences and reflections suggest that mathematics education needs to be

contextualised so that it is accessible. A study that was conducted by Gerdes (1988b) in Angola focused on traditional Angolan sand drawings. It was meant to provide a concrete example of how it is possible to use indigenous mathematical ideas in the teaching context. Nicol, Archibald, and Baker (2013, p. 76) describe this approach as "culturally responsive education" in which learning and teaching are facilitated by acknowledging the significance of relationships while "drawing from the culture, knowledge and language of students, teachers, and the local community". Likewise, Gerdes (1988a, p. 138) argues that building a bridge between community acquired mathematics and school mathematics can motivate learners to learn and make sense of mathematics. He advises that "the teacher should begin with materials of the indigenous culture, leading the child to use them in a creative way", and from there, progress to the Mathematics curriculum at school. It was against this backdrop that I was motivated and inspired to model this proposal in my teacher education practice. This meant that I had to make an effort to link the sociocultural contexts of my pre-service teachers' learning and to build upon these in the mathematics that they were learning in the teacher education context.

3.4 Lived Experiences of Learning to Teach Mathematics in a Tertiary Setting

After finishing high school, I enrolled for a Primary Teacher's Diploma in 1985 at a college of education. The college was located in a township in Pietermaritzburg. It offered primary teacher training, which was divided into Junior Primary (Grade 1 to 4), Senior Primary (Grade 5 – 8), and Secondary School (Grade 9 to 12) teacher training models. This teacher education college was widely considered to be one of the best colleges at the time. It was managed by the Department of Education and Training and accommodated only Black students. Most of the lecturers were white, with only a few Black lecturers who taught mostly IsiZulu.

Before 1994, the South African education system comprised of different departments that served diverse ethnic groups. In the mid-1990s, the various education departments were amalgamated into one National Department of Education divided into two departments: one for primary and secondary education (currently known as the Department of Basic Education) and tertiary education (known as the Department of Further Education and Training). Table 3.2 summarises the different education departments during the apartheid era.

Table 3.2: South African education departments in the apartheid era (Adapted from Fiske and Ladd, 2004)

Department	Abbreviation	Demographic
Department of Education and Training	DET	Previous apartheid department for Blacks in urban areas
Department of Education and Culture	DEC	Previous apartheid department for Blacks in rural areas
House of Assembly	HoA	Previous apartheid department for Whites
House of Delegates	HoD	Previous apartheid department for Indians
House of Representatives	HoR	Previous apartheid department for Coloureds

From 2000, the colleges of education closed their doors, and pre-service teachers' training was moved to universities. The Mathematics curriculum at the colleges of education focused on how to teach mathematics in Grade 1 to Grade 4. During that time, Grade 4 was part of the Junior Primary (Foundation Phase). During the 1980s and early 1990s, primary school teachers were trained to teach languages, mathematics, health education, handwriting, religious education, environmental studies, physical education, needlework and gardening. During my teacher education training, theme teaching was emphasised. We were also taught how to involve learners practically. In our teacher training course, the lecturers worked collaboratively with neighbouring schools to provide us with hands-on, practical teaching experiences.

I remember that there was a viewing room that was used for lesson observations. Learners were brought to the college from neighbouring schools to be taught by student teachers while other students viewed and made notes for discussion later. The two rooms were separated by tinted glass. If you were in the viewing room, you could not see the people watching you, although you knew they were there.

Figure 3.7: Images of the teacher education viewing room

Figure 3.7 depicts the viewing room from different angles. When I was writing this chapter, I felt a need to visit the institution where I had obtained my primary teacher education. I took these pictures (Figures 3.7, 3.8 and 3.9) to show the rooms and resources we used as we were prepared to become primary school teachers. Being exposed to this type of learning where practicals were the focus indicated the importance of an integrated approach that allowed us to see how learning occurred in practice. In my view, classroom observations are essential in enhancing teaching practice. Barends and Nel (2017) maintain that many studies have shown the advantages of linking teacher preparation to teaching practices. In my opinion, the viewing room was fundamental to our teacher preparation and our ability to teach young learners one day. Thus I need to motivate my pre-service teachers to learn to encourage them to understand and apply appropriate practices as Foundation Phase teachers.

Chalkboard writing was another fundamental learning experience during our training at the college of education. I remember our lecturer emphasising the writing of number symbols and number names. We did not take this seriously as it looked so easy when the lecturer was writing on the chalkboard. However, when we practised writing on the board, it was not as easy as we had thought. Chalkboards were mounted on walls in certain corridors. This is shown in Figure 3.8, a photograph I recently took at the college I studied. The picture depicts chalkboards in rooms that were newly refurbished. Reflecting on this vital requirement, made me feel apprehensive about preparing my pre-service teachers, especially for the Foundation Phase. I realised I needed to expose them to more practical experiences in the module, including chalkboard writing.

Figure 3.8: Chalkboards mounted on the walls in corridors in a college of education

I feel that our pre-service teachers are not given enough practical experiences**,** such as micro teaching. Micro teaching is similar to a simulation where the focus is on practising a particular teaching method, for example, problem solving.

Figure 3.9: The micro teaching classroom

The micro teaching classroom depicted in Figure 3.9 shows where we practised different teaching methods in a small group. These rooms have since been renovated. I also took this picture when I visited the college recently. It brought back good memories of how we were prepared to teach. Practical activities were the focus. I remember a task we were given to prepare a lesson on subtraction using concrete objects. When presenting that lesson, we had to be mindful of the terminology we used, such as “take away” or “make less” or “decrease”, so that we would not confuse the learners. We presented these lessons to our classmates. Having gone through this kind of preparation, I felt well equipped and could not wait to be in a classroom of my own and implement everything I had been taught. I was really motivated and ready by the end of the three years of training as a Junior Primary student teacher.

3.5 Lived Experiences of Teaching Mathematics in a Primary School Setting

I started teaching in 1986 after completing my Primary Teacher's Diploma at a college of education. Because a post was not available at a school in the township where my home was, I was happy to start my career at a school in a rural area. The school was far from home, so I was accommodated in a school cottage. Most of the teachers in the school were not from the local community.

This was an exciting time for me. After studying for three years, I was eager to implement what I had been taught at college. I had a box full of resources that I had created over the three years at college, including puppets, flannel boards, charts, flashcards, etc. The school where I started teaching had no resources, and thus, the materials I brought were useful.

The classroom that I was allocated for my Grade 3 teaching had no cupboard, no door and most of the windows were broken. The charts that I used got dirty. There was no running water in the school. Absenteeism was rife. I remember that most of the boys would not come to school on Tuesdays because it was the day that livestock had to be dipped. Nevertheless, we tried our level best under challenging circumstances.

The following year I moved to a township school. The context there was totally different. The school had some resources compared to the rural school, but not enough. For example, all the classrooms had enough desks for the learners and a table and cupboard for the teacher. However, we did not have resources such as an abacus (counting frames), building blocks, or dominoes for mathematics lessons. I would ask the learners to bring bottle tops for counting, cardboard for cutting out shapes, old calendars and other things from their homes and what they could source from the community.

My most vivid memory is of how the teachers in the whole school would engage in theme teaching. We would select a theme and teach all the subjects around that theme in a particular week. Björklund and Ahlskög-Bjorkman (2017, p. 98) describe a theme as an "exploration of many different aspects of a topic or subject, involving constant interaction between teacher, child and the environment". For example, if we did the theme 'Water', I would teach about capacity in Mathematics, Noah's ark in Religious Education, sources of water in Environmental Studies, and the 'Importance of water for our health' in Health Education. The

thematic approach provided ample opportunities for learners to explore and experiment with mathematical connections with other subjects.

3.6 Lived Experiences of Teaching in a Tertiary Setting

In 1995, I was appointed as a lecturer at a college of education. However, I did not teach Mathematics but Environmental Studies. I was employed in the Junior Primary department, which was well established with 10 staff members who were specialists in the Foundation Phase. This department was grounded in Foundation Phase teaching principles and offered different subjects such as Handwriting, Needlework, Physical Education and chalkboard writing over and above the more 'academic' subjects such as Languages, Mathematics and Environmental Studies (or Life Skills). This curriculum was structured to provide the student teachers with a solid foundation to prepare for them for their roles to teach learners in primary school.

To ensure that student teachers were prepared well, we as Foundation Phase lecturers would each engage with a small group of student teachers to facilitate micro teaching activities. Coffman (2006) states that, in this situation, student teachers are assigned tasks that require them to act within that setting involving the content and methods needed. Furthermore, McGlynn-Stewart (2010) emphasises that pre-service teachers need to be allowed to display competence in mathematics teaching. Micro teaching afforded student teachers opportunities to learn and practise different teaching methods. As I carried out these tasks with my student teachers, I gained confidence as a Foundation Phase teacher educator. Thus, it was essential to understand the significance of reflecting on my ideas and practices and learning from my teaching experiences while constructing knowledge about teaching pre-service teachers.

When we engaged student teachers in micro teaching sessions, a lecturer would sit in with a small group of students to focus on one teaching method for teaching young learners. Throughout the three years of their training, the student teachers were afforded opportunities to develop teaching resources.

3.7 Lived Experiences of Mathematics in Teacher Education

3.7.1 Coordinating mathematics modules

In 2002, I became involved in the National Professional Diploma in Education (NPDE) programme at a local university. The programme's purpose was to upgrade teachers who were

un- and under-qualified to improve teaching quality. The previous teacher education certificates, diplomas, higher diplomas and further diplomas were being phased out, and these teachers had these older qualifications. The NPDE provided teachers with an alternative access route to become fully qualified professionals and be on par with the new qualification framework (Moll, Welsch, & Naidoo, 2004). The programme was practice-based and had a strong classroom focus. It aimed to equip teachers with the foundational, practical and reflective competencies required for further practice and study. The university had regional learning centres in the KwaZulu-Natal and the Eastern Cape provinces. The teaching sessions were facilitated using a mixed mode approach where the teachers attended the sessions on Saturdays, were taught by tutors, and spent time on their own studying and doing activities.

My role was to coordinate the Mathematics module. My responsibilities also involved appointing and training tutors and assessors, moderating assignments, setting examination papers, and training tutors in teaching the Foundation Phase Mathematics module. I was also part of the team responsible for overseeing the whole programme's running with emphasis on work integrated learning. My teaching and learning of mathematics in teacher education began when I worked in the NPDE programme as an academic coordinator.

I found myself having to learn mathematics to train tutors who were going to teach in-service teachers in different learning centres. When I started in the programme, the training manual and student guide had already been developed. Therefore, it was not as challenging to learn because the language used in the material was easy to understand. Going through the material made me realise that I lacked content knowledge of primary school mathematics. This was due to the nature of the education that I had received at school. I concur with Schuck (2009) that primary school teachers and teacher educators may value mathematics's importance at this level, but many feel unprepared to teach it. As I reflected on this, I realised that my college training had not prepared me to teach the content of mathematics as the focus had been on teaching methods only. Thus lack of confidence drove me to invest time in learning and gaining content knowledge of mathematics.

The Mathematics modules in the NPDE programme focused on both content and method. Thames and Ball (2010, p. 223) state that, to teach well, teachers need "an abundance of mathematical skills and of *usable* mathematical knowledge – thus mathematical knowledge in and for teaching". Being involved in this programme equipped me with mathematical

competences and established a good foundation for me as an early childhood mathematics teacher educator. I gained knowledge of what the Foundation Phase teacher is expected to know regarding the content areas of Mathematics as a subject. Thames and Ball (2010) argue that mathematics requires efficient teaching for which teacher education and development are vital. My experience in the NPDE marked the start of my learning to teach mathematics as a teacher educator, and I began to gain confidence in teaching Mathematics as a subject.

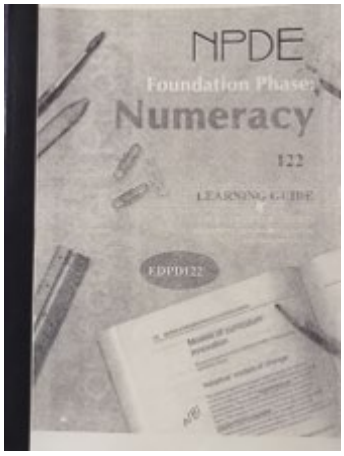


Figure 3.10: A numeracy learning guide used in the NPDE programme

Figure 3.10 depicts one of the Mathematics learning guides that we used for in-service teachers. This module covered geometry and data handling in the Foundation Phase. It was the first time that I learnt about Pierre and Dina van Hiele and their model, which proposes five hierarchical levels through which learners develop their understanding of geometry (Luneta, 2014). I have since been drawing on the van Hiele model in my teaching of geometry in teacher education.

3.7.2 Teaching pre-service teachers in a rural area

In 2013, I started working at a private higher education institution. The pre-service teachers that I taught received tuition bursary from the KwaZulu-Natal (KZN) Department of Basic Education (DBE). During that period, South Africa experienced problems in supplying teachers in the Foundation Phase. Sayed and McDonald (2017, p. 2) note that many interventions, such as the Teacher Rural Incentive Scheme (TRIS), the Funza Lushaka Bursary Programme (FLBP) and the Strengthening Foundation Phase Teacher Education Programme (SFPTEP) were implemented to rectify the problem. Funding was provided to support teachers and students and to expand research in this field.

Approximately 1 200 students were registered at the nine centres in KZN by a private higher education institution to offer the B.Ed. programme to Foundation Phase and Intermediate Phase pre-service teachers in 2013, specifically in rural areas. I was based at the Ixopo Student Support Centre as a teacher educator responsible for teaching B.Ed. FP and Intermediate pre-service teachers. Ixopo was one of the nine centres that offered the programme in KZN. The DBE embarked on this initiative due to the shortage of Foundation Phase teachers in the country, especially in rural areas – which, in my view, was a commendable initiative as it "took education to the people".

Figure 3.11: Entrance to the Seminary used as a student support centre in Ixopo

Figure 3.11 shows the Ixopo centre where the B.Ed. programme was offered for four years. The Seminary is perched on the top of a hill and is surrounded by ancient cedar woods. It was built in 1928 by German Trappist Monks and was once a high school for Catholic priests in training. The Seminary is now a nursing college and is home to mostly women students. Like most missions, it is quite spectacular, and its appeal lies not only in its religious background, but also in its architecture, history, and enchanting environment. There is a steel gate with a lock and chain which is opened in the morning and locked in the afternoon. Wedding ceremonies also take place at the chapel.

The photograph was taken by one of the Intermediate Phase pre-service teachers in 2013[10]. It was taken just a few months after the B.Ed. programme had commenced in KwaZulu-Natal.

[10] I received permission from the student to include this photo in my thesis.

This picture reminds me of good memories of the two years I spent in Ixopo teaching student teachers at the Seminary. I remember the first time I came to view the place before the lectures commenced in February 2013. The site looked deserted, lifeless and dilapidated. I learnt that it had been abandoned for some time. The structure still looked strong, and it was apparent that it had been well built. Coming back to a rural area to work there was not strange for me at all. I related well with the environment, mainly because I had spent my high school years in boarding schools located in rural areas. This photograph also symbolises my journey as a teacher and a teacher educator who taught in rural settings.

I taught the B.Ed. programme for Foundation Phase (FP) and Intermediate Phase (IP) pre-service teachers. In 2013 I taught three Mathematics modules: a Fundamental Mathematics module (Academic Numeracy) that was taken by both FP and IP pre-service teachers, a methods module for FP (Numeracy for Foundation Phase), and a methods module for IP (Mathematics Teaching in the Intermediate Phase). All the students received learning guides and student guides for these modules. These guides were well structured to provide them with both content knowledge and pedagogic content knowledge. Shulman (1987) emphasises that teacher education courses should focus on mathematical knowledge that is the foundation of effective teaching. Thus, the teacher education courses in Mathematics could transform subject knowledge into pedagogical content knowledge (Thames & Ball, 2010). I found that these modules successfully achieved that.

I was confident in teaching the Foundation Phase Mathematics module because of my experience in this phase. The module focused on the following content areas: numbers, operations, and relationships. All 35 students in this group were female. It was easy to engage these pre-service teachers in group activities because of the small number and their commitment. I also integrated games in my teaching. Ramani et al. (2012, 669) note significant improvements regarding “number line estimation, numerical magnitude comparison and numerical identification” associated with the playing of board games. The photo below shows pre-service teachers engaged in group activities. It must be noted that, when I taught these pre-service teachers in the rural area, I did not use any technology. I used my computer for preparing lesson plans and not for teaching. That was one of the shortcomings of this programme. There was no audio-visual equipment in the student support centres. Therefore, I did not use PowerPoint presentations, which was regrettable. However, I observed that the pre-service teachers became competent in presenting their simulation lessons using resources such

as charts, counters, and board games. This reminded me that we did not use any audiovisual technology when we were trained to become teachers. Still, we did our best to implement the teaching methods, using available resources.

Figure 3.12: Pre-service teachers engaged in a group activity

During the first semester of the first year of the programme, the pre-service teachers engaged in simulation teaching every Wednesday. They would prepare lessons and present them to the whole group. The students were also given study time in the afternoons. On Tuesday afternoons, the students who had been selected to present simulation lessons the following day used this time to prepare for their lesson presentation and develop the resources that they needed. They would also consult with me to guide them by checking their lesson plans and advising them on what they needed to do. Four students would be selected to do the presentations on one day. This allowed enough time for engagement and discussion after the presentation. Murray, Grant, Howarth, and Leigh (2008, p. 6) describe simulations as "offering experiences for teaching and learning that emulate the properties of a real-life experience". According to (Coffman, 2006), simulations afford pre-service teachers a chance to practise and apply a specific teaching and learning skill: "An experience or real-life situation is imitated" (Coffman, 2006, p. 2). During these sessions, I noted that these pre-service teachers were learning from one another, and they also learnt to think critically. During the simulation lessons, my role was two-fold: a facilitator and someone more knowledgeable. I was also learning from them and welcomed their complete involvement and participation.

This programme offered significant learning experiences for the students who were given opportunities to practice what they had learnt. I remember one student presented a lesson on place values. I was very impressed as she had gone out of her way to create a poem that learners could use to better understand the concepts. She also used the resources effectively.

At the beginning of the programme the students did not have any resources to stimulate integrated learning. I had to provide resources such as flip charts, A4 charts, koki pens, an abacus, counters, and others from previous projects I had been engaged in. Barends and Nel (2017) state that insufficient resources and a lack of provisioning for pre-service teachers' practical experiences may hamper the attainment of the programme's objectives. This is especially vital to curb in Foundation Phase education.

Figure 3.13: Pre-service teachers engaged in a simulation lesson

Teaching mathematics in the Intermediate Phase module was a challenge because I had been trained in the Foundation Phase and not the Intermediate Phase. This compelled me to learn fast. The module covered the content from Grade 4 up to Grade 7. It aimed at empowering the pre-service teachers to effectively teach mathematics in the Intermediate Phase. The module addressed the content area and focused on numbers, operations and relationships. I remember experiencing difficulties when teaching ratio and rate, especially when solving word problems associated with ratio and rate. My own judgement of my inability to do the mathematical problems informed me that I lacked mathematical self-efficacy (Bates, Latham, & Kim, 2011). I sought help from a friend who was skilled in mathematics and the more competent students assisted in explaining these skills to other pre-service teachers. I am afraid I was one of the mathematics teacher educators that Pereira (2011) refers to as those who do not have sufficient knowledge to teach the subject to pre-service teachers.

At some point, teaching the Fundamental Mathematics module was challenging. This module aimed to equip pre-service teachers with basic mathematical concepts and practically strengthen their knowledge of mathematics. It focused on the following three content areas: numbers, operations and relationships, and measurement and data handling. I was excited to

see what was covered in the learning guide, but at the same time a bit apprehensive about teaching it, given that I was not a mathematics specialist and had had negative experiences of formal learning of mathematics throughout my life. I now see that I lacked confidence because I had been taught mathematics in an inappropriate way (Dewah & Van Wyk, 2014). I did not feel entirely comfortable teaching this module, especially to Intermediate pre-service teachers. I felt some of them knew more than I did as they had taken Mathematics up to Grade 12. I thought that I did not possess sufficient content knowledge of mathematics. I concur with Brady and Bowd (2005, p. 43), who affirm that some mathematics teachers connect "their lack of confidence in teaching mathematics to a lack of sufficient academic preparation in the subject". Likewise, Bates et al. (2011) proclaim that there is an indication that early childhood teachers lack content knowledge and a positive attitude towards mathematics compared to their Intermediate Phase counterparts. Hence, I challenged myself to learn more.

Figure 3.14: The clock with Roman figures that I hung in my classroom

I recall how I brought a clock to the classroom when I taught the Roman number system (Figure 3.14). It reminded me of a mistake I had made in class and that I had been corrected by one of the pre-service teachers. In one of the lessons, I made an error of writing the number 40 in Roman figures. I wrote XXXX on the board instead of XL. I recall seeing how surprised one pre-service teacher was that I had got it wrong as a teacher educator. It was as if I had betrayed his trust by making an error. Samaras and Roberts (2011, p. 43) note that "teachers, like learners, learn from their mistakes". This incident allowed me to discuss the fact that, as teacher educators, we also make mistakes. Furthermore, I wanted them to understand that teacher

educators and teachers do not know everything and should continuously learn to improve their knowledge and practice. Goos (2014) believes that it is invaluable to understand how mathematics teacher educators continue to learn professionally in their careers.

I decided to embrace this disturbing incident and to view it as a lesson. As the semester progressed, the mathematical concepts became increasingly difficult. I arranged meetings with my friend, a mathematics lecturer, to explain the difficult concepts. He would take me through the concepts that were challenging. This links with McGlynn-Stewart (2010), who advises that teacher educators who are not mathematics experts should learn more to become competent in teaching content and methodology. Gradually, I was able to enhance my level of mathematical understanding. I felt that my confidence was increasing as I continued to teach mathematics. I began to enjoy teaching the subject and looked forward to learning more.

The photograph (Figure 3.15) of pre-service teachers laughing and looking happy upon receiving the golf shirts reminds me of their joy and how culture played an essential role in preparing these pre-service teachers. As indicated earlier, the institution at which these pre-service teachers were enrolled was a private institution with its head office in another province. This created rumours from certain sources that this institution was ‘not genuine’. Colleagues from other institutions teased the students, saying they were registered at a ‘bogus institution’. When the pre-service teachers received the golf shirts, they felt they were in the right place − that they belonged to a credible institution. It did not matter then that they attended their sessions at a student support centre and not at a ‘real’ institution. The golf shirts with the institution’s logo signified a sense of belonging and prominence, which was important to them.

Figure 3.15: Pre-service teachers at the Ixopo student support centre

This photograph evokes positive memories of my journey as a teacher educator[11]. I value the experiences that I gained throughout the years of preparing Foundation Phase pre-service teachers in an initial teacher education programme. It also symbolises my interest in cultivating an integrated learning approach to teaching the early childhood mathematics module. First, the photograph represents my integration experience in teaching at the Foundation Phase level, a college of education and higher education institutions in rural and urban contexts. Second, it represents my experiences of employing an integrated learning approach involving pre-service teachers in the Foundation Phase's mathematics module. Lastly, it symbolises my commitment to making a difference as a teacher educator.

As a teacher educator, my experiences taught me to make sure that pre-service teachers can grasp the concept of bridging informal learning with formal school learning to lay a good foundation for young learners' future learning. I thus always aspired to help my pre-service

[11] This section of my journey as a teacher educator has been published in a book chapter: Dhlula-Moruri, Kortjass, Ndaleni, and Pithouse-Morgan (2017). A stove, a flask, and a photograph: Learning together through object inquiry in self-study research. In D. Pillay, K. Pithouse-Morgan, & I. Naicker (Eds.), *Object medleys: Interpretive possibilities for educational research* (pp. 81-98). Rotterdam, Netherlands: Sense Publishers.

teachers unlock their potential as well as that of young learners. I realised that it is crucial to consider students' backgrounds when preparing them for their roles as teachers.

The pre-service teachers experienced many problems during their training. As the bursary they received covered tuition only, they had to be supported financially by their relatives who paid for their food and accommodation. By showing the pre-service teachers that I respected them and acknowledged the problems that most of them had, I gained their love and trust. I listened carefully and with genuine interest as they described their experiences before they received the bursary. Some of them had lost hope of ever getting any qualification as their families could not afford to enrol them at a tertiary institution. In the photograph, the smiles on their faces are symbolic of their joy at being afforded the opportunity and the hope that they would be able to make a difference at the schools at which they would be working and in their homes. This taught me not to take things for granted, and I thankfully embraced the experience of working in a rural community.

As the Seminary was very far from the main road, the students had to walk a long distance to the centre. Those that could afford the transport fee managed to organise a taxi that would transport them from where they stayed in an informal settlement to the centre. Many teachers in South Africa work in dire conditions and teach children who experience difficulties because of poverty and other unfavourable conditions. Therefore, as teacher educators, we need to ensure that pre-service teachers are well prepared for their various roles, many of which go beyond teaching. I felt that my responsibility went beyond teaching these pre-service teachers. I found myself caring for them, bringing food to some of them and often providing funds for necessities. Likewise, Case et al. (2018) described university students' circumstances in a rural area in South Africa who were assisted by university professors for more than academic issues. Such incidents cannot be taken for granted as they validate what Morrow (2007) alludes to regarding educators' work, which entails more than being in the classroom and delivering the curriculum.

The red brick building in the photograph (Figure 3.15) signifies the importance of knowing pre-service teachers' backgrounds to address their needs. According to Ladson-Billings (1995), education that is relevant to pre-service teachers' backgrounds and experiences can allow them to maintain some cultural integrity while gaining academic excellence. For example, throughout the hardships that the pre-service teachers encountered, they chose academic

excellence, as is proposed by Ladson-Billings (1995, p. 160). They worked hard and obtained good results.

This photograph (Figure 3.15) depicts the metaphor ‘weathering the storm’ and reinforces the significance of the many difficulties the pre-service teachers experienced, but that they persevered, succeeded and were in their final year of study. I was amazed by the dedication they displayed during the lectures. As a result, they performed really well in assignments, tests, examinations and in their work integrated learning. The teachers in the schools where these pre-service teachers did their integrated learning were impressed with how they taught Foundation Phase learners. I travelled with a colleague to visit the schools, mostly located in deep rural areas. The roads to most of the schools were in terrible condition. This context is not unique to rural South African regions, and it is a global phenomenon that communities in such areas tend to be impoverished (Case et al., 2018). Even though some of the schools were so isolated, when we arrived there, we realised that the pre-service teachers were well prepared, and they and the learners exuded enthusiasm. This was a very motivational experience.

3.7.3 Teaching pre-service teachers in an urban area

In 2015, two years after my involvement in the pre-service teacher education programme in the rural area, I was employed at a university in an urban area in the Early Childhood education discipline. (This is my current place of work.) I observed some differences and some similarities with my previous experience in the rural area. In terms of infrastructure and technology, the contrast was striking. The institution was well resourced in that all classrooms had audio-visual equipment and many students had laptops. They had access to the learning area network system (LANS) to utilise Moodle, the university’s online system. Moodle is an acronym for Modular Object-Oriented Dynamic Learning Environment. It is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalised learning environments. Most South African universities have adopted and integrated e-learning platforms to teach and learn in undergraduate programmes (Mpungose, 2019). However, because the majority of the students in the B.Ed. programme came from disadvantaged backgrounds, most of them would have attended poorly resourced rural schools. As they entered the university, many faced many challenges, and some had never touched a computer before. Those who received bursaries were given laptops, but they could not use them because they were not proficient. Those who did not have laptops found that the LANS venues were always full, which prevented them from

doing assignments on computers. Hence, there was a mismatch between pre-service teachers' challenges and their delight at being accepted at a higher education institution.

In the first few lectures, I had to show my students how to access Moodle. I projected it and explained the process. I then asked one of the students to log in and show the others. It was vital for me to consider their knowledge and experiences in terms of computer literacy. I could not pretend that all was well as I would have posted notes and activities on Moodle that would be useless. This experience caused me to believe that there needs to be a transition phase in which students are gradually introduced to the practices and culture at a university. Achieving a balance between using technology and giving students the material on hard copies is a necessity.

The pre-service teachers in my class came from diverse cultural backgrounds and racial groups as I had White, Coloured, Indian and Black students. It was the first time that I taught a multi-racial class in an undergraduate programme and I saw this as a challenge. I remember thinking that I had to be on my toes and make sure that I did not make mistakes when I used English, not my mother tongue. I was always well prepared and engaged all my pre-service teachers and I felt good when I received a positive evaluation from them.

Before 1994, during the apartheid era, the Early Childhood education sector was neglected and viewed as insignificant. According to Ginsburg (2008), professionals in this sector are often associated with low prestige. I thus felt that I needed to continually motivate my students and show enthusiasm so that they would understand the value of working with young learners. I strove to commit myself and make a difference as I proceeded with my work in the module I was teaching, and I considered this commitment when I planned my lectures. The experience I brought with me encouraged me to inspire my students to reach their potential. I felt that it was essential to use innovative strategies to improve their learning and enhance my practice.

Weber (2014) argues that "teaching is a complex act involving many things happening at once. Visual methods such as video and photography help capture that complexity and sets [sic] it up for inspection" (p. 11). The photograph in Figure 3.16 demonstrates my attempts to make use of different teaching methods in my class. In this lesson, I showed videos of student teachers teaching counting to Grade R learners. I had asked pre-service teachers to facilitate this session. After observing the classes, the other pre-service teachers reflected on what they

had seen, guided by the questions I had provided. It was good to see how vividly their interest was stimulated and they enjoyed watching the videos. They felt that the videos showed them how teaching and learning occurred in Grade R.

Figure 3.16: Pre-service teachers in an urban context

As I moved forward with my work as a teacher educator, I acknowledged what I had learnt and that I was still learning from working with students from different contexts. I embraced learning as a two-way process and hoped to engage my pre-service teachers more intensely in the process of learning to teach. My goal was to set high expectations for my students and myself as I believed that we could weather any storm together.

3.8 My Learning

In this chapter, I have so far re-examined my educational past, starting with my informal learning of mathematics before school up to my experiences as a university-based teacher educator. In narrating my personal history, I echoed the same sentiments as Cole (2011). She asserts that "teacher story, teacher narrative, life story, and life history … are interrelated with memory studies, especially memory as transformation and memories as a means of self-reflection and self-construction" (p. 227). By exploring my lived experiences in this chapter, I elucidated my growing understanding of learning and teaching mathematics in the Early Childhood Phase and how this motivated me as a teacher educator.

The memory drawings I created revealed my negative experiences of learning mathematics in the Early Childhood and Secondary School phases. They made me realise that our primary school teachers mostly employed teacher-centred, puunitive approaches when they taught mathematics. This was done without the aid of physical objects or relating concepts to our prior

experiences. We often did not grasp the concepts and disliked mathematics. Fletcher (2012) emphasises the importance of learners' previous experiences as teachers need to harness these in creating positive learning experiences.

When reflecting on my memories, I contemplated their influence on my educational journey and what I had learnt from them about myself as a learner, teacher and teacher educator. I then used concept maps to elucidate the meanings I could harness from these memories. Samaras and Freese (2006, p. 73) explicate that concept maps as "artistic and cognitive tools" enable a researcher to see and show the links between key learning experiences. Similarly, Weber (2014) asserts that visual images compel us to take a step back and look at our experiences from a different viewpoint, thus enhancing the potential for a more in-depth self-analysis. Butler-Kisber (2008) asserts that, through concept mapping, researchers can pause and focus visually on the interpretations of emerging concepts. They can then illustrate the emerging concepts through diagrams. The concept maps helped me see and explain how my lived experiences influenced my learning and teaching.

I thus present a concept map in Figure 3.17 below. I designed this map to categorise and convey particular ideas in response to the first research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with my memories?* Drawing from relevant literature, I endeavoured to strengthen and highlight my learnings.

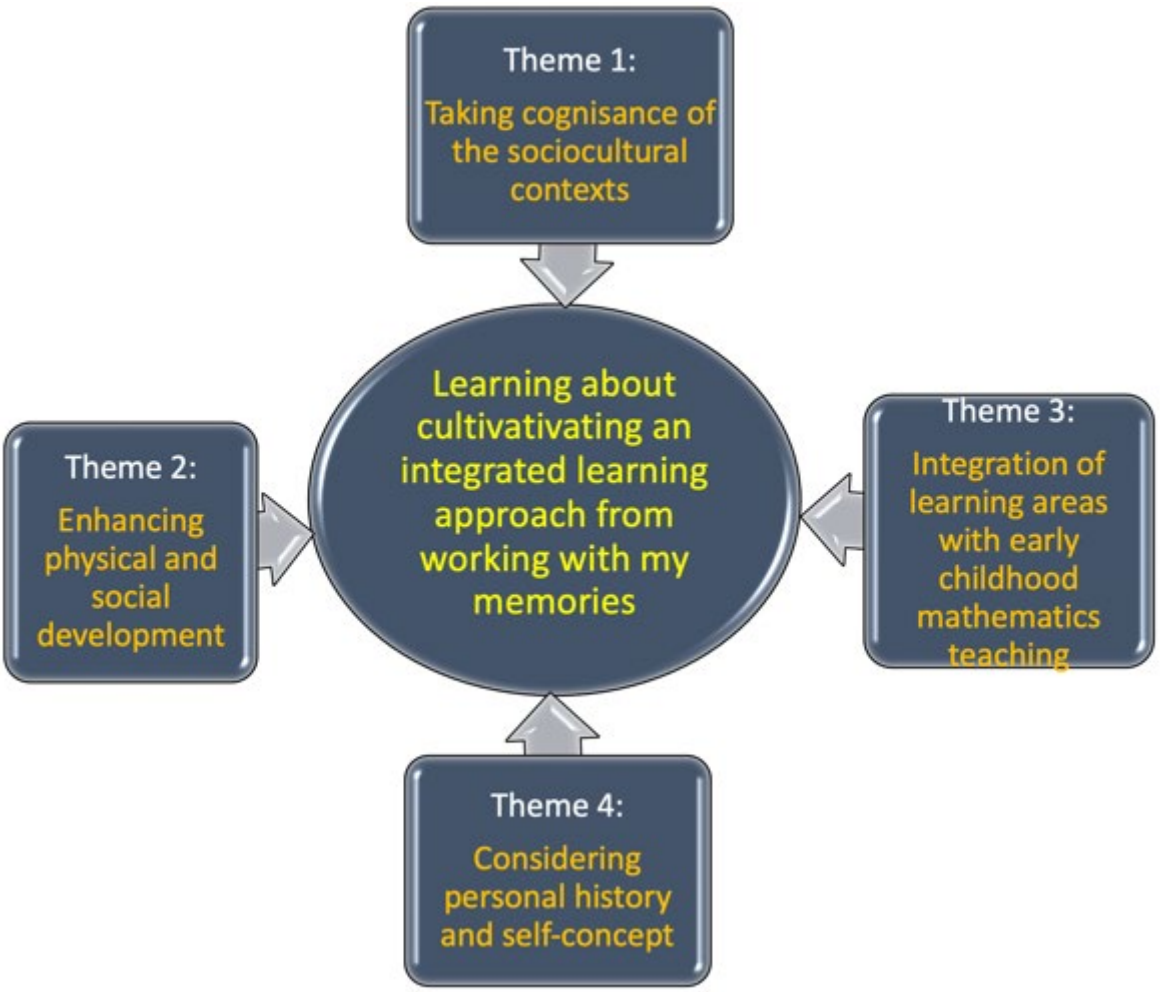


Figure 3.17: Concept map depicting the themes pertaining to research question one

3.8.1 Theme 1: Taking cognisance of sociocultural contexts

It is essential that teacher educators who lecture in mathematics take cognisance of their students' sociocultural contexts. By being conscious of this, teacher educators may motivate their students to understand that the acquisition of mathematical concepts is a social experience in which learners should participate actively. By narrating my personal history, I understood how educational it was to play with stones and how we were learning subconsciously. As l looked back, I saw how mathematics was embedded in our community activities and how we were imbibing mathematical knowledge through the activities and games we played. The metaphor 'making bricks without straw' captures the concept of how we used ordinary resources like stones and tins to entertain ourselves. These games and activities were associated with recreation, competition, enjoyment, and many other aspects of life (Pradhan, 2018). We were such happy children when we played different games all the time.

Looking back at my childhood experiences through a sociocultural theoretical lens, I could see how, by playing games, we acquired counting and numerical understanding using everyday objects such as pebbles and discarded tins. Goos (2014) points out that, as individuals, we have access to different items in our environment that allow us to improve our learning. Zayyadi, Hasanah, and Surahmi (2018) also argue that traditional games are valuable resources that can be used to teach young learners about mathematics in their early years of development.

In my practice, I need to think about what is valued in pre-service teachers' households and communities and use this to enhance their mathematics learning. I believe that various traditional games use objects that can be reinvented to accommodate contemporary teaching and learning elements. Nkopodi and Mosimege (2009) acknowledge that numerous mathematical concepts are engendered by various childhood games that can be related to multiple content areas of mathematics. Gerdes (1998, p. 46) notes that mathematics is "a universal activity − that is, it is a *pan-cultural* and *pan-human* activity". Thus, mathematical thinking occurs in everyday activities and games in all cultures, whether spontaneously or in an organised way. This suggests that we should learn about different cultural heritages to understand pre-service teachers' backgrounds and motivate them to learn about their learners' upbringings in the future. In this context, Gerdes (1998, p. 48) suggests the following:

> [People] may be doing mathematics [and] may be engaged in thinking that involves mathematical thought processes without themselves calling their activity 'mathematical'; they may even say that they do not know mathematics, or that they are not able to do mathematics.

For example, children learn about turn taking and sequencing in their games without being aware of it. By playing games, they learn to estimate, count, add and subtract without consciously thinking about these concepts as being the basis of mathematics. Although they may differ in nature and application, games are universal among children of all sociocultural contexts. Through games, mathematical concepts are first acquired, which challenges the prevalent notion that subjects such as Mathematics and Science "are associated with Western culture and are never linked with African culture" (Nkopodi & Mosimege, 2009, p. 377). Likewise, Charlesworth (2012) highlights that games can also be related to cultural customs. They provide opportunities for developing social competencies such as cooperation and following rules. Thinking about such moments in my own childhood brought back pleasant

memories as I recalled how we played and simultaneously learnt mathematics. Therefore, if we understand that the social context is ever-changing, we should aspire to incorporate games to stimulate young pre-service teachers' interest in mathematics learning (Samaras, 2002). As a pre-service teacher educator, I also want them to see how these games come into the picture to draw on their learners' cultural contexts. It is, therefore, crucial that I draw on pre-service teachers' sociocultural experiences.

Learning about anything is a social and cultural phenomenon. According to Nkopodi and Mosimege (2009), subjects such as Mathematics and Physical Science have often been associated with Western culture. However, Gerdes (1998, p. 46) proclaims that "in all cultures, mathematical thinking has taken place, whether spontaneously or in an organised way". Further, Gerdes (1998) refers to the concept of 'ethnomathematics' that he describes as "the study of relationships between mathematics and culture" with a vital cultural component. As a teacher educator, it is critical to learn about different cultural heritages to understand the students I work with. Gerdes (1998) notes that awareness of mathematics' social and cultural bases among future mathematics teachers is imperative. He believes that this awareness can enhance student teachers' self-confidence, capacity, and readiness and openness to work in a multicultural environment (Gerdes, 1998).

According to Samaras (2011), "when teachers begin to look at their own education-related life history experiences, it helps them gain insights into their thinking about learning" (p. 96). As a teacher educator, it matters in the sense that it is essential to link what I teach to what the pre-service teachers already know. We move from the known to the unknown to enhance our teaching and thus, understanding students' cultural backgrounds and their prior knowledge is vital for me. I agree that it is essential for teacher educators "to help pre-service and in-service teachers to see how they can give each other examples of mathematics in their life and history" (Gerdes, 1998, p. 47). I was enthused and motivated by Gerdes (1998) work, who maintains that there is a relationship between mathematics and cultural heritage. Additionally, Nkopodi and Mosimege (2009) contend that, as people engage in any game, language, vocabulary, mathematical competences, and various mathematical activities are generated. Although some of these aspects may be very basic, these authors note that they serve as essential components in developing mathematical concepts. Nkopodi and Mosimege (2009) also believe that, within the sociocultural context, there are issues of ethnomathematics. The correlation between

culture and mathematics and utilising these relationships thus seems crucial in a Foundation Phase classroom.

By revisiting my childhood memories, I learnt that mathematics can be made accessible through games. I thus need to be aware of how I can assist my pre-service teachers in developing learners' cognition by involving them in different games. I understand that the games we played as children underscored and promoted various mathematical concepts when we were still very young. Some of these are summarised in the table below.

Table 3.3: Mathematical concepts embedded in games

Games	Mathematics concepts
Amagende	Counting and number sense • One-to-one correspondence • Counting of real objects • Understanding the value of numbers
3-tins tennis ball	3-D objects • Describe, sort and compare 3-D objects • Objects that roll
Hopscotch	2-D shapes • Recognise and name 2-D shapes • Undersatnding geometric shapes (square, circle, rectangle)
Tyres	3-D objects Circular objects Objects that roll Understanding a geometric shape (circle) and its association with motion, speed and balance (science)

Table 3.3 above depicts my analysis of the mathematical concepts that are entrenched in different childhood games. I support the view of Laridon, Mosimege, and Mogari (2005) that cultural games have the potential to be used in mathematics classrooms and that this requires the identification of the variety of games and the mathematical concepts embedded in them.

Even if the games are played socially for play and fun, the learning is invaluable. Dockett and Perry (2010) note that affording learners opportunities to play does not only warrant the development of mathematical concepts but also provides valuable educational possibilities. However, Schuck (2009, p. 119) asserts that enjoyment in mathematics classrooms should not be promoted at the cost of the "development of deep conceptual understanding". Against this background, I reflected on how I could support pre-service teachers to help learners construct mathematical concepts to enhance their knowledge and a positive attitude towards mathematics.

I realise that we already had a sense of counting and geometric shapes even before we went to school. Dewah and Van Wyk (2014) noted that the knowledge of mathematics learners obtain informally outside the school can be used when teaching mathematics in the classroom. Unfortunately, these experiences were never incorporated into mathematics teaching when I was in the early schooling phases. I thus want to be aware of and capitalise on pre-service teachers' prior knowledge so that they can do the same with their learners one day.

3.8.2 Theme 2: Physical and social development

This theme is associated with the milestones that learners achieve when playing different games. I must help pre-service teachers understand that Foundation Phase learners are still developing physically and socially. Therefore, they need to create a playful atmosphere for learners to grow in these areas. According to Ginsburg, Lee, and Boyd (2008), mathematics learning comes naturally for young children but requires developmentally appropriate activities. In recalling the childhood games we played, I learnt that we were developing fine motor skills and hand-eye coordination while throwing and catching stones when playing the stone game. Krog (2015) affirms that the development of fine motor skills requires that learners perform many acts, such as picking up objects, drawing, or threading. As they jump and run, children develop gross motor abilities. Many physical activities are associated with the development of gross motor skills using "the large muscle groups in the arms and legs" (Krog, 2015, p. 434). We were also developing socially through adhering to the rules of the games and learning about taking turns. My responsibility is to incorporate such games into my practice and model how student teachers can do the same with their future learners.

An excellent early childhood mathematics programme is fundamental for the optimum social, physical and educational development of young learners (Atmore, 2013). I want to draw

attention to young learners' social and physical development, which is as important as other aspects, such as cognitive development. Ladson-Billings (2006) notes the importance of providing pre-service teachers with opportunities to work with children in settings that will allow them to experience after-school activities to enhance their learning. Correspondingly, Dewah and Van Wyk (2014) argue that mathematics teachers need to take responsibility for using children's everyday activities to afford them various opportunities to make useful connections with what they already know. For example, I remember that one of my friends could not catch the stones. Now I understand that he probably had a hand-eye coordination problem.

3.8.3 Theme 3: Integration of learning areas with early childhood mathematics teaching

There are many opportunities to use creative approaches in teaching early childhood mathematics, such as integrating other learning areas. Barends and Nel (2017) contend that it is essential that teacher education institutions apply inventive strategies to improve the work integrated learning component. Correspondingly, the Department of Higher Education and Training (2015, p. 10) highlights that practical learning is one of the fundamental types of learning connected "with the acquisition, integration and application of knowledge for teaching purposes" which includes "learning from and in practice". Pre-service teachers must be exposed to different practices for learning. Kampmann (2018, p. 3) argues that "there is no better teacher than experience". As a pre-service teacher, I was provided with some experiences as I was given opportunities to teach in a real context. This gave me insight into what to expect before I was exposed to teaching in a school.

Using an integrated learning approach is useful in linking the Mathematics learning area with others. For example, tyres are 3-D objects associated with the content area 'space and shape' in geometry. Tyres also bear the features or properties of 3-D objects because they are curved/circular and can roll. Linking this with language, learners could be asked to use the correct vocabulary when naming and describing a tyre's shape. As Ginsburg et al. (2008, p. 5) note, young children can learn mathematical words such as the names of shapes ('square') and words for quantity ('bigger than ') or ('less than'). Teachers and teacher educators need to focus on these terminologies and approach mathematics as a human language. As a teacher educator, I can see how I can bring this to my pre-service teachers' attention so that they can give learners opportunities to explore real 3-D objects interactively. This can be done by

placing shapes or objects on piles or putting them together in other ways and allowing learners to explain their decisions.

Currently, various games involving tyres are visible features in our communities. Most Grade R outdoor activities involve play areas where old tyres are used strategically in sand pits or elsewhere. We loved our tyre-rolling experiences, and today many children still experience what we enjoyed doing many years ago. In rural areas, tyres are put on the roofs of houses to prevent lightning from striking them. What is significant about these observations is that teachers and teacher educators need to understand how young learners learn through these objects. Teacher educators should also harness student teachers' experiences regarding play objects. We can then incorporate them in our lessons to establish a sound foundation for learning mathematics by building on what is already known and understood. Dockett and Perry (2010) draw attention to the fact that teachers influence what is utilised for learning by deciding on the experiences, materials and ways in which the activities can be incorporated in mathematics learning in their classrooms. To use a metaphor, hope is a small pebble tossed into a pond, and what is observed are ever-widening circles that expand, like more opportunities. We can make learning an exciting experience for young learners by drawing on their prior knowledge and using simple household items that become learning tools.

Table 3.4: Integration of the learning areas

Learning Areas	**Integration**
Life Skills	Through play learners develop to be creative, imaginative and appreciate the arts. Through movement and games learners develop positive attitudes and values.
Language(s)	Use the correct vocabulary to name and describe shapes: round, solid, hollow, roll, slide, square, circle, rectangle, etc. Communication
Mathematics	Counting, adding, subtracting, shaping – developing progressively to multiplication and division

The above arguments clearly imply that, as a teacher educator who lectures in the early childhood discipline, I need to be creative by taking my pre-service teachers' sociocultural contexts into account. By being conscious of this, I may inspire them to teach mathematical concepts as a social experience in which learners should participate actively and interactively. Moreover, resources that are familiar to pre-service teachers should be used in a novel and creative way. By engaging pre-service teachers in practical activities, they may be able to assist learners in "crossing the border between their own culture and the culture of Mathematics or Science" (Lee, 2014, p. 1041). Therefore, pre-service teachers need to be exposed to different practices for learning and teaching early childhood mathematics.

I found that using themes creatively made learning meaningful because it integrated various knowledge areas to facilitate more in-depth knowledge and understanding of the world we live in (Björklund & Ahlskog-Björkman, 2017). When I was a novice teacher, I experienced theme teaching as we would dedicate one week in a year to a specific theme. For example, if we decided on the theme 'Water', all the topics in different subjects would centre around this theme. Thus, my college experience influenced me to explore an integrated learning approach in the module that I was teaching to help pre-service teachers embody this approach in their teaching, during work integrated learning, and ultimately in the school where they would be teaching.

According to Björklund and Ahlskög-Bjorkman (2017), teachers and teacher educators should make mathematics part of everyday activities. They argue that if learners and pre-service teachers perceive and discover mathematics in their daily lives, its meaning and use can be simplified. Integration is a fundamental approach in the Foundation Phase, and this proposes that the early childhood mathematics programme should incorporate a holistic view of teaching.

3.8.4 Theme 4: Considering personal history and self-concept

As I progressed on my self-study journey and narrated my personal history, I learnt about my self-concept and efficacy as an early childhood mathematics teacher educator. According to Bates, Latham and Kim (2011, p. 325), "mathematical self-efficacy refers to one's beliefs in their [sic] ability to do mathematics". They argue that this concept is commonly measured in terms of evaluating oneself in solving problems and completing specific mathematical tasks (Bates et al., 2011). I thus acknowledged the importance of developing my own self-concept

so that I could set out to build my pre-service teachers' self-concept. In narrating my history, I recalled how I lacked confidence and had to seek help to develop my mathematical knowledge. Therefore, at one point, it was difficult to see how I would succeed in what I had set out to do and how I could prepare my pre-service teachers if I was not confident in my own abilities.

I agree with Bates et al. (2011) that having self-assurance in mathematical aptitudes affects mathematics teaching efficacy. I became aware of the value of connecting experiences of informal and formal learning of mathematics. As I delved into my personal recollections, I became mindful of how mathematics is embedded in games and that mathematical concepts can be integrated into various content areas and across learning areas. This awareness prompted me to reconsider my lesson plans. I embarked on using methodologies geared towards teaching early childhood mathematics in an integrated manner to enhance the teaching and learning of this subject. Thus, I became conscious of how I could harness past experiences and build my own and my students' confidence.

3.9 Conclusion

The purpose of this chapter was to explore my personal cultural and historical experiences that were related to the acquisition of early childhood mathematics. I also gave an account of my personal history and my learning and teaching experiences of mathematics. I used photographs to illustrate my history and memories of my early childhood years, my tertiary experiences, as well as my experiences of teaching mathematics in primary school and higher education institutions as part of an undergraduate Early Childhood education programme. The photographs that I presented helped illuminate my experiences and encouraged me to divulge my emotions and sentiments regarding my learning. As noted by Samaras (2011, p. 97), "it is only when the teacher understands, reflects and looks at events that shaped his/her own educational experiences and beliefs that *real* growth or change can occur in their teaching practices". I recalled and described the games we played at a very young age and in primary school. As illustrated in my drawings, my memories of learning mathematics in primary and high school were not so positive. Through this exploration, I began to transform how I comprehended mathematics teaching and learning in the Foundation Phase. Upon reflection, I realised that I needed to think more deeply about preparing pre-service teachers and making mathematics accessible and enjoyable. I reflected on how pre-service teachers could think about the usefulness and necessity of taking children's environments into account in their teaching. These thought processes culminated in my exploration of the integrated learning

approach to teaching mathematics in the Foundation Phase. They drove how I applied various methodologies to achieve the aim of the study (see Chapters Four, Five, Six and Seven).

By narrating my educational life history, I meant to touch and enrich other people's lives, especially in teacher education (Nash, 2004). Describing my personal history also allowed me to view my experiences in a new light. It permitted me to think about the value of an integrated teaching approach in preservice education. My interrogation of the phenomenon of games as a foundation for mathematics learning enabled me to see how numerical values as well as counting, addition and subtraction are developed through childhood activities. Therefore, to create a meaningful learning environment where pre-service teachers can develop their own understanding of the pedagogy required to teach their prospective learners, I must consider what my students already know. They need to build on this knowledge (Nkopodi & Mosimege, 2009). This exploratory investigation transformed how I used to comprehend teaching and learning mathematics in Early Childhood teacher education. I wanted to facilitate similar learning experiences for my students.

In the following chapter that I titled '*Getting my feet wet'*, I describe the lessons I presented in a pilot project using an integrated learning approach in the early childhood mathematics module. I also show the activities that pre-service teachers engaged in to cultivate this approach. I discuss the value of utilising an arts-based approach in my lessons. It offered hands-on, creative tools from a cultural context to help my pre-service teachers grasp the concept of an integrated learning approach.

CHAPTER FOUR: GETTING MY FEET WET

Integration of the curriculum is an excellent way to enable pre-service teachers to embrace the bigger picture of learning

Anastasia Samaras

4.1 Introduction

This self-study research focused on what and how I learnt as an early childhood mathematics teacher educator, emphasising the implementation of an integrated learning approach. My aim was to comprehend and interpret my lived experiences of learning and teaching and explore alternative ways to better support Foundation Phase pre-service teachers. In the previous chapter, I addressed the first research question: *What can I learn about cultivating an integrated learning approach from working with my memories?* I narrated my personal history by focusing on my learning mathematical concepts even before going to school, in primary school, and right up to the tertiary level. I also recounted my experiences as a teacher and a teacher educator in diverse contexts. Based on my reflections, I appreciated the importance of continually learning to improve my practice and to thus better motivate my pre-service teachers to understand the value of working with young learners.

This chapter is titled '*Getting my feet wet',* a metaphor describing my initial attempts to explore an integrated learning approach in my teaching of the early childhood mathematics module. I address the second research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* Anastasia Samaras' words of wisdom, "Integration of the curriculum is an excellent way to enable pre-service teachers to embrace the bigger picture of learning" (2002, p. 58), were encouraging and affirming as I attempted this new approach.

I commence this chapter by explaining my engagement in a pilot project with a class of 34 pre-service teachers in the Bachelor of Education (B.Ed.) programme specialising in the Foundation Phase (Grades R to 3) at the university where I am currently based. I describe four lessons and the different activities we participated in, using arts-based methods. I explain how I tried out new ideas and how my learning developed so that I could shape the next implementation phase of the study. I used my reflective journal to reflect on each of the lessons I presented at the time, which I did a day or two after each class. These journal entries reflected

my initial perspectives at that time. I give my observations and reflections as I looked back on how events took place and the lessons I learnt. My pre-service teachers' evaluation of the module, as well as my learnings, are also discussed in this chapter.

In 2016, I applied for and was awarded the Teaching and Learning Innovations and Quality Enhancement Grant (TLIQEG) to implement this pilot project. I received the ethical clearance for the pilot project from my university (see Appendix E). This grant was established by the University Teaching and Learning Office (UTLO) to support innovations and quality enhancement in teaching and learning. The grant responds to a crucial need within the university and funds projects or initiatives that focus on improvements related to a broad range of aspects linked to teaching, learning, assessments, curriculum development and delivery. This grant's allocation demonstrates a commitment to continual improvement in the university's quality of educational initiatives.

At the proposal development stage of my doctoral study, I piloted the project that I refer to in this chapter. This pilot project initiated my attempts to explore different strategies to cultivate an integrated learning approach and deepen my understanding and application of the sociocultural theoretical perspective underpinning my practice. This is in keeping with Anastasia Samaras' words of wisdom: "Teachers can be the change agents in schools, countries, and states when they take their first steps into unknown waters that will chart the way for others" (2002, p. 149). In my efforts to implement an integrated teaching and learning approach, I felt I was taking the first tentative steps into unknown waters. I could only hope that I would be able to map my progress as a change agent.

Yin (2011) contends that pilot studies assist in testing and refining certain study elements and offer opportunities to practise what needs to be applied in the actual research. I thus employed the integrated learning approach as a pedagogical approach to motivate pre-service teachers to develop and plan mathematics lessons and activities (McGlynn-Stewart, 2010). I wanted to accentuate the value of an integrated learning approach so that the pre-service teachers would be inspired to do the same with their future learners. I explain how I used arts-based methods, such as collages and concept maps, to promote an integrated learning approach in early childhood mathematics teaching. I also highlight my reflections on how I presented the lessons and their outcomes. I conclude this chapter with my thoughts on what I learnt in trying this approach the first time.

4.2 Utilising Arts-based Methods in a Pilot Study to Explore an Integrated Learning Approach

The early childhood mathematics module is one of the specialisation modules for Foundation Phase pre-service teachers registered for the B.Ed. programme. It is offered in the first semester of an academic year. Although the module is referred to as the Numeracy in the Early Years module, I use the term early childhood mathematics in this study report. As I have explained in Chapter Three, I taught this module to first year pre-service teachers. This was the second year (2016) that I taught this module to introduce pre-service teachers to mathematics teaching in the Foundation Phase. In the previous year, I had focused solely on the content and pedagogy of early childhood mathematics. For example, I would introduce a concept, explain what it meant, give examples, and asked the pre-service teachers to provide their own examples. Embarking on this study, I felt a need for my pre-service teachers to develop a broader understanding of early childhood mathematics and how it connects with everyday life. Given my unpleasant experiences of learning mathematics at school, as narrated in Chapter Three, I felt it was vital to elicit a better understanding of mathematics in the light of learners' everyday experiences. It is also important to note that not every lecture was dedicated to the integrated learning approach. I only devoted four lessons to exploring the integrated learning approach using arts-based methods in this pilot.

Arts-based self-study methods help researchers to reflect, investigate and engage in dialogue about improving their teaching through the arts (Samaras, 2011). I decided to use arts-based methods in teaching the early childhood mathematics module to create a bridge between the Mathematics and other learning areas. This approach was based on visual art, and I encouraged the students to create collages and concept maps to enhance their knowledge and understanding of the subject matter. I hoped to draw on the visual arts to create meaning through artistic forms of expression (Weber, 2014). Visual methods assist researchers to "keep their own and their students' bodies in mind and push for more sophisticated analysis and theorising that considers [sic] learning and teaching" (Weber, 2014, p. 11). I thus used PowerPoint presentations, charts, objects and other visual tools to enhance my mathematics lessons. I involved my pre-service teachers in creating collages and concept maps to explore and illustrate their understanding and experiences of an integrated learning approach to teaching mathematical concepts in the Foundation Phase.

Table 4.1 summarises the lessons I presented when piloting the integrated learning approach. It should be noted that I used PowerPoint as a visual aid in the lectures, and I include some of the pictures in my PowerPoint slides.

Table 4.1: Lessons presented on an integrated learning approach

Lesson Topics	**Integrated Learning Approach: Mathematics, Languages and Life Skills learning areas**
Lesson 1: Introduction to an integrated learning approach 8 March 2016	Integration: - within the Mathematics learning area - Languages learning area - Life Skills and holistic development
Lesson 2: Teaching strategies 16 March 2016	Stages of learning: concrete, semi-concrete and abstract
Lesson 3: Classroom environment 30 March 2016	Classroom organisation and management
Lesson 4: Number concept development 5 April 2016	Pre-number concepts

4.2.1 Lesson 1: Introduction to an integrated learning approach - 8 March 2016

In this lesson, I focused on acquainting pre-service teachers with an integrated learning approach. I had requested the pre-service teachers' permission to participate in the project in the previous session and they had signed the consent forms (see Chapter 2). I was a bit anxious at the beginning of the lecture, as it was my initial attempt to explore this concept. I began the lesson by reminding the pre-service teachers that this pilot project aimed to explore an integrated learning approach. I explained that they would participate in different activities as part of the study.

I projected my PowerPoint presentation, which included a definition of the integrated learning approach. Drawing from Adamu (2003), Mwakapenda (2008), and Björklund and Ahlskög-Bjorkman (2017), I described an integrated learning approach. I explained it as an approach to teaching and learning by making connections within mathematics and other subject areas and

the real world, thus making connections with the surrounding world that influence or are influenced by mathematics. I stated that an integrated learning approach was critical because young learners viewed the world as an integrated unit. I added: "Teachers work towards enabling children to discover mathematical phenomena in their everyday lives", as articulated by Björklund and Ahlskög-Bjorkman (2017, p. 107). As I explained this phenomenon, I maintained eye-contact with the pre-service teachers. I wanted to see if they understood what I was saying, and their facial expressions reflected that my words were making sense. Some of them were nodding. Observing their gestures gave me the confidence to elaborate further.

I explained that, by employing this approach, I aimed to improve my practice as an early childhood mathematics teacher educator. I envisaged that this strategy would support them in their learning to teach and hoped they would implement it in their teaching. Furthermore, I highlighted that it would be advantageous for them as they would be teaching all the subjects in the Foundation Phase in a particular grade and that integration would be a powerful tool. I emphasised that they could integrate within content areas in mathematics, across the Languages and Life Skills learning areas, and consider their learners' holistic development. I drew on the example of a lesson I had presented previously on the three kinds of knowledge: physical knowledge, social knowledge, and conceptual knowledge. I reminded them of the example that I had given on social knowledge:

Example

When a mother asks her child to help her in the kitchen and says, "I need 8 potatoes. I already have three, so please get me the rest". Then the child will respond to the question in one of two ways: either she will count on: "…four, five, six, seven, eight", touching the potatoes while counting, or she will count out eight potatoes from the packet and put three back. The first action could be called addition, while the second is subtraction.

I explained that integration in this example occurred when the child was counting, adding and subtracting (mathematical concepts), saying the number names (word problem - language), touching the potatoes (sense of touch, which is a social skill and knowledge of vegetables which is a life skill). Regarding integration within the mathematics content area, I drew on the object that was counted, namely potatoes. I explained that potatoes could be seen as 3-D objects because they are ball-like objects that can also roll (properties of 3-D objects). As I explained

these concepts, some of the pre-service teachers looked puzzled. I gave another example and engaged them through more questions.

I reminded them of the lesson we had done the previous week to discuss multisensory learning. I had asked: "What different types of learning activities may you use in your Foundation Phase classroom?" A few raised their hands. One of them answered, "Visual learning". After this response, more hands went up. They then mentioned other learning modes, such as auditory, tactile, kinaesthetic, analytic and global learning. I then asked them to describe kinaesthetic activities. They were eager to answer and provided answers such as: "Kinaesthetic learning is like playing games", or "When they sing, they use gestures", or "It's like doing exercise type activities which require running and jumping", or "It's craft activities". Their responses told me that they still remembered our previous discussions and would better understand the concept of an integrated learning approach when I used another example. In the following example, I wanted the pre-service teachers to understand integration in view of the young learners' holistic development.

Example

A Grade 1 teacher involved her learners in using number tracks to enhance their understanding of number concepts and ordering numbers. She had drawn a number track on the floor in her classroom with numbers from 1-10. She asked one learner to jump up to number 3 and asked the class to count aloud. She then asked another learner to jump two jumps forward from number 2. Then she asked a few more learners to jump up and down the number track. As learners were jumping on the number track, she would ask questions such as: "Where did Lindo end?" and "How many jumps did Sello take from 6 to 10?"

I emphasised that the holistic development of a Foundation Phase learner is crucial. I then explained that, while learners were involved in a mathematics activity, they were also using their bodies as they jumped along the number track. I raised the following point clearly: Because young learners are still developing physically, it is vital to involve them in activities that will enhance their physical development and not solely focus on cognitive development.

To heighten the pre-service teachers' understanding of the integrated learning approach, I engaged them in an activity where they had to work in pairs. I asked them to write down three

mathematical words that have more than one meaning. For example, “left” could mean a position or gone away. I did this to show the students how mathematics is connected to other learning areas and our environment. As they worked on this activity, I interacted with them in their pairs to check if they were getting what they were supposed to do. I then asked the pre-service teachers to share some of the words they had written with the class. The following table provides some of the words given by pre-service teachers:

Table 4.2: Mathematical words with different meanings

Mathematical words	**Different meanings**
right	position, being correct
volume	the amount of space (an object or substance occupies), loud or soft sound
cube	a solid object with six equal square surfaces, ice cube
square	four straight equal sides, square something with something (if one idea squares with another they both seem good)
bracket	punctuation mark (parentheses), metal or wooden pieces used to mount something on the wall
circle	round, circle of friends

At the end of the session, I asked the pre-service teachers to bring magazines, newspapers, glue, and scissors to the next lecture, which would be the following day.

4.2.2 Working with pre-service teachers to create collages

The first arts-based method that I explored in this study was collage making. I had asked the students to bring magazines and scissors to class for this lecture. I had also got many magazines to make sure that we had enough to make collages. I brought three different colour A1 charts and stationery (glue, chart paper, pens, pencils, koki pens, etc.) that I had bought with the TLIQEG funds.

I explained to the pre-service teachers that we were going to create collages. I described a collage as a work of art composed of numerous materials such as paper, newsprint, photographs, ribbons, or other objects attached to background support such as plain paper. I further explained that a collage could be created using physical materials or electronic images

attached to a digital background. Originating from the French word ‘coller’, meaning ‘to glue’, the collage allows you to experiment with a wide range of materials to achieve excellent end results (Butler-Kisber, 2008). I showed them an example of a collage (Figure 4.1), which I had downloaded from the internet.

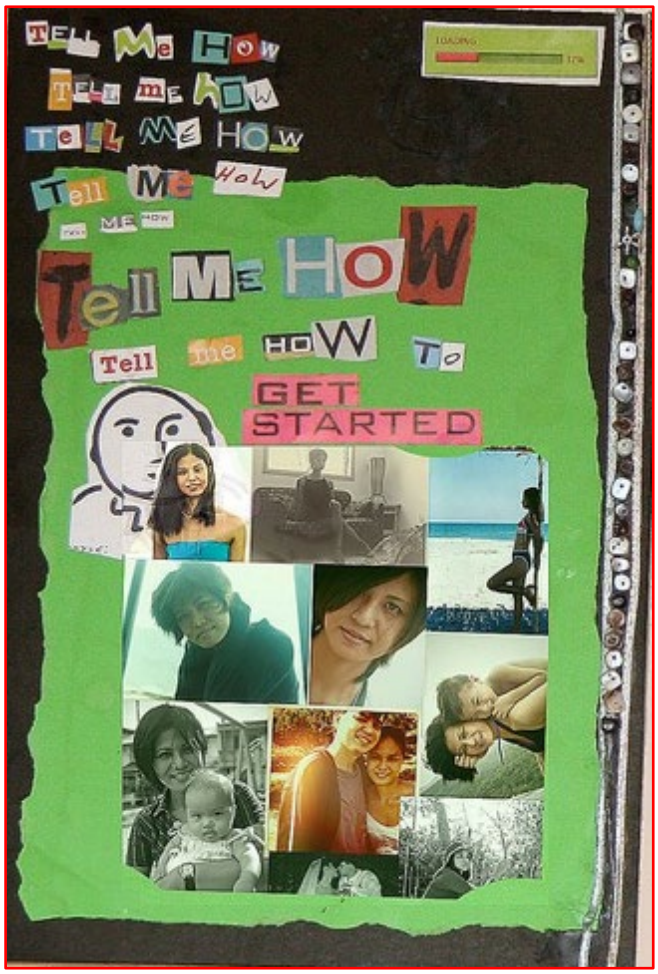


Figure 4.1: An example of a collage

To involve the student teachers in creating collages, I divided them into three groups. I gave each group a different colour chart that also a group name. The red, orange and yellow groups each pasted the images they had collected on charts of the same colour. Each group had to consider the following questions for procuring the images: “How can we integrate the Mathematics learning area with Languages and Life Skills in the Foundation Phase?” and “How can we integrate mathematical concepts or content areas with one another within the Mathematics learning area?” Following the collage making method described by Van Schalkwyk (2010), the pre-service teachers perused magazines and collected about 12 main images per group. They cut out these images and pasted them onto the charts to illustrate the

connections and concepts the groups wished to represent. I gave each group a handout that explained the task as summarised in Table 4.3.

Table 4.3: A brief summary of the activities to encourage an integrated learning approach

9 March 2016

Integrated learning approach: Early Childhood Mathematics

Creating Collages

Your collage is a poster or visual representation of an idea or a theme. Make use of cuttings of images, texts, and drawings to represent diverse ideas about integrating Mathematics with the Languages and Life Skills learning areas. These images (and words) will tell a story about how we can integrate learning areas when teaching mathematics in the Foundation Phase. Try to include at least twelve main images. Paste all the pictures and texts you chose on the chart provided.

Try to answer the questions:

- *How can we integrate the Mathematics learning area with Languages and Life Skills in the Foundation Phase?*
- *How can we integrate mathematical concepts or content areas with one another within the Mathematics learning area?"*

Collage transcription

- Number the main images on the collage consecutively.
- Create a transcript of the collage by referring to the numbered images.
- Write a brief description of each main image in your transcript, giving reasons for selecting it and discussing your associated thoughts and feelings about each image.

(Guidelines adapted from: Van Schalkwyk, 2010)

Figure 4.2: Images of pre-service teachers engaged in creating collages

The images in Figure 4.2 depict pre-service teachers engaged in the collage making process. Butler-Kisber and Poldma (2010, p. 3) maintain that cutting and sticking are basic skills that have usually been developed early in life, and this practice "has become part of everyone's repertoire". So, they argue that "a collage can be done by novices while acquiring more sophisticated aesthetic and compositional expertise". However, in the beginning, the pre-service teachers were not sure what to do and were unresponsive. Some of them were just paging through the magazines and some were looking for pictures related to mathematics only. I discussed with them in their groups and tried to guide them. For example, I pointed out that they could use any picture, but they needed to say how the selected image linked with the Mathematics, Languages and Life Skills learning areas.

Guiding the students, I gave the red group an example of the picture of two ladies smiling at each other. I indicated that it could represent a pair, which is used for two things. In a Life Skills lesson, learners can identify two parts of their bodies (for example, two eyes or two legs). I further explained that in terms of language development, a pair can be described as two corresponding things designed for use together. As I moved among the groups while the pre-service teachers were creating their collages, I could see that they were starting to understand how to create a collage.

The interactive collage-making process (Figure 4.2) encouraged the student teachers to reflect, plan, and deliberate on how integration could occur across the Foundation Phase's learning areas. From a sociocultural perspective, I wanted to afford the pre-service teachers opportunities to interact and learn from one another. I followed Gerhard and Mayor-Smith's (2008) advice in trying to advance my practices by stimulating the pre-services teachers' attempts in various ways to assist them in making sense of the integrated learning approach.

Figure 4.3: Collages created by the pre-service teachers

Figure 4.3 are photographs of the collages that the pre-service teachers created. The images and words told how they could integrate the learning areas when teaching mathematics in the Foundation Phase. After completing this exercise, I took the collages for safekeeping to my

office. This reminded me of the unfavourable conditions in the classrooms of Foundation Phase pre-service teachers at the university: small desks, no cupboards, and no display boards for Foundation Phase material. The pre-service teachers had to combine small desks to create a space to work with big charts when they made the collages.

In the session that followed as a continuation of this lesson, I brought the collages back to class. I asked the pre-service teachers to discuss the meaning or message of their collages by developing collage transcripts. I asked them to write briefly about the images in their collages. When writing the collage transcripts, I encouraged them to record their ideas and be as authentic as possible about what was coming to mind about the images. Van Schalkwyk (2010) maintains that the collage images act as helpful prompts that support the elicitation of rich ideas. I emphasised that there were no wrong or right answers in doing this activity. I allowed them to feel free and start embracing how they could be creative in a Foundation Phase class. I saw that they were warming up to the idea of this arts-based method. They were engrossed in their groups, smiling and talking to one another. The scribe in each group took notes. I was inspired and encouraged by how they interacted, and I believed that I was heading in the right direction by using this arts-based method. I felt that I was getting closer to them by engaging with them in their groups and guiding them by answering their questions. Figure 4.4 depicts some of the pre-service teachers' collage transcripts.

Red Group

1) Largest - the picture shows size. A life skill here can be learning about colour, different pets and different breeds. - two big dogs

2) Team work - the picture shows children working together and also having fun. - chilren playing

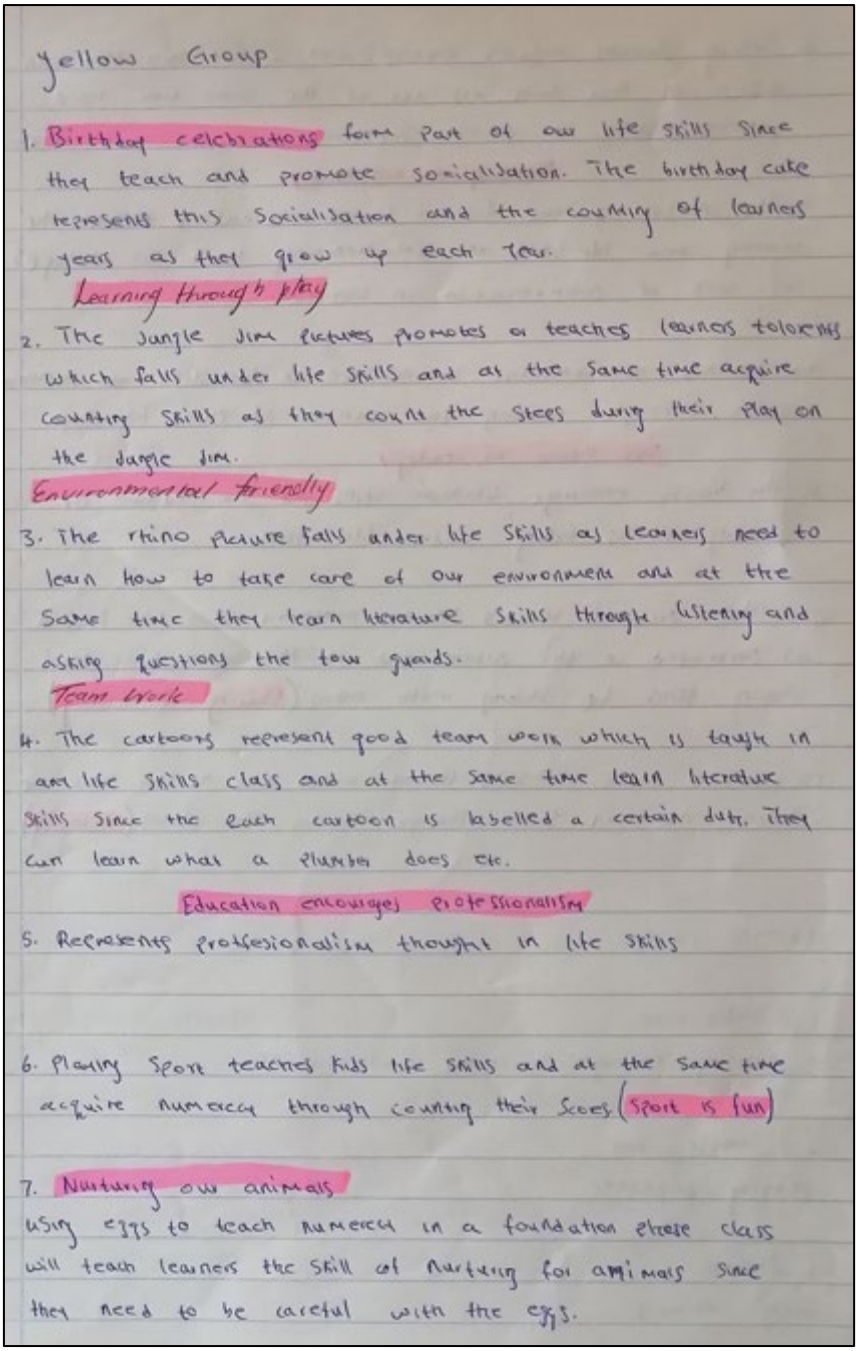
3) Love - this picture teaches a child the concept of emotion. It can also help the children understand what the meaning of love is. Pupils can learn how to treat each other. - mother cuddling the baby

4) Future - it depicts hardwork. This word can also teach learners the concept of tense, example, past, present and future. - award winners

5) Many - this picture embraces culture. The learners will learn to understand the idea of what many is and also the ideq of opposites. For example many and few - bourgo

6) More - the concept of amount. It can promote healthy foods and table manners as a life skill. - culinary and food

7) Talking - learners will be able to exchange words and innovative ideas. The life skill here is communication and developing speech. - playing chess


Yellow Group

1. Birthday celebrations form part of our life skills since they teach and promote socialisation. The birthday cake represents this socialisation and the counting of learners years as they grow up each year.

Learning through play

2. The Jungle Jim pictures promotes or teaches learners tolerance which falls under life skills and at the same time acquire counting skills as they count the steps during their play on the jungle jim.

Environmental friendly

3. The rhino picture falls under life skills as learners need to learn how to take care of our environment and at the same time they learn literature skills through listening and asking questions the four guards.

Team work

4. The cartoons represent good team work which is taught in our life skills class and at the same time learn literature skills since the each cartoon is labelled a certain duty. They can learn what a plumber does etc.

Education encourages professionalism

5. Represents professionalism thought in life skills

6. Playing Sport teaches kids life skills and at the same time acquire numeracy through counting their scores (Sport is fun)

7. Nurturing our animals

using eggs to teach numeracy in a foundation phase class will teach learners the skill of nurturing for animals since they need to be careful with the eggs.

Figure 4.4: Transcripts of pre-service teachers' collages

In this session, the pre-service teachers worked in the same groups as before. They gave brief descriptions of the collages' images and provided persuasive reasons for selecting the images by describing the thoughts, feelings, and interpretations that each image evoked. For example, the Red group linked the picture of two dogs to the word 'largest' in the text with a Life Skills lesson where learners may learn about pets of different breeds and colours. They also connected these images and words with measurement in mathematics that young learners learn to measure

length using parts of their bodies, such as their hands. I was impressed by the thought they had given to these activities.

The yellow group presented a picture of a cake and the text “happy birthday” with birthday celebrations. They indicated that this represented a celebration and that birthday celebrations promote socialisation, linked with the Life Skills learning area. They also suggested that the image represented the learners’ ages and dates of birth, which correlated with numbers. Numbers are pivotal in the acquisition of mathematical skills. To integrate Mathematics, Language and Life Skills, they used a picture of women wearing traditional clothes, which they argued embraced culture. They indicated that learners might learn what ‘many’ denotes and that the opposite would be ‘few’, which would enhance vocabulary.

Journal entry – 11 March 2016

I felt that the venue [classroom] was somewhat conducive to the work we were doing. It was flat and had tables and chairs. But, I was not happy with the small desks because the students had to put them together when they were creating collages. I would have preferred big tables for Foundation Phase pre-service teachers. Because the Foundation Phase is a specialised discipline, it needs specialised resources such as big tables to work on and storage spaces in the classrooms so that we do not always have to pack up and bring in resources every time we go to class. We cannot even display the work that the students have done. I think it is important that we not only tell our students what they can do in their classrooms, but we need to actually do it with them.

I had asked the students to bring magazines, scissors, glue, etc. to create collages. I was happy that most of the students brought these materials. At the start of engaging in collages, I was not so confident as this was the first time that I engaged in such an enterprise with students. I was worried when they were not responsive at the beginning. Overall, I think it was a promising start and the students seemed to grasp the concept of an integrated learning approach.

Retrospective reflection – 18 July 2018

In retrospect, I needed to be creative to inspire my pre-service teachers with the sense of being innovative teachers in the Foundation Phase. I wanted to model how pre-service teachers could use resources effectively when teaching mathematics in the Foundation Phase. I thought about practical devices such as bead bars, rods, and counting frames that Montessori used in her 'alternative' school (Delaney, 2010). Devices should be used for teaching different mathematical concepts. This did not come easy because when I had taught at a primary school, such tools had not been available, and I had never thought of making them. I also needed to be creative about how and where I stored the material. Instead of complaining about having a small office where I could not keep the resources that I used in class, I could have thought of obtaining access to a storeroom two doors opposite my office to keep some resources.

4.2.3 Lesson 2: Stages of learning – 16 March 2016

In this lesson, I focused on different stages of learning in the Early Childhood phase. My pre-service teachers needed to understand young children's development. They should be aware that learners' level of development affects how they solve problems and the ease with which they understand and complete a task. Therefore, teachers have to ensure that the teaching strategies are chosen to cater to all the learners.

I started the lesson by asking the pre-service teachers which resources they thought could be used in the Foundation Phase mathematics classroom. They mentioned resources such as stones, bottle tops, magazines, calendars, abacus, pictures, puzzles, scales, etc. When teaching Foundation Phase learners, I then explained that they needed to think about the concrete, semi-concrete, and abstract stages of teaching and learning mathematics.

Concrete stage

In the early years, children should be exposed to mathematical experiences that give them many opportunities "to do, talk [about] and record their mathematical thinking" (DBE, 2011). To do mathematics in this way, learners must make use of concrete objects and resources. New concepts should be introduced using tangible objects to understand the concept by relating it to an actual experience or item. I showed the students the counters, abacus and the geoboard that I had brought to class. I then projected the slide with the pictures in Figure 4.5, explaining that these would be suitable for learning and teaching support material for this phase.

Figure 4.5: Concrete materials

During the concrete stage, learners can use their bodies and their senses to learn number concepts. They thus need to be physically involved to see, hear, touch, smell and even taste real objects. For example, in learning how to count, learners can use their fingers, toes or other body parts. I emphasised that it is vital to progressively move learners from using their fingers and body parts to using objects such as stones, bottle tops or any other counters instead. Counters are useful in teaching young learners basic counting as well as sorting and patterning skills. Manipulating objects helps engage learners' attention and makes the retention of knowledge simpler. Once learners have mastered counting and calculating with concrete objects, they are set to advance to the semi-concrete level and work with slightly more abstract resources. Bruner refers to this stage as the 'enactive stage' because it involves learners through hands-on experiences of physical objects, movement and actions (Conkbayir & Pascal, 2016).

Semi-concrete stage

When learners have had many counting and other mathematics related experiences with actual objects, they do not have to have the actual item present to think about it. At the semi-concrete stage, learners will understand what objects a picture or model represents. This stage is sometimes referred to as the 'two-dimensional' or 'pictorial stage'. I showed my pre-service teachers some items that could be used as practical learning and teaching support material at this stage, such as:

- Pictures
- Number charts
- Graphs with pictures
- Dominoes with dots

Figure 4.6: Number charts

During the semi-concrete stage, learners do not have to use concrete objects to solve a mathematical problem any longer. However, they still need to use things that represent (stand for) the real objects, e.g., drawings or other 2-D materials. By counting objects in pictures or dots on dominoes, learners begin to realise that it is possible to represent actual numbers or things with symbolic meaning (e.g., dots or drawings represent numbers). Once learners have had sufficient experience using concrete and semi-concrete resources, they are ready to work with numbers and begin to calculate. When learners use symbols (numbers) to calculate, they have reached the abstract stage. According to Conkabyir and Pascal (2014), this stage represents Bruner's iconic representation in which young learners store information of objects and categorise them as images in the mind.

Abstract stage

At the abstract stage, the learner can think without using concrete or semi-concrete materials and can count and solve problems mentally. I explained that it was essential to guide learners towards the abstract stage. The learner who functions on an abstract level can understand the symbolic representation of an object, picture, number or word. To read and write and use symbols to communicate, a learner needs to be able to function on an abstract level.

Suitable learning and teaching support material at this stage would be:

- A 100 number chart
- Expansion cards (flard cards)
- Tape measure

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Figure 4.7: 100 Number chart

The abstract stage is where symbols represent concrete objects, e.g. one apple (concrete) 1 – one (number symbol -1, number name – one). They learn that letters and numbers have meaning – that they represent something. At the abstract stage, learners can think without using concrete or semi-concrete materials and can count and solve mental problems (in their minds). For example, they do not have to physically put together and count three counters and two counters to find the answer, as they can now add mentally (3 and 2 are 5) or solve a problem like 3 + 2 = 5. At this stage, the young learner can think abstractly and no longer rely on images (Conkabyir & Pascal, 2014). The pre-service teachers were attentive and showed that they understood the concepts that I explained to them.

4.2.4 Working with pre-service teachers to create concept maps

Another arts-based method that I used in this study was concept mapping. To create concept maps, I asked the students to put together the concepts related to their developed transcripts. They had to number these concepts. For example, they would categorise "size, large, many and more" together. The aim of this activity was to show relationships between ideas and focusing on how integration occurred. These tasks were not easy for the students, and they struggled at first. It was problematic for them to transpose the collages' concepts and the collage transcripts into the concept maps. I observed that they included concepts that were not related. While working in groups, I moved among them and saw what they were doing and directed them to organise their ideas. For example, I pointed one group to a group of words or phrases that had to do with enjoyment when learning mathematics. We discussed that terms such as 'learning through play', 'colourful', 'fun' and 'games' could be grouped together, as illustrated in Figure 4.5 below.

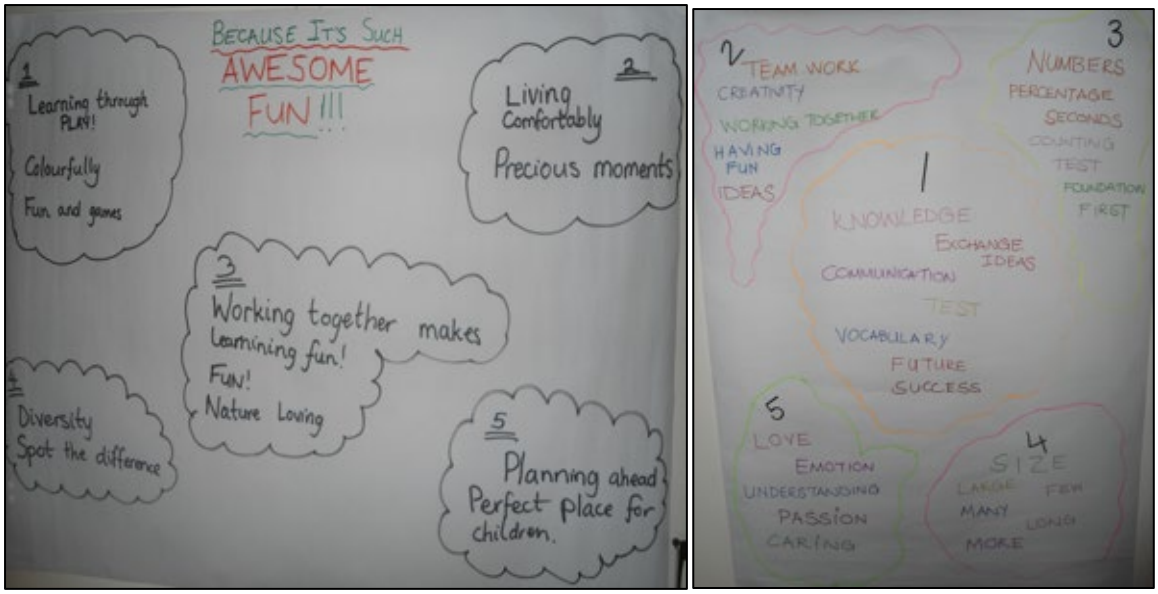


Figure 4.8: Concept maps created by the pre-service teachers

Figure 4.8 depicts the two concept maps that were created by the pre-service teachers. Different keywords and phrases were grouped together to show the links that emerged, and these links reflected the integrated learning approach. It was interesting to note how the students could "move from written analytic text to the visual and back again" (Butler-Kisber & Poldma, 2010). For example, numerical and other concepts depicted by the images in Figure 4.5 (such as the *number* of dogs, *many* people wearing traditional attire, a *long* queue of ballerinas and a comparison of the cutlery items in the collage) are captured in the concept map on the left in Figure 4.8. Concepts such as *large*, *many*, *long* and *more* that emerged were grouped together to represent measurement concepts. During concept mapping, I was able to help the students understand integration as the fundamental idea of the integrated learning approach and that this often clarifies difficult words or concepts (Butler-Kisber & Poldma 2010). For example, by guiding the students, they could link the ideas of percentage, seconds and counting with the theme 'numbers' (see Figure 4.8, concept map on the right).

Butler-Kisber and Poldma (2010, p. 6) explain that concept maps "are created using hand-drawn sketches or virtual tools in a non-linear and visual format by drawing on paper to show the thinking as it emerges". By creating these concept maps, the pre-service teachers were able to make connections across the concepts that were illustrated by the collages. In this manner, they explored and gave direction to the application of an integrated learning approach. They understood that making collages and creating concept maps were ways of communicating their

ideas and formulating an interactive approach to learning that could help their learners understand the concepts they would teach one day (Butler-Kisber & Poldma, 2010). They also understood that the concept mapping process served as a method to reorganise ideas, which limited text to brief words or phrases (Weber, 2014). I believe that these collages and maps' visual impact was highly appropriate for learning in the Foundation Phase, notably because the images related to children's early experiences of the world around them. At the same time, they also demonstrated particular mathematical concepts.

While the pre-service teachers were engaged in creating these collages and concept maps, I observed and made notes of my observations and reflections. For example, I noted that, as the students understood what they needed to do, they became more interested. As they discussed the pictures that should be pasted on the charts, they were confident to explain why that particular picture represented integration. Butler-Kisber and Poldma (2010) suggest that students are excited when confronted with such a task and gain confidence once they have achieved what they set out to do. Even I found it interesting and exciting to observe their progress.

My journal entry – 18 March 2016

I felt like I was pushing myself and spreading my horizons when engaging in arts-based methods. I was a bit relieved after doing the concept maps with the pre-service teachers. Since I was still learning about these arts-based methods, I was not sure that they would work. But I was pleased to realise that it was possible, and it is doable. The students enjoyed it, and this made learning mathematics fun. I felt that it was advantageous, and it is something that I will continue doing. The students struggled initially, but as time went on, they started to grasp the concept of the integrated learning approach.

Retrospective reflection – 26 July 2018

I think it is important that I engage my students in arts-based methods to learn actively and interactively about the integrated learning approach. The arts-based methods provide ways of creating meaning (making sense) through artistic expression (Weber, 2014). The representations of the art forms help capture what is otherwise hard to describe or put into words. To grasp a concept, it is better to learn it by doing. As a Foundation Phase teacher educator, I should encourage my students to do this with their learners. More importantly, because young learners are still developing, their physical and psychomotor development is crucial. To develop the gross and fine motor skills, they need to manipulate tools and engage in actions. By doing such activities with my pre-service teachers, I am learning that I should always strive to make learning enjoyable – especially when learning mathematics. When I motivate and guide my students, I also change, develop and progress as a teacher educator.

4.2.5 Lesson 3: Classroom organisation and management – 30 March 2016

This lesson's aim in the pilot project was to help the pre-service teachers understand how to create an effective learning environment for teaching mathematics. Foundation Phase teachers should continuously ask themselves if their classroom environment supports young children's learning and what they need to improve. I began the lesson by asking the pre-service teachers if they wanted to be successful, inspiring Foundation Phase mathematics teachers. They all responded positively, which is what I had expected. It was important to me to know if they were enthusiastic about teaching in this phase. I was aware that some students had only chosen to become Foundation Phase teachers because they had received a bursary. One male student told me that he had wanted to enrol for the Further Education phase and specialise in Accounting. I also wanted to inspire them about how fulfilling it is to teach young learners.

I then explained that they needed to know how to create an inviting classroom to make the most of mathematics learning. To be a successful and inspiring mathematics teacher, one should feel that the task one has undertaken is worthwhile. It is also crucial that young children should not only be able to 'do sums', but they must also understand and enjoy mathematics. Mathematics teachers in the Foundation Phase can do many activities to create an appropriate learning environment for mathematics. I thus clarified that the teacher has the responsibility to plan and organise the classroom to create a learning environment conducive to teaching and learning of mathematics. The classroom has to be arranged to encourage learners to explore, discover,

work independently and with others, and take responsibility for their own learning. Teachers need to create a rich mathematics classroom filled with numbers and concepts that learners can see all day. A Foundation Phase classroom should contain clocks, calendars, a temperature chart for the weather, a height chart and a birthday chart. Sentence strips such as, “The door is a rectangle”, should be displayed. This will teach shapes and support reading.

True to a Vygotskian sociocultural perspective of teaching and learning mathematics, learners need to communicate their ideas and share their thoughts and findings on mathematical issues (Goos, 2014). The classroom has to be equipped to encourage learners to explore, discover, work independently and with others, and take responsibility for their own learning.

I told the students that when I was in primary school, the desks were organised in rows and group work was never allowed. Then, I showed my pre-service teachers a picture of what a Foundation Phase classroom should look like. They were fascinated by the image of the classroom (Figure 4.6). My aim was to focus on what they needed to consider when managing and organising their classrooms. When I showed them the picture, their eyes lit up, and they were alert and intrigued at the view of this bright classroom with countless resources. This was new to them, and they were excited that they might have a classroom like this one day. Although they might want to teach in an ideal environment, I cautioned them that they might find themselves teaching more than 50 learners with insufficient desks or teaching resources. They were disappointed to learn about the realities of the state of some schools in this country. However, some of them were not that surprised as they came from under-resourced schools. One pre-service teacher indicated that it was important that the government increase expenditure to provide enough support and resources to lay a solid foundation for young children’s learning.

Figure 4.9: Example of a Foundation Phase mathematics classroom

I also emphasised the importance of utilising floor space and how necessary it is to have access to all areas of the classroom. For example, there should be open space near the chalkboard where a group of learners can sit on the floor while working with the teacher as the rest of the class carries on with their work. However, I was mindful that this might not be possible in overcrowded classrooms. The walls could be used as a display area where learners could find information when needed. For example, while the teacher works with a group on the mat, learners may find what they need by looking at the wall's information, and they need not interrupt the teacher.

Following this lesson, I asked the students to bring learner teacher support material to class to create mathematics corners. I encouraged the students to get things like playing cards, mathematics books and board games they played when they were young children.

Using concrete objects, visuals and involving Foundation Phase learners in practical activities is vital. Delaney (2010, p. 72) highlights the importance of Bruner's work, which focused on the three modes of representing the world: enactive (actions), iconic (pictures) and symbolic (words and numbers). I explained that Bruner's approach also resonates with the integrated learning approach. Research has shown that young children learn best by initially using concrete materials with a visual and tactile appeal for hands-on experience. Mathematics requires materials for learners to manipulate, handle and explore. Foundation Phase teachers could use shoe boxes (or any other appropriate containers) to organise and store their resources, mark them, and have them readily accessible. It may be helpful for Foundation Phase teachers

to have rules that are clearly understood by all learners in their classes with regards to removing, using and replacing materials.

Furthermore, all materials used or displayed in the classroom project a particular view of the world and may influence learners' attitudes and expectations. Changing the displays and activities regularly to support the work done in class is vital. Teachers should, therefore, take care that the resources they use do not depict stereotypes. Activities, objects, and roles assigned should not show a particular gender, culture, ability, belief, lifestyle, home, or family life as better or more desirable than others.

4.2.6 Creativity corner for teaching mathematics

I grouped the pre-service teachers into three groups, naming them the Red, Yellow and Orange groups. I also brought three tablecloths of these colours. The pre-service teachers put small desks together to create a large flat surface in their respective mathematics corners. I also brought different objects to class such as an abacus and numbers and geometric charts that are often used in a mathematics classroom. My aim was for the student teachers to see the importance of using physical objects when dealing with young children who learn by using their senses.

Physical objects in a mathematics classroom form a foundation for the integrated learning approach because they are linked to different cultural influences. Adamu (2003) explains integration by drawing attention to the constructivist view of learning. This notion is based on the works of Piaget, Dewey, Bruner and others who embraced a holistic idea of education (Adamu, 2003). Research has shown that children learn best by initially using concrete objects with a visual and tactile appeal for hands-on experiences. Teaching mathematics requires materials that learners can manipulate, handle and explore. I explained that Foundation Phase teachers could use shoe boxes (or any other appropriate containers) to organise and store their resources, mark them and have them readily accessible to the learners. I also emphasised the need to have rules that are clearly understood by all learners in the class with regard to removing, using and replacing materials. Following the rules and understanding routine is vital for Foundation Phase learners, and my pre-service teachers had to understand this from the start.

Figure 4.10: Pre-service teachers creating mathematics corners

Engaging pre-service teachers in group work allows them to learn with and from one another. In terms of the sociocultural perspective, Samaras (2002) notes that, by providing support structures for pre-service teachers, they come to know one another well. When the pre-service teachers were creating mathematics corners, I observed how supportive they were as they communicated freely and shared ideas. I learnt that such an environment stimulated their interest in the learning and teaching of mathematics.

Figure 4.11: Picture of a corner created by pre-service teachers for teaching mathematics

Illustrations and other visual media are useful when teaching mathematics. According to Boaler, Chen, Williams, and Cordero (2016, p. 1) "good mathematics teachers typically use visuals … and motion to enhance students' understanding of mathematical concepts". I concur with this view as tangible objects in teaching mathematics in the Foundation Phase are vital. In this regard, the National Council for the Teaching of Mathematics (NCTM) and the Mathematical Association of America (MAA) have been promoting the utilisation of various representations for learners to learn mathematics for quite some time (Boaler et al., 2016). Teachers may use numerous classroom resources for demonstrations and support teaching and learning (Delaney, 2010). This cannot be emphasised enough, especially in the Foundation Phase, where learners' understanding of mathematical ideas and concepts is a continuum of their earliest childhood experiences. McGlynn-Stewart (2010) explains how astonished her student teachers were when they observed how learners who had battled with paper-and-pencil tasks succeeded when they were supported "to solve problems with concrete objects [in a manner that] made sense to them" (p. 183). I understood that I had to promote an active learning environment where my students were lively participants as individuals and as members of a group (Figure 4.7). Thus my pre-service teachers needed to be aware of how they could do the same with their future learners and they had to understand the power that concrete objects wield in the teaching and learning of mathematics.

My journal entry – 1 April 2016

I had so many thoughts about what I could have done better. Upon reflection, I realised that I should have asked the students to talk about their classroom organisation and management experiences and how they felt in those classrooms. I realised that I should have emphasised where they would get the resources from (e.g., from their homes or the community). We discussed what resources they could use in a mathematics classroom and we also discussed the fact that we could not buy all the resources we required. I reminded them they always needed to organise and manage their resources in a way that promotes learning.

However, the students did not bring containers like cereal boxes and food cans. When we embarked on establishing mathematics corners, it dawned on me that I should have emphasised that they should bring ordinary objects and materials from home without incurring extra costs. I realise that I did not stress this enough. Also, among the resources I got should have been 'good junk'. Good junk means the things thrown away in households such as empty containers,

toilet rolls, bread tags, etc. Unfortunately, the students predominantly sourced purchased items, which was not the point of the exercise.

Retrospective reflection – 12 August 2018

After the pre-service teachers had created mathematics corners, I should have discussed teaching in a rural school with limited resources. I could have presented a scenario or given them a case study to explore ideas if they should find themselves in such a situation. This could have increased their awareness of the complexity of teaching in different contexts. I need to model how my pre-service teachers can use resources effectively when teaching mathematics to young learners.

I'm thinking about creating more practical activities using devices such as bead bars, rods and counting frames. This does not come easy for me because I did not use such items when teaching in a primary school. I taught in rural and township schools where we did not have these kinds of devices. Fortunately, I have videos on how to use such materials. These resource materials were provided to us by the Department of Higher Education through the Primary Numeracy National Project. Therefore, I shall be using them to learn continuously and to improve my practice.

4.2.7 Lesson 4: Teaching pre-number concepts - 6 April 2016

The fourth lesson I presented on an integrated learning approach focused on teaching pre-number concepts to Grade R learners. I started the class by giving my pre-service teachers a speed test. My aim was to model how they could do mental arithmetic with their Foundation Phase learners daily. Young learners need to know the basics of addition, subtraction, multiplication and division. The speed test was at a pre-service teacher level and not at the Foundation Phase level. After the test, I asked them to peer mark it. I explained that mental arithmetic plays a crucial role in the prescribed curriculum. It is used extensively to explore the higher number ranges through skip counting and doing activities such as 'up and down the ladder'. For example, mental mathematics (or arithmetic) features strongly in both the counting and the number concept development sections relating to the topic 'number and patterns'. It may also occur during measurement and data handling activities. I clarified that when doing mental mathematics, the CAPS curriculum document specifies that the teacher should never

compel learners to do mental calculations that they cannot cope with. Materials and counters should always be accessible for those learners who may require them.

I then explained that this lesson's aim was to lay a foundation and cultivate an understanding of what learners need to learn to develop their number sense. I further explained that, before learners can understand numbers properly, some pre-number (before formal) concepts need to be established. Teaching pre-number concepts may be more appropriate for Grade R and 1. However, it all depends on the ability level and the quality of the learners' previous exposure to mathematics. One might find learners in Grade 2 and 3 still need to develop some of these pre-number concepts. I then explained the concepts as follows:

One-to-one correspondence: (also called matching) is a foundational mathematical skill for young learners. For this reason, teachers must provide learners with plenty of opportunities to practise one-to-one correspondence. Children can find many options in daily life to experience one-to-one correspondence. They can place one sock inside one shoe or one shoe on one foot or one cup on one saucer.

Figure 4.12: Cups and saucers illustrating the concept of one-to-one correspondence

Matching leads to the understanding of equivalence (=) more than (>) and less than (<).

Classification: Classification means that learners can put things together that are alike or that belong together. When learners are busy with classification, they are practising sorting and grouping. While they sort, group and regroup, they find out how things differ and how items are classified by unique characteristics or properties according to their colour, size, length, form, texture, etc. Therefore, learners learn to distinguish similarities and differences of objects and sort things together based on their common characteristics. Learners can gain experience sorting and classifying as they play with rocks, leaves, buttons or other household items.

Figure 4.13: Assorted leaves depicting the concept of classification

Ordering: Ordering means that things can be ordered or arranged in a sequence from first to last, big to small, long to short, fat to thin, light to heavy, and so on.

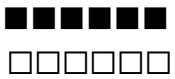
Figure 4.14: Screws illustrating the concept ordering

Conservation: Conservation means that certain features remain the same (are conserved) despite changes in other features. The principle that quantity such as mass, volume, length and number stay the same despite changes in shape is an example of conservation.

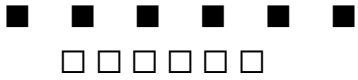
Table 4.4: An activity for the concept of conservation

Suggested activity for the concept of conservation

1. Arrange two rows of blocks (or cut-out squares) in two different colours side by side. Then look at them together with your learners.



2. Let learners compare the two rows to decide whether there are lighter blocks or more dark blocks. Let the learners count and record the quantity (6 in both rows).
3. Now spread out the dark blocks in the following way (or in another pattern).



Ask learners: "How many dark blocks are there now?" and "How many light blocks are there now?" Let learners count and say the number (6 in both rows).

Adapted from the SANTS Numeracy in the Foundation Phase Student Training Manual, (SANTS, 2013)

Subitising: Subitising is a term coined by the theorist Piaget and defines the ability to instantaneously recognise the number of objects in a small group without counting them. An example often used to explain this is to think of a die – we immediately recognise the number of dots without counting each one individually. Subitising helps children see small collections as one unit. This provides an early perceptual basis for number, but it is not yet 'number knowledge'.

Many activities can be done to teach learners to classify things, and my students and I discussed this in detail. Learners can gain experience sorting and classifying as they play with rocks, leaves, buttons or other household items.

Activities

I gave each student a set of 30 A4 charts to create dot cards, picture cards and number friezes. They used 10 A4 charts to create each of these resources. They started them in class, but had to finish them in their own time. The resources were part of their portfolio which also included activities they had to complete for each unit.

Explain how you will teach the concept ‘conservation’ to your Grade 1 learners.

My journal entry – 10 April 2016

I think this lesson went well. I was glad to see that the students were willing to participate. But, I feel that I dominated the discussion when I described the pre-number concept. I was telling them and not engaging with them. In the future, I should try to create opportunities for students to talk, have discussions, argue and express their opinions. From their reaction when developing resources, I saw that they were enthusiastic about becoming early childhood mathematics teachers.

Retrospective reflection – 22 August 2018

My perception of this lesson was that I should try to stimulate pre-service teachers’ ideas by probing more. I must also encourage pre-service teachers to ask questions and make suggestions. In some instances, I felt a need to get this lesson over with because of time. I had to pause and reflect on whether I engaged them meaningfully in the lesson. I need to use strategies that will challenge them to think more deeply about ideas and practice. I should prepare questions beforehand and structure them so that they promote the depth of knowledge and thinking. It is essential to adjust my lessons as I reflect and think about what is best for my pre-service teachers.

4.3 Pre-service Teachers’ Evaluation of the Module

As mentioned in Chapter Two, the pre-service teachers filled in questionnaires to evaluate the module. These questionnaires were developed by the university’s Quality Promotion and Assurance (QPA) unit. The responses are anonymous and can be accessed by the lecturer. I then accessed the students’ feedback online.

I shall briefly discuss some of the comments that I extracted from the QPA report. It is important to note that this questionnaire is generic and used by lecturers across disciplines. Questions such as “*What aspects of the module were facilitated well?”*, “*Which areas do you believe need to be improved in this module?”*, and “*Any other comments?”* were posed. I grouped the responses into categories. I decided on these categories because they linked well with the sociocultural perspective about the way mathematics expresses context and practicality (Siemon et al., 2017). They relate well because they characterise the sociocultural

contexts and the teaching in the classroom. The categories are strategies, practicals, affective domain, and improvement. The students' comments are summarised in Table 4.5 below.

Table 4.5: Module evaluation and comments by pre-service teachers

Questions	**Category**	**Summary of Comments**
What aspects of the module were facilitated well?	Strategies	• *Various strategies of teaching Foundation Phase mathematics and the use of appropriate teaching materials were taught well.* • *The presentation of content areas with activities was facilitated well.* • *The lecturer explained the topic well and brought practical examples of what she was explaining.* • *I like the use of play in the Foundation Phase.* • *Representations were used.*
	Practical	• *The practical work [exercises] done for each unit was excellent.* • *The speed tests (this has not been mentioned yet) in class were very useful since they helped me realise my strong points and weaknesses so that I can improve on my mathematical skills in order to be an excellent mathematics teacher.*
	Personal attributes	• *My lecturer was good.* • *I love the lecturer, she is amazing.* • *The lecturer was always approachable and friendly.* • *Carry on using the same lecturer and all will be well.*

		• *The lecturer showed us the real meaning of becoming a Foundation Phase teacher – passion and patience are important.*
What areas do you believe need to be improved in this module?	Improvement	• *We need to have another module of numeracy.* • *There is a whole lot of work and the content is packed.* • *There should be more practicals for this module with the Foundation Phase numeracy teaching materials already provided for the students.* • *Enough time should be spent on each content area.*

4.3.1 Strategies

In responding to the question: "*What aspects of the module were facilitated well?"*, most pre-service teachers brought the issue of strategies, highlighting that the content was facilitated well, mainly as different approaches had been used. They mentioned the use of play in the early years to promote the learning of mathematics. As Dockett and Perry (2010) suggest, Foundation Phase pre-service teachers need to be taught how to integrate play to promote mathematics learning. My pre-service teachers pointed out that play as a strategy was important when teaching Foundation Phase learners. They also mentioned that the mathematics content areas (number, patterns, space and shape, measurement and data handling) were well presented through the activities. The pre-service teachers grasped some strategies for teaching mathematics in the Foundation Phase concerning facilitating learners' active involvement through the use of appropriate teaching materials.

What emerged from my pre-service teachers' module evaluation comments was that they understood mathematics content areas after their exposure to the different strategies and activities they had engaged in to consolidate and apply what they had learnt. Mntunjani, Adendorff, and Siyepu (2018) highlight how resources can help increase understanding of mathematical concepts. I learnt that the pre-service teachers valued the incorporation of play and representations in the mathematics classroom. Therefore, I need to provide more

opportunities for pre-service teachers to assimilate play and understand the significance of young learners' cultural and social backgrounds. Thus, in my practice, I should consider that prior knowledge shapes new learning.

4.3.2 Practical

The comments about the practical work's importance showed that the pre-service teachers were beginning to comprehend what it entailed to teach in the Foundation Phase. I gave practical examples in my teaching and let the pre-service teachers engage in practical work. For instance, at the end of each unit, there were exercises and activities to apply the concepts they had learnt. I also gave them speed tests and exercises based on four basic operations (addition, subtraction, multiplication and division) at their level and not at the level of the young learners they were preparing to teach. I concur with Pereira (2011), who asserts that pre-service teachers crave practical significance in mathematics modules. My pre-service teachers believed that their proficiency improved through practical applications, and they looked forward to becoming excellent mathematics teachers one day. Maasepp and Bobis (2015, p. 102) found that primary pre-service teachers participating in an intervention programme believed that mathematics should be taught using "carefully planned practical activities grounded in concrete mathematical ideas". These comments point to the significance of providing practical teacher education experiences, particularly in early childhood mathematics. It tells me that I should think of more ways to involve my pre-service teachers in practical work when learning how to teach mathematics in the Foundation Phase.

4.3.3 Personal attributes

The pre-service teachers' comments suggested that they understood that there was more to teaching than facilitating learning in class. I think they reckoned that specific attributes were important than others in the teaching profession. Based on their comments such as a "loving the lecturer", I believe these attributes are love, passion and patience. I agree with Pereira (2011), who argues that as much as the mathematical and pedagogical content knowledge is significant, as teacher educators, we also need to concentrate on learning mathematics' emotional experiences. Displaying this attitude may help me accomplish my goal to cultivate an integrated learning approach among my pre-service teachers by instilling in them an enthusiasm for active and interactive learning through my interactions with them.

In general, how teacher educators employ methodologies in their classrooms influences their role as educators. Lovin et al. (2012) claim that teacher educators usually learn about teaching on their own. I learnt that I need to have empathy and understand my pre-service teachers' challenges, uncertainties and stress as learners in becoming teachers of mathematics. I thus hope that they will be able to assist their learners in overcoming any difficulties. I also need to create a warm classroom climate in which my pre-service teachers will feel free to talk about their challenges when they try to understand the mathematical concepts they will have to teach one day.

4.3.4 Improvement

The pre-service teachers' evaluations were essential to me as I strove to improve my own teaching practice. According to Lovin et al. (2012), teachers and teacher educators should not be content with time-honoured strategies. Instead, they should try to be flexible and use innovative methods to prepare their students to become efficient thinkers and doers. Although my pre-service teachers were satisfied with the module, the lack of time to allow their learning to develop progressively was a drawback. It appeared that they felt the need for more time to master the requirements of the module. Their comments inspired me to consider a more time-efficient presentation of this module's content for development and learning. For example, I tried to cover all the mathematical concepts and content areas in this module. This meant that I was not able to explore the content area in depth. However, I realised that if I spread the content area into two modules, I could cover all the components more adequately. This will be possible because there is an additional early childhood mathematics method module in the new B.Ed. programme. I will start teaching the additional module as of 2021.

4.4 My Learning

I observed how the pre-service teachers engaged with the collage and concept map activities in terms of time. I found that a double period of 90 minutes was appropriate for a planned activity but that I was unsuccessful when I required the completion of too many activities in one session. I became aware of the preparation involved before the lessons and the nature of the materials that I needed to bring to class. Some students helped me carry cumbersome materials to and from the lecture room.

In hindsight, I realise that I neglected to stress enough to the students that mathematics teaching and learning would require considering the learners' contexts and cultures. The lessons I

presented focused on the integration of the Mathematics, Languages and Life Skills learning areas. However, I also needed to consider the sociocultural elements (including language. Cultural demands have a strong influence on learning. Samaras (2002) states that it is essential that teachers incorporate learners' interests and backgrounds in the lessons they teach, stimulating their curiosity, and motivating them to learn. Samaras (2002, p. 27) also notes that it is imperative that teacher educators "employ levels of reflection to consider the technical, interpretive, and critical consequences" of their teaching decisions. I noted that my pre-service teachers embraced the celebration of family connectedness such as birthdays and family get-togethers and that they could effectively utilise this knowledge to teach their learners numerical values, dates and counting skills. They were able to harness family connectedness and they highlighted this as a critical element in the acquisition of prior knowledge that they could use to teach their learners.

When I taught this module as a new employee for the first time in 2015, I focussed on delivering the content as per the module template. As I was developing the learning guide for the early childhood mathematics the following year, I was motivated to do things differently. I decided to teach early childhood mathematics in a more interactive and integrated way when I conceptualised my proposals for the Teaching and Learning Innovations and Quality Enhancement Grant (TLIQEG) and my doctoral study. I also wanted to improve my teaching practice by engaging in a self-study project.

In the 15 years that I worked as a teacher educator, I had never before embarked on an arts-based teaching method, so I was somewhat apprehensive about using this approach. Still, I persevered in exploring the arts-based practice as I wanted to help my pre-service teachers understand the integrated learning approach. Admittedly, I was worried when I first introduced the concept of creating collages as my pre-service teachers appeared unresponsive. However, as I mingled with the groups and explained what they needed to do and why they began to understand and gained the confidence to tackle the task. It was rewarding to see their excitement and the sense of achievement they experienced when the collages were completed.

The pilot study was approached without developing a lesson plan, which was one of the weaknesses that I identified. I recognised that I needed clear lesson plans with objectives. As much as the students enjoyed engaging with these new methods, I could not assess if the desired outcomes had been reached. However, I focused on the arts-based process to understand how

I could enhance my students' understanding of an integrated learning approach. I also wanted to gain confidence in using this approach as I was still learning about it myself. I experienced that the arts-based lessons facilitated the use of hands-on, creative tools from a cultural context and that this helped my pre-service teachers better grasp what I was trying to teach (Samaras, 2011). The power of visual approaches expands the possibilities for constructing knowledge differently (Butler-Kisber & Poldma, 2010). Because I was trying this for the first time, I was nervous, but I learnt that it was achievable, which was the pilot study's purpose.

I always reminded myself of Weber's (2014) argument that, although arts-based approaches are used for a wide range of purposes, they are especially useful in self-study research. I understood that, although I had been using learner-centred methods such as presentations and group discussions for many years, I had never ventured into an arts-based approach as I had thought these activities were for artistic people. When I embarked on this journey, I was forced out of my comfort zone – and what a fantastic experience it proved to be!

Having undertaken all these activities with the pre-service teachers, I learnt more than I had anticipated about the integrated classroom environment and how I could teach my students to make it even more attractive, challenging and learner-centred. These experiences shaped the future lessons that I planned. I realised that I needed to equip my pre-service teachers with hands-on experiences to better understand the concept of an integrated approach to teaching and learning mathematics in the early childhood development phase. This pilot study informed my thinking of how I could address the research questions. I needed to structure the lessons. Therefore, in the following year, I planned eight lessons that would focus on an integrated learning approach as I wanted to cover as many content areas as possible (see Chapter Five). I also developed an evaluation form that would help me evaluate my efforts to promote an integrated learning approach among the students and see what I needed to do to improve my efforts. I paid attention to group work to allow for more interaction with my pre-service teachers to strengthen this approach's implementation. The pilot study also helped me clarify the analysis process I should use, which I developed further when I implemented the integrated learning approach with another group of student teachers.

4.5 Conclusion

This chapter described the purpose of and the methods used in the pilot study that I launched while developing the proposal for my doctoral study. I envisaged that modelling an integrated

learning approach would enrich my practices and enhance pre-service teachers' understanding of curriculum integration. I envisioned that this approach would enable me to combine my teaching of the Mathematics learning area with the Languages and Life Skills learning areas rather than teaching it in isolation. I intended to help my pre-service teachers learn how to implement appropriate educational approaches to prepare learners for lifelong learning.

Conducting this pilot study from within a sociocultural theoretical perspective guided me to reflect deeply on new approaches to teacher education, particularly concerning mathematics teaching and learning in the Foundation Phase. The importance of considering the cultural background and mathematical experiences of pre-service teachers was emphasised. I was motivated by Samaras' (2002) visions of the cultural and social effects that mould pre-service teachers' development.

As a mathematics teacher educator in the early childhood education discipline (i.e., the Foundation Phase), I recognised how I could better understand my pre-service teachers' thinking about mathematical concepts. I saw how I could guide them to teach mathematical skills and mathematical reasoning in their Foundation Phase classes one day. I introduced innovative techniques that the pre-service teachers did not understand at first. I had taken certain reasonings and behaviour for granted, which did not always have the desired results. However, some shifts occurred that were encouraging.

I also engaged in deep reflection and appreciated that I should improve my approach by structuring lessons that would focus on an integrated learning approach. I had to abandon my comfort zone and learn from a position of vulnerability, which was new and frightening. Samaras and Freese (2006) highlight that reflecting, learning, and thinking in self-study involve a particular vulnerability.

The following chapter is titled '*Keeping my head above water'.* This chapter describes the lessons I presented using an integrated learning approach with a different group of first-year pre-service teachers after the pilot study. I explain how I employed what I had learnt during the pilot study. I also clarify how and why arts-based methods, such as collages and concept maps, enhanced my efforts to encourage my pre-service teachers to use an integrated learning approach more effectively than in the pilot study.

CHAPTER FIVE: KEEPING MY HEAD ABOVE WATER

Stories of our teaching can effectively portray our practice as a complex, situational, and uncertain activity that is full of pitfalls as well as possibilities.

Peter Pereira

5.1 Introduction

In the previous chapter, I addressed my second research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* I recounted how I involved pre-service teachers in a pilot project to trial an integrated learning approach in the early childhood mathematics module that I taught. I described the activities that we engaged in to understand mathematical concepts in the Foundation Phase, using an integrated learning approach. I elucidated how arts-based methods such as collages and concept maps were used to help me understand how an integrated learning approach could be introduced to pre-service teachers. I recognised that I needed a clear structure when presenting my lessons in the following year. More importantly, I learnt more about the integrated classroom environment to make it more fascinating, challenging and learner-centred.

In the current chapter, I continue to address the second research question. The title '*Keeping my head above water*' is a metaphor for my struggles when I worked with a larger group of pre-service teachers. Peter Pereira's (2005, p. 72) argument that "stories of our teaching can effectively portray our practice as a complex, situational, and uncertain activity that is full of pitfalls as well as possibilities" reminded me that the journey I had embarked on to improve my practice had both highs and lows. Difficult experiences helped me to grow and appreciate what I had accomplished.

In the next phase of the study, which took place in 2017, I planned lessons based on what I had learnt in the pilot study, and I involved a different group of pre-service teachers. I engaged in various activities and conducted classes that focused on teaching selected mathematical concepts in the Foundation Phase to better understand an integrated learning approach.

Chapter Five begins with an overview of the principles of integration that guided my practice. I then give a detailed account of four of the eight lessons I planned and conducted as part of my self-study research. I chose to split my discussion of the eight lessons between this chapter

(Five) and the following chapter (Six) as I taught these eight lessons with different groups of pre-service teachers in 2017 and 2018. The comprehensive table with all the lessons is presented in Appendix A. I discuss four out of these eight lessons in this chapter. My account of the selected four lessons is followed by examining the pre-service teachers' feedback on an integrated learning approach and their module evaluations. I conclude the chapter by highlighting my learnings.

As previously noted, the primary language of learning and teaching at the institution was English, and therefore lessons were presented in English. The majority of the pre-service teachers were IsiZulu home language speakers.

As explained in Chapter Two, I taught the early childhood mathematics module to a different group of pre-service teachers in the first semester (February to June) for three consecutive years. I audio recorded all the lesson presentations that I conducted on the integrated learning approach, and I documented my reflections on these lessons in my journal. In this chapter, I outline the lesson topics I presented in the module and show how integration was accomplished across the learning areas and within the Mathematics learning area. The lessons that I focus on in this chapter were conducted from February 2017 to June 2017. After the description of each lesson, I discuss the reflections that I documented.

5.2 Principles of Integration

When teacher educators prepare Foundation Phase pre-service teachers, they need to make them aware of how integration should occur among subjects so that they will be able to apply these principles. Pre-service teachers should guide a learner during a language lesson to spot similarities and differences with mathematics (NAEYC, 2002). For example, when learners assemble a puzzle, they must look at the different pieces and spot colours or shapes that are the same and see the difference between corner pieces, pieces that fit on the edge of the puzzle, and the pieces used inside the puzzle. Haylock and Manning (2014) believe that, through integration, learners get to enjoy mathematics and experience a sense of pleasure from solving a problem or a mathematical puzzle.

Venville, Wallace, Rennie, and Malone (1998) note that integration often occurs naturally in primary schools because the teachers teach most of the learning areas to the same group of learners. Integration can also happen within a subject. For example, in mathematics,

connections can be made between numbers and geometry. By counting the sides of shapes using arrays to understand number combinations or measuring the length of their classroom, learners strengthen concepts from both areas and build knowledge and concepts about mathematics as a coherent system. NAEYC (2002) urges that young learners can link mathematics to other learning areas such as Science, which improves knowledge of these subjects and the broad application of mathematics. Likewise, Parker (2006, p. 63) believes that it is very sensible to introduce integration in the Mathematics learning area.

To promote integration, learners need to access and make connections among various concepts and knowledge fields. According to the Department of Education (2003), "integration within a learning area is automatic in the sense that you cannot work with measurement without integrating [it] with number" (p. 76). Therefore, pre-service teachers should be equipped to determine which activities are suitable to achieve this. I thus tried to offer various practical exercises in class to strengthen my students' understanding of how the integration of content areas in the Mathematics learning area can materialise. Mwakapenda (2008) provides an example of the integration of content areas in mathematics. For instance, when learners learn about shape and space, they should use algebra and geometry knowledge. It means the two content areas (i.e., space and shape and pattern functions and algebra) are integrated.

Samaras (2002) believes that pre-service teachers need to learn through exemplary practices. My stance in the preparation of my pre-service teachers was aligned with Samaras' (2002) motto to "teach by example" (p. 127). I anticipated that adopting this position would allow my pre-service teachers to see that learning using the integrated learning approach was achievable. Pereira (2005) states that, by providing pre-service teachers with a range of opportunities, they get to experience mathematics in a more accessible way. Because the Foundation Phase teacher is responsible for teaching all the learning areas, guiding pre-service teachers to adopt methodologies informed by integrated learning principles is necessary. NAEYC (2007) highlights that mathematics is taught because of its functionality in different contexts, including other curriculum learning areas. I thus support the view that "Mathematics is a subject that can support learning across the curriculum" (NAEYC, 2007, p. 7). Teacher educators and student teachers need to be aware of how this can be applied in different contexts.

5.3 Lesson Presentations

As was indicated in Chapter Two, I worked with first year students who had enrolled for the B.Ed. Foundation Phase. In 2017, this group comprised 141 pre-service teachers and I divided them into two groups. As indicated in Chapter Four, there were only 34 pre-service teachers registered for the Foundation phase in 2016. The following year, the numbers grew significantly. In part, this was because, to address gender inequalities, the university increased the number of male pre-service student teachers in the Foundation Phase (as explained in Chapter Two).

In 2017, I worked with 85 pre-service teachers, and the intermittent staff worked with the other 56 pre-service teachers. During the first lecture, I explained that I was conducting a research study to explore an integrated learning approach to improve my teacher educator practice. I explained that I would be taking photographs but would not show their faces. I also explained that I would analyse the activities we would do in class during specific lessons focusing on an integrated learning approach. I further explained that I would be audio recording these lessons and our conversations in class. All the pre-service teachers signed consent forms with the understanding that they could withdraw their consent at any time they chose. I asked for their consent to use their contributions to the class as data for my study. I explained that if they withdrew consent, they would still continue with all the class activities, but I would not use their contributions as research data. The pre-service teachers responded positively and did not raise any questions or objections.

The early childhood mathematics module is designed to equip student teachers with knowledge of and competencies to teach mathematics in the Foundation Phase. It also provides them with both theoretical and practical mathematics experiences. This module also aims to develop pre-service teachers' mathematical subject knowledge so that they will be able to teach using an integrated mathematics programme. Student teachers need to master mathematical knowledge and embrace a positive and motivated teaching approach that enhances particular knowledge and skills (Thames & Ball, 2010). Pre-service teachers in the Foundation Phase need to have a good grasp of early childhood mathematics, and they need to impart that knowledge to their future learners in an appropriate manner.

This chapter presents four of the eight lessons that I taught that focused on an integrated learning approach. It must be noted that each period for this module was 90 minutes. I presented two 45-minute lessons for one content area in one period.

5.3.1 Numbers, operations and relationships

Table 5.1 below summarises Lesson 1 and Lesson 2 on using an integrated learning approach. These lessons were based on the content area "numbers, operations and relationships". According to the Department of Education (DoE, 2011, p. 9), the following is essential:

> "Number concept development helps learners to learn about properties of numbers and to develop strategies that can make calculations easier. Solving problems in context enables learners to communicate their own thinking orally and in writing through drawings and symbols".

Teaching Grade R Learners Counting and Number Recognition - 28 March 2017

In the Foundation Phase, attention must be focused on learners' number concept development. This can be achieved by working with physical objects to count collections of objects, do partition, and combine quantities and skip counting to enable learners to build up and break down numbers and solve word problems.

Table 5.1: Lessons on counting and number recognition in Grade R

Grade	**Content Areas**	**Lesson Topics**	**ILA - Maths (Integration of concepts within the mathematics learning area)**	**ILA – Lang (Integration with the Languages learning area)**	**ILA – Life Skills (Holistic Development) (Integration with the Life Skills learning area)**	**Sociocultural Theoretical Perspective (Vygotsky)**
Grade R	Numbers, Operations and Relationships	**Lesson 1**: Counting	Number patterns	Say and use number names in familiar contexts (listening & speaking)	Fine motor skills Performing arts – action rhyme rational counting, value of numbers *Cognitive development Physical development*	Human activities take place in cultural contexts, are mediated by language and other symbols, systems, and can be best understood when investigated in their historical development.

	28 March 2017	**Lesson 2**: Number recognition	Number of 2-shapes and 3-D objects	Recognise and read number names Rhymes Story	Familiar contexts – learners' personal details: age, house no. *Social development* *Cognitive development*	Modes of tools like artefacts – social resources Sociocultural researchers emphasise methods that document cognitive and social change.

These two lessons' objectives were to guide the pre-service teachers to understand how learners learn counting and number recognition. I aimed to encourage them to develop activities to enhance learners' awareness of numbers in the world around them using an integrated learning approach. I started the first lesson by giving the pre-service teachers a speed test and an exercise that involved high numbers. Even though this module focused only on pedagogy, I wanted them to develop their own number sense and show them that they were being prepared to graduate with knowledge appropriate for the level at which they would teach.

I introduced the first lesson by asking the pre-service teachers to recite counting rhymes, for example: "*1, 2, 3, 4, 5, once I caught a fish alive*" and "*One, two, buckle my shoe*". When they were reciting the rhymes, I encouraged them to do some actions. I asked the pre-service teachers to recite the rhymes because I wanted them to experience a Foundation Phase teacher's work. Initially, they were surprised that I was asking them to recite rhymes. They thought it was something that should be done by young learners and not by young adults. However, as they recited the rhymes, I could see that they were enjoying this activity. They were smiling and looking at one another. I got the impression that they were starting to understand that they would teach young learners soon. Even the male students who at first found it difficult to go to the level of Foundation Phase learners warmed to this activity.

Following this activity, I projected slides to illustrate my presentation on counting. I spent some time explaining that, according to the Curriculum Assessment Policy Statement (CAPS) for the Foundation Phase, "the approach to learning mathematics should be based on the principles of integration and play-based learning" (Department of Education, 2011, p. 13). During this phase, I further explained that Grade R learners are expected to estimate and count at least 10 everyday objects consistently and accurately (DoE, 2011). The pre-service teachers were surprised that this was the expectation for Grade R learners. This taught me the importance of

explaining every little detail about Foundation Phase requirements and the importance of developmentally appropriate activities for young children. I considered the fact that the pre-service teachers were in their first year at university. They had just come from high school, and it had been almost nine years since they had been in the Foundation Phase. One pre-service teacher asked: "*When teaching learners rhymes, do I need to do all these actions?*" I responded that, as a Foundation Phase teacher, you should. Cancienne and Snowber (2003) note that mathematical perceptions begin from counting simple concepts and combining movement and mental forms to establish relationships between body and mind. Such activities are suitable for young learners, as they are still developing physically and intellectually. Doing this validated that my students were really being prepared to teach in the Foundation Phase. According to Brandenburg (2011), teacher educators need to continuously provide support and motivation for pre-service teachers. I tried to exude enthusiasm and excitement. I wanted to show them that it was enjoyable to teach young children.

I needed to link this lesson to the previous lesson, which had focused on pre-number concepts by using counters and cut-out shapes. I wanted to model how to build conceptual progression. I highlighted that some Grade R learners might already know some counting words but might not use them in the correct sequence. I indicated that they needed to teach them step-by-step by gradually increasing the counting sequence until they knew the sequence from one to ten by heart. Learners must recite counting words in the correct order before they can count with understanding, which is called rote counting. Pre-service teachers need to understand that, to count objects accurately, the learner must know the number names in the correct order and coordinate eyes, hands, speech and memory.

My first lesson included rote counting and rational counting. I explained that rote counting in Grade R means to be able to say the counting words in the correct order: One, two, three … up to ten. When teaching rote counting in Grade R, we want learners to feel the rhythm of counting, which can be achieved using number rhymes and songs. I explained the meaning of rational counting – that is counting objects with understanding. Charlesworth (2012) describes rational counting as counting that involves matching each numeral name to an object in a group. According to Linder, Powers-Costello, and Stegelin (2011, p. 31), "counting skills develop number sense in young learners and lay the foundation for learning advanced concepts in the future, such as identifying relationships between numbers and examining patterns in numbers". Therefore, I emphasised that learners should be afforded opportunities to recite the counting

words in the correct order before they can count with understanding. I highlighted that when they taught rote counting, rhymes and songs should be used. For example:

> One, two, buckle my shoe
> Three, four, shut the door
> Five, six, pick up sticks.
>
> One, two, three, four, five
> Once I caught a fish alive
> Six, seven, eight, nine, ten
> Then I let it go again
> Why did you let it go?
> Because it bit my finger so
> Which finger did it bite?
> This little finger on my right!

The main objective is to teach learners the correct order of counting words informally. Linder et al. (2011) refer to this as enumeration, where learners say the number word, count, recognise a number of objects, and read and write numbers. Moreover, Gerdes (1994, p. 41) states that "...counting and numeration systems provide a good start, because learners can begin to analyse and compare the various ways of counting and numeration they learnt in their life". Thus, teaching counting requires pre-service teachers to think about developing learners' counting skills for future learning. Charlesworth (2012) argues that number sense and counting can be integrated into other content areas. They need to incorporate language by using rhyming words and life skills by doing actions using body parts. This is how learners begin to use numbers to solve problems they encounter every day, such as how many cups they will need for a group or how many sides are in a triangle (Charlesworth, 2012).

Table 5.2: An extract from the CAPS document on the topic "counting"

TOPICS	GRADE R	GRADE 1	GRADE 2	GRADE 3
NUMBER CONCEPT DEVELOPMENT: Count with whole numbers				
1.1 Count objects	**Count concrete objects** Estimate and count to at least 10 everyday objects reliably.	**Count concrete objects** Estimate and count to at least 50 everyday objects reliably. Counting by grouping is encouraged.	**Count concrete objects** Estimate and count to at least 200 everyday objects reliably. Counting by grouping is encouraged.	**Count concrete objects** Estimate and counts to at least 1000 everyday objects reliably. Counting by grouping is encouraged.
1.2 Count forwards and backwards	Count forwards and backwards in ones from 1 to 10 Use number rhymes and songs	Count forwards and backwards in ones from any number between 0 and 100. **Count forwards in:** • 10s from any multiple of 10 between 0 and 100 • 5s from any multiple of 5 between 0 and 100 • 2s from any multiple of 2 between 0 and 100	Count forwards and backwards in: • 1s from any number between 0 and 200 • 10s from any multiple of 10 between 0 and 200 • 5s from any multiple of 5 between 0 and 200 • 2s from any multiple of 2 between 0 and 200 • 3s from any multiple of 3 between 0 and 200 • 4s from any multiple of 4 between 0 and 200	Counts forwards and backwards in: • 1s from any number between 0 and 1000 • 10s from any multiple of 10 between 0 and 1000 • 5s from any multiple of 5 between 0 and 1000 • 2s from any multiple of 2 between 0 and 1000 • 3s from any multiple of 3 between 0 and 1000 • 4s from any multiple of 4 between 0 and 1000 • in 20s, 25s, 50s, 100s to at least 1000

The second part of the lesson focused on number recognition, where we discussed the importance of learners' ability to recognise the number symbols and name them. I explained that, in Grade R, we focus on the numerals 0 – 10 by introducing one number at a time. By the end of the Grade R year, these learners should read any number from 0 – 10. I then asked the pre-service teachers, "*Which number do we teach first?*" They answered "0". I explained that this was not the case as 0 is a complex number concept that is difficult for learners to grasp. I explained that the first number to be introduced in Grade R is number 1. I demonstrated this by saying:

> "*You will show your learners the number 1 using one dot and one picture of one thing. The learners should find one thing in the classroom, one thing on the body, and draw one thing. All this is done to show the learners what one is and for them to recognize and identify one thing, one picture, one dot and the number 1 all as one*".

I stressed that this makes Foundation Phase unique, and no one should teach in the Foundation Phase unless adequate preparation has occurred. I explained that Foundation Phase teachers need to be playful and creative in their thinking to improve their experience and practice as they work with young learners (Harris, 2007).

The aim of number word recognition is to focus on each number individually and continually revise the numbers that have already been introduced. When introducing a new number, for example, the number 5, learners should be guided to find the number 5 on their number frieze.

Teachers should count with the learners to make sure they reach the right number. I demonstrated how they could do this using a number frieze (Figure 5.1).

Figure 5.1: A number frieze

A number frieze is a large wall poster with objects from 1 upwards and the number symbol to represent the quantity and the number name associated with it. There are many different types of number friezes. The number frieze in Figure 5.1 shows objects, number symbols, the number names for numbers 1 to 10, as well as the names of the objects. It exemplifies how integration is actually happening when the number symbols for mathematics, the number names for language and the objects for life skills are represented. Cross, Woods and Schweingruber (2007) articulate that, as learners learn about object counting, they get to understand that the last number word indicates the total number of items in a collection. Additionally, Ensor et al. (2009) contend that counting forwards and backwards by counting in 1s, 2s, 3s, 5s, etc., develops an understanding of patterns that assists in early addition and subtraction skills.

From this point, I moved on to discuss numbers in familiar contexts. I highlighted why it was necessary to use numbers in a way that would be familiar to learners. Learners need to see where numbers are used in their lives and in the world around them. This will give meaning to the numbers that are being taught. For example, young learners should know their ages, birthdays, house numbers and addresses, and their home or cell phone numbers. Many number games could be used to practise and reinforce learners' counting skills, e.g., the board game

"snakes and ladders". I stated:

> "*Learners throw a dice and count the number shown on the dice on from where the counter is on the game board. You must use similar games from your own culture in your class*".

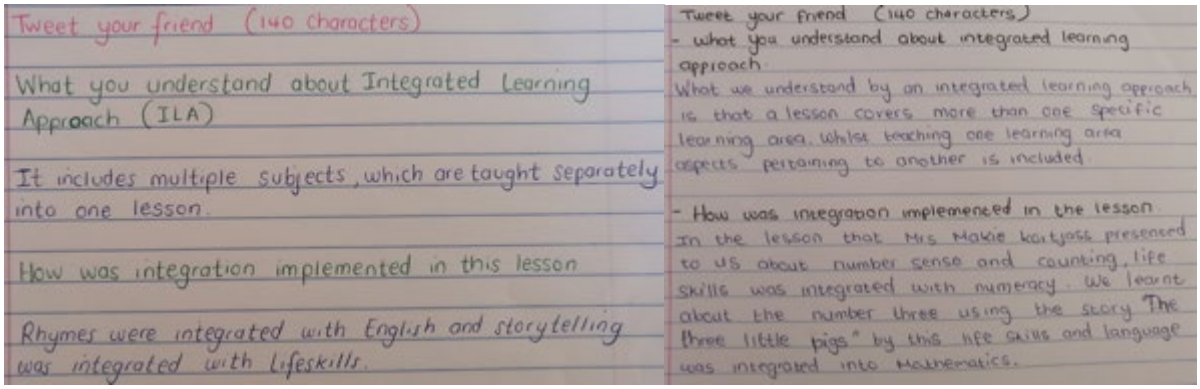
We discussed using numbers in familiar contexts. For example, learners love their birthdays and teachers need to talk to their learners about their ages during free play by asking questions such as: "*How old are you?"* and *"What age will you be on your next birthday?*" I also explained that when it is one of their learners' birthdays, they could focus on the learner's age by involving the entire class. I said:

> "*Tell the class that Aphile is turning 5. Ask them what age she was before she turned 5. Ask them to put their hands up if they are also 4. Then ask the learners who have turned 5 to put up their hands. You may have learners of different ages in your class; make sure you involve each age groups in your class*".

To contextualise the lesson using an integrated learning approach, I asked one student to read the story 'Three little pigs'. I asked the pre-service teachers to think about a Life Skills lesson and how to integrate mathematical concepts with numeracy. In this activity, they were provided with an imaginary story setting that demonstrated how integration occurs in a Foundation Phase class. According to Ramani and Eason (2015, p. 31), teachers should explore the integration of mathematics "...into language arts classes by discussing and building on the math content that occurs in many children's books". This presentation taught me that I needed to provide a variety of examples to cultivate this approach. I also felt the need not to tell them how to show them how they could do this. Linder et al. (2011) note that teachers need to plan suitable strategies for young learners when introducing mathematical concepts because mathematics becomes increasingly demanding at the Foundation Phase level.

In conclusion, I emphasised focusing on each number individually and continually revising and reinforcing the numbers that have already been introduced. The CAPS document states that the numbers should be presented over the four terms of a year as follows: Term 1 – 1; Term 2 – 2, 3, 4; Term 3 – 5, 6, 7; and Term 4 – 8, 9, 10 and 0 (DoE, 2011). At the end of the lesson, I asked the pre-service teachers to reflect on the lessons by doing the following activity:

- Send a tweet to your friend using about 140 characters to explain:
    - What you understand about an integrated learning approach;
    - How integration was achieved in this lesson.



-

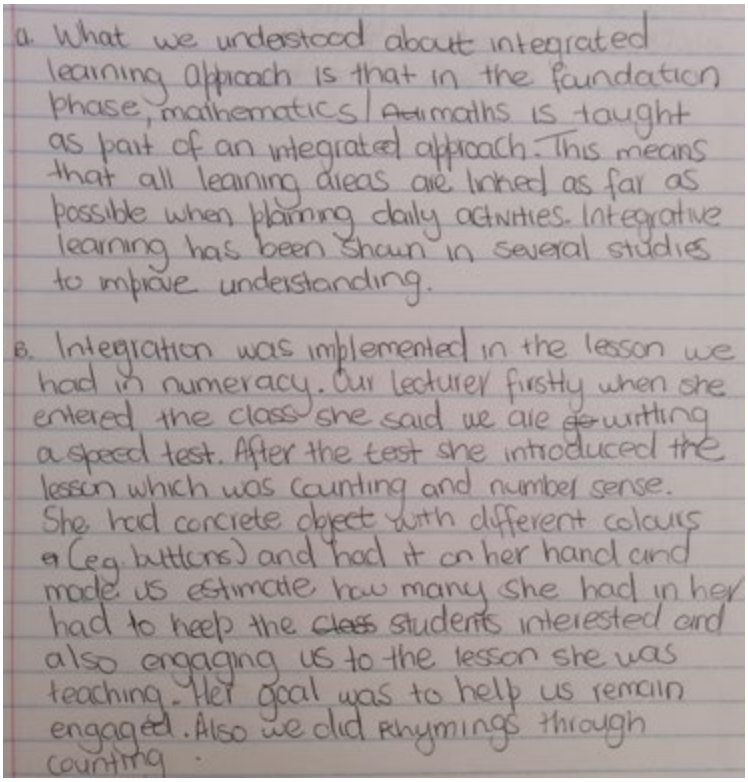


Figure 5.2: Pre-service teachers' tweets about their understanding of an integrated learning approach

The idea of engaging pre-service teachers in writing tweets emanated from a discussion I had with my supervisor. I liked this idea and felt that it would be beneficial to involve them in using the 'language of technology' to simply and succinctly represent an integrated learning approach. Mpungose (2020) suggests that higher education institutions need to engage students in using technology to learn and reflect on their learning experiences. However, I did not

require the students to use Twitter on their cell phones, but rather to handwrite the tweets. I was aware that the pre-service teachers came from different socioeconomic backgrounds and did not want to exclude students who might not have smartphones. This activity was offered as a way for pre-service teachers to think creatively about an integrated learning approach.

It was clear that the pre-service teachers understood that an integrated learning approach means that different learning areas are linked in one lesson to enhance learners' understanding of a particular topic. As part of their portfolio activities, I instructed them to design a number frieze (using 1-10). They used 10 A4 charts, dot cards and number cards. By asking them to develop these resources, I wanted them to practise making their own support material for their future classrooms. I wanted them to see how these support materials really support teaching and the learning of young children. The pre-service teachers had to discuss how they would use the number friezes to teach mathematics in Grade R. They were given a month to prepare these materials. Figure 5.3 below is an example of the resources that were developed by pre-service teachers.

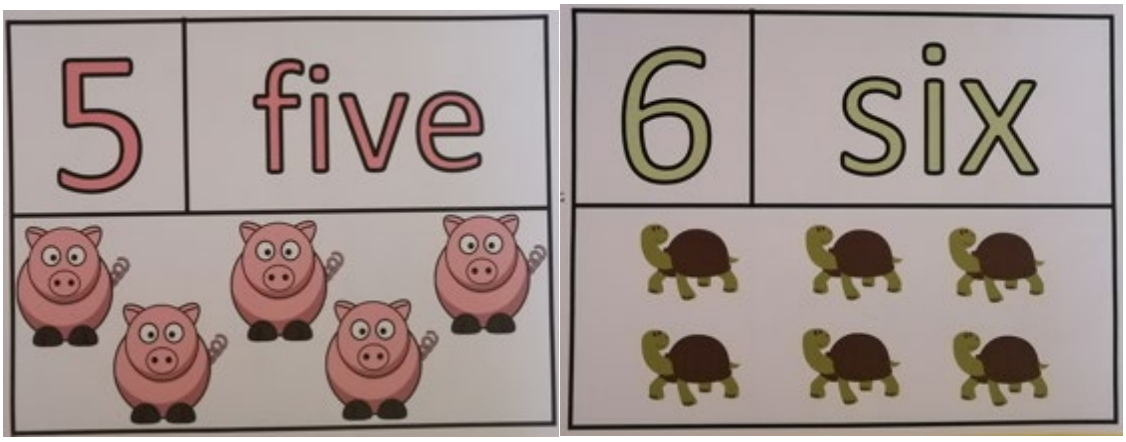


Figure 5.3: Examples of number friezes (depicting numbers 5 and 6) created by pre-service teachers

I was really impressed by the work that some of the pre-service teachers produced. It demonstrated their growing understanding of the integrated learning approach and that they were committed to their studies.

Journal entry - 28 March 2017

My first lesson on the integrated learning approach went well. But, I was disappointed that I forgot to bring my audio recorder to record this lesson. So, I decided to write in my journal

immediately after the lesson, to remember how the lesson progressed. I had brought all the resources I needed for this lesson, such as counters, a geoboard, playing cards and others. I was pleased to observe the pre-service teachers enjoying reciting the rhymes. I felt confident that they were eager to learn. I considered using the things that they were familiar with, like the activity on tweeting. I soon realised that some of them did not understand what it means to tweet. We then discussed this application and some students explained to the others how to 'tweet'. I realised that I should not take anything for granted.

Retrospective reflection – 4 September 2018

It would help to have a small notebook to jot down a list of things that I will do and bring to class each day. I plan to have a notebook where I will insert a date and all the day's activities. I figure this will help me to be more organised. Working in over-crowded classrooms has a negative influence on learning and teaching. However, it will not help to complain, but I need to come up with a plan. I want to explore dividing the time for tutorials and plan the activities we can do together carefully. I also need to consider online activities that they can do on their own.

5.3.2 Measurement

The last two lessons, Lesson 7 and Lesson 8, were based on measurement. The DoE (2011, p. 10) defines measurement as follows:

> "Measurement focuses on the selection and use of appropriate units, instruments and formulae to quantify characteristics of events, shapes, objects and the environment. It relates directly to learners' scientific technological and economic worlds, enabling the learner to make sensible estimates and be alert to the reasonableness of measurements and results".

Measurement in this phase must enable the learner to measure and solve measurement problems involving measurement of length, mass, capacity and time.

Teaching measuring length, perimeter and area to Grade 3 learners - 3 May 2017

In the Foundation Phase, attention must be focused on learners' ability to measure, first informally and then formally, to develop a sense of the 'muchness' of things. Through measuring they also encounter situations that cause them to think about the need for parts of a

whole to describe specific quantities – this is an essential introduction to the concept of fractions.

Table 5.3: Lessons on measuring length, perimeter and area in Grade 3

Grade	Content Areas	Lesson Topics	ILA - Maths (Integration of concepts within the mathematics learning area)	ILA – Lang (Integration with the Languages learning area)	ILA – Life Skills (Holistic Development) (Integration with the Life Skills learning area)	Sociocultural Theoretical Perspective (Vygotsky)
Grade 3	Measurement 3 May 2017	**Lesson 7**: Measuring length	Space and shape Measuring 2-D shapes Operations – adding measures of the sides	Solve word problems and participate in discussions & conversations. Vocabulary: long, short, wide, narrow Enjoy rhymes	Body movements - physical education Perceptual skills *Cognitive development* *Social development*	Extended opportunities for discussion & problem solving in the context of shared activities in which meaning & action are collaboratively constructed & negotiated.
		Lesson 8: Measuring perimeter and area	3-D objects Operations – adding measures of the sides	Solve word problems Language skills - Vocabulary: long, short, wide, longest, narrow, thick, thin, as long as, low, deep, shallow, shorter, longer, shortest, tallest	Objects from the community. Cooperative learning Perceptual skills *Cognitive development*	Education thought in terms not of the transmission of knowledge but of transaction & transformation of knowledge & creation of the new.

This lesson's objectives were to equip my pre-service teachers with knowledge and understanding of perimeter and area − thus, to teach them to measure at concrete and semi-concrete levels and demonstrate how to teach area and develop problem-solving activities involving area to Grade 3 learners. I started the lesson by recapping the previous lesson, which had been on space and shape. I began the lesson by informing the pre-service teachers that this lesson was about teaching Grade 3 learners how to measure length, perimeter and area. I projected my PowerPoint presentation and started explaining that it is essential that Foundation Phase learners experience the concept of measurement in a practical way. When we teach

young children, we begin at the concrete level. Young learners have to be taught how to estimate because it helps them to visualise a measurement. Estimation is not about guessing the right answer, but about judging how correct one's answer is. I asked the pre-service teachers: "*What do we measure?*" and received different responses, such as: "*We measure distance, weight, height, and mass*". I indicated that those were correct and added that we also measure time.

I proceeded by telling them that length is usually the first measurement learners master. Many Foundation Phase learners already have some understanding of length and some vocabulary associated with it, but that does not mean that they have a clear grasp of length measurement. The lesson aimed to make the students aware of the importance of teaching each grade's content as prescribed in the curriculum. Yes, I agreed that they could draw on what the learners already know, but I reiterated that they needed to build on this knowledge. They needed to understand that length is the measurement of something from one end to the other. We determine how tall, how long, how short, how far and what the distance is around an object through length. I stressed that learners should be involved in many practical activities where they measure informally before being introduced to standard measurement units and measuring instruments' correct use. The extract from the CAPS document (Table 5.4 below) shows what needs to be taught in different grades regarding length.

Table 5.4: An extract from the CAPS document on the topic "length"

TOPICS	GRADE R	GRADE 1	GRADE 2	GRADE 3
4.2 Length	**Informal measuring** • Compare and order the length, height or width of two or more objects by placing them next to each other. Use language to talk about the comparison e.g. longer, shorter, taller, wider	**Informal measuring** • Compare and order the length, height or width of two or more objects by placing them next to each other. Use language to talk about the comparison e.g. longer, shorter, taller, wider • Estimate, measure, compare, order and record length using non-standard measures e.g. hand spans, paces, pencil lengths, counters • Describe the length of objects by counting and stating the length in informal units	**Informal measuring** • Estimate, measure, compare, order and record length using non-standard measures e.g. hand spans, paces, pencil lengths, counters • Describe the length of objects by counting and stating the length in informal units **Introducing formal measuring** Estimate, measure, compare order and record length using metres (either metre sticks or metre lengths of string) as the standard unit of length.	**Informal measuring** • Estimate, measure, compare, order and record length using non-standard measures e.g. hand spans, paces, pencil lengths, counters • Describe the length of objects by counting and stating how many informal units long they are. **Introducing formal measuring** • Estimate, measure, compare, order and record length using metres (either metre sticks or metre lengths of string) as the standard unit of length • Estimate and measure lengths in centimetres using a ruler (No conversions between metres and centimetres required)

I proposed various activities that learners can do. For instance, they can compare lengths of real objects visually. For example, at first, they need to help their learners build the concept of

length as an attribute of long, thin things, and learners should compare the same type of objects (same type, same colour, etc.), except for length. I demonstrated how they could hold up two objects and a long and a short object and ask them: "*What is the difference*?" I emphasised that they needed to visually demonstrate the shorter, taller and longer concepts and then introduce the vocabulary. This exercise could be repeated with objects that are not the same, (e.g., objects with different colours, shapes, functions, etc.), but focus on the length. For example, let the learners compare the difference between the length of a pencil and a crayon, or a pencil and a ruler. I used examples so that the pre-service teachers would understand that the focus in the early years is on developing the concepts of measurement and using appropriate language to compare and describe measuring in children's everyday lives, as noted by Kühne, O'Carroll, Comrie and Hickman (2013).

Considering that the pre-service teachers were in their first year, I knew that I needed to demonstrate and provide activities for Grade 3 learners. For example, I referred to non-standard measurement as I showed them that learners could use their feet to measure their classroom length. I showed them how they could use hand palms to measure their desks' lengths, and so on. These activities resonate well with an integrated learning approach where learners are using their body parts. Such activities link with the Life Skills learning area. I did this to give them some insight so that when they started using formal measuring, that foundation would have been laid. Foundation Phase means precisely that: we lay firm foundations for future learning. The pre-service teachers were amazed to see what teaching in this phase involved. One student said: "*I want to teach a Grade 3 class!*" It was encouraging to observe that they were becoming enthusiastic.

Regarding formal measuring, I drew the pre-service teachers' attention to rulers and different kinds of tape measures that are useful in teaching learners about units of length – i.e., metres and centimetres. I added that, in the Foundation Phase, the formal measuring of length and distance focuses on the use of the ruler as a standard unit instrument and the correct use of it. Activities for formally measuring length and distance are the same as with informal measurement, but with the help of standard units. I concluded this section by asking the pre-service teachers to think of ways to teach their learners to make accurate length measurements, use the measuring instruments effectively, and correctly record the results. They were going to do an activity for their portfolio.

The second part of the lesson focused on teaching measuring perimeter and area to Grade 3 learners. I asked the pre-service teachers what a perimeter is. Only a few hands were raised in response to this question. I wondered why some of the pre-service teachers were not familiar with basic mathematical concepts. I understood that most of them had done Mathematical Literacy in Grade 12 and a few had done pure Mathematics. One student answered: "*It is measurement of a distance around an object*". I accepted the answer and showed them a slide using the following definition:

> "Perimeter is a special type of length. It describes the distance around a region. The perimeter of a shape, for instance, is the distance around the shape. It is the length of the boundary around the outside of the shape. If the shape is round (like the shape of a circle), we talk about the circumference of the shape".

Moving on, we discussed the concept of area, noting that an area is the space we want to measure within the perimeter – the size of the flat surface inside the boundary of the shape. The pre-service teachers seemed to be familiar with the concept of area. They were responding more enthusiastically to the questions. I indicated that they could let the learners use measuring tapes (or string) to measure the distance around a number of body parts (their heads, waists, arms or ankles) because they would be working with young learners. I guided the learners on how to measure around body parts. Then we discussed the height and distance around tins, which is longer (height or distance around) and deceptive. In this lesson, I did a lot of modelling as I felt that they needed to understand the level they would be teaching. I did not interact with individual pre-service teachers much because of the large number of students in the class. The class was packed, which prevented me from moving around much, and I could not reach the students at the back.

In conclusion, I reminded the pre-service teachers to do the activities at the end of the learning guide for their portfolios. The activities stipulated that they should plan three activities for Grade 3 learners by: (i) using direct comparisons (using body parts and strings); (ii) measuring areas (using boxes and cut-out shapes); and (iii) tiling an area (tessellation). They then engaged in group discussions to reflect on the value of integration.

Journal entry - 9 May 2017

The lesson I presented today focused on teaching measuring length, perimeter and area in the Foundation Phase. I felt that I had to emphasise various elements pertaining to FP teaching to give my pre-service teachers an in-depth understanding of what teaching in this phase entails. I could not do all the activities that I had planned, such as giving them time to practically explore the concept of measurement. Because I was working with a large group, I could not provide them with concrete experiences and ended up dominating the class by telling, explaining and demonstrating. For example, I had planned to let them measure the area using the cereal boxes and the toothpaste boxes that I had brought to class. Time was also a limitation. When I realised that I had a lot to cover, I did not give them time to talk as I wanted to finish what I had planned. This is an area that I need to work on as active learning is more effective than passive listening and observing.

Retrospective reflection – 18 September 2018

It is challenging to cover so many things in one lesson. As this was the method module, I wanted to incorporate both theory and practice and so that I did not refer to integration but actually did it in class. A lesson that I am learning is to think deeply about how much content and how much practice I can do in one session. As we are developing the templates for the new B.Ed. FP programme, I am relieved that I will be able to structure lessons that will incorporate both content and pedagogic content knowledge. The Revised Policy on Minimum Requirements for Teacher Education Qualifications specifies that the B.Ed. FP programme should offer pre-service teachers comprehensive and specialised knowledge of Early Childhood Education to successfully teach in this phase. As I explore this through self-study, I am continuously reviewing my practice. I was influential in the revision of all Foundation Phase mathematics modules.

It appears that the issue of large numbers in our classes is something that we shall be faced with for a long time. I have to be creative when working with large numbers. This will require that I work collaboratively with my colleagues in the discipline to devise new teaching strategies.

5.4 Cultivating an Integrated Learning Approach by Using Arts-based Methods

Once again, in my endeavours to encourage using an integrated learning approach among my pre-service teachers, I engaged them in arts-based methods. The artistic mode is a powerful self-study approach (LaBoskey, 2004). Arts-based self-study methods help researchers reflect on, investigate and engage in dialogue about improving their teaching through the arts (Samaras, 2011). I decided to use arts-based methods in the early childhood mathematics module to integrate mathematics with other learning areas. In this approach based on visual art, I encouraged the pre-service teachers to create collages and concept maps to enhance their knowledge and understanding of the subject matter. Visual art tools incorporate various ways to make meaning through artistic expression (Weber, 2014). Visual methods assist teacher educator researchers to "keep their own and their students' bodies in mind and push for more sophisticated analysis and theorising that considers [sic] learning and teaching" (Weber, 2014, p. 11). Therefore, the pre-service teachers created collages and concept maps to explore and illustrate their understanding and experiences of an integrated learning approach to teaching mathematical concepts in the Foundation Phase.

5.4.1 Creating collages

Before this lesson, I had requested the students to bring magazines and newspapers to class. I also got all the resources we were going to use, such as glue, scissors and coloured charts. I had bought these materials with the funds I had received from the University Teaching and Learning Office (UTLO), as explained in the previous chapter. As mentioned, the group I worked with this time comprised 84 pre-service teachers. It was a large group compared to the last group of only 34 pre-service teachers in 2016.

I divided the students into 10 groups and gave each group a coloured chart. For example, I gave two groups the same colour chart using the colours red, yellow, blue, green and orange. I showed them an example of a collage from the ones created by the previous group in 2016. This gave them a clear understanding of what they needed to do, as it was going to be difficult for me to spend much time with each group because of the large number of students. Figure 5.6 illustrates examples of the collages created by these pre-service teachers.

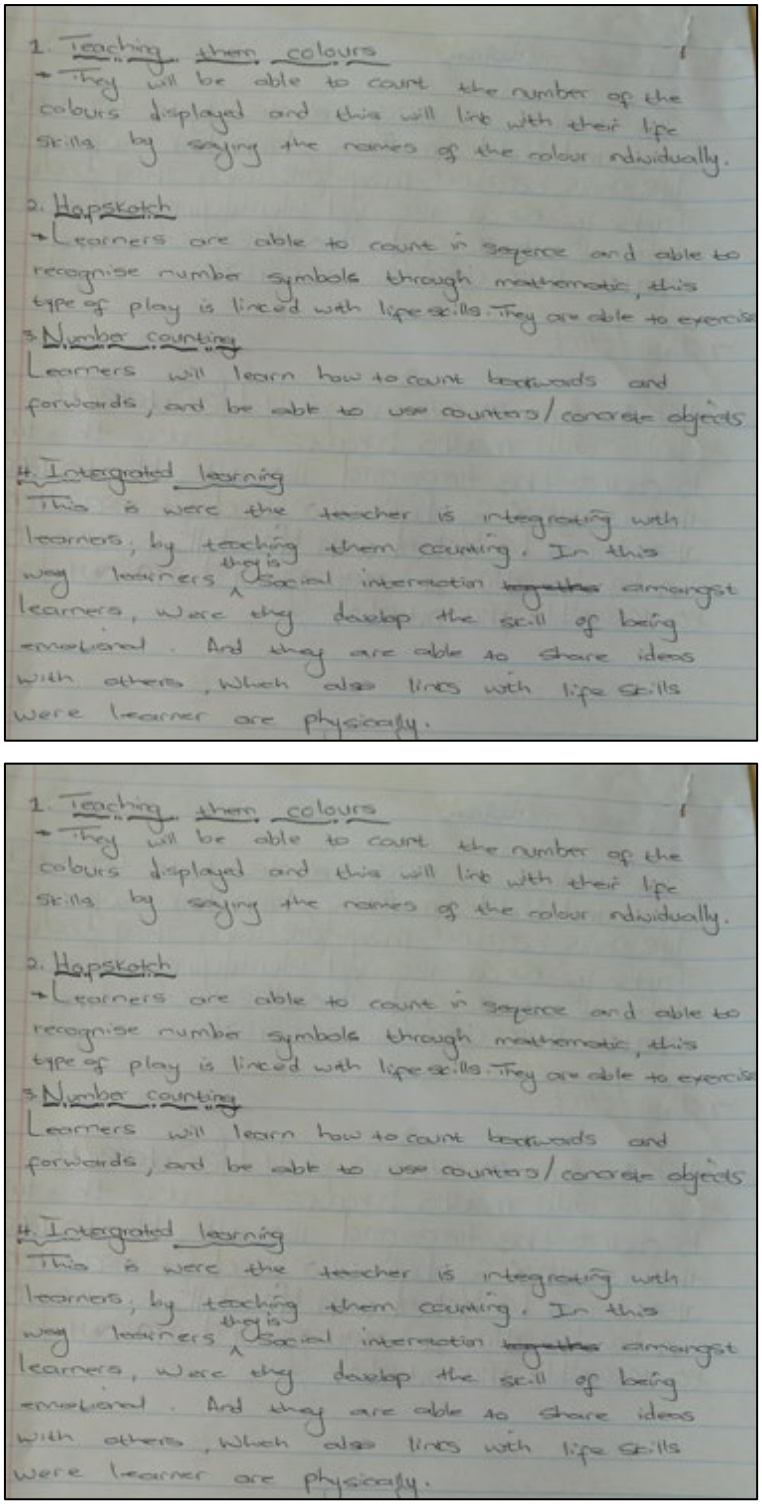
To create the collages, I asked the students to think about integrating the Mathematics learning area with the Languages and Life Skills learning areas in the Foundation Phase and integrating mathematical concepts within the Mathematics learning area. They had to peruse magazines

and cut out about 12 images, which they would then paste onto charts to illustrate the connections and concepts meaningfully. I also encouraged them to number the images on the collage consecutively. The interactive collage-making process encouraged the pre-service teachers to reflect, plan and deliberate on how integration learning areas in the Foundation Phase could be integrated.

As the pre-service teachers were creating the collages, I moved among the groups. Because of the large numbers and crowded space, it was difficult to interact with each group, especially those at the back of the classroom. However, I tried to help them as much as I could. I was gaining confidence as I was doing this for the second time. I listened to their discussions and heard a student in the green group saying, “Integration occurs when learners learn about the days of the week. They learn about time and also about the activities they engaged in during those days”. I commented, “That is very good. They can discuss what they do on Sundays, for example, as part of their religions”. The groups seemed to get the hang of it. The class looked chaotic, but the pre-service teachers were working and engaged in their work. In Figure 5.4, I present some of the collages that they created.

Figure 5.4: Collages created by some of the pre-service teachers

After completing the collages, I guided the pre-service teachers through the development of collage transcripts to capture the meaning of their numbered images. I gave the students clear instructions for this activity. I explained that they had to write a brief description of each main image in the collage, providing reasons for choosing that image or caption and their accompanying thoughts and feelings and the meanings that each image elicited. Most of them quickly grasped the concept and helped one another. Figure 5.5 depicts the transcripts that developed from the above collage.



1. Teaching them colours
→ They will be able to count the number of the colours displayed and this will link with their life skills by saying the names of the colour individually.
2. Hopskotch
→ Learners are able to count in sequence and able to recognise number symbols through mathematic, this type of play is linked with life skills. They are able to exercise
3. Number counting
Learners will learn how to count backwards and forwards, and be able to use counters / concrete objects
4. Integrated learning
This is were the teacher is integrating with learners, by teaching them counting. In this way learners (they is) social interaction ~~together~~ amongst learners, Were they develop the skill of being emotional. And they are able to share ideas with others, which also links with life skills were learner are physically.

Figure 5.5: Collage transcripts developed by pre-service teachers

These transcripts were able to link Mathematics with Life Skills. For example, they indicated that the people wearing traditional attire could be associated with customs and traditions and that these are components of the Life Skills programme. The clothing could link with the Mathematics learning area as it displayed patterns and shapes. The writing of the numbers and

the colours linked with the Languages learning area. The children playing connected with the holistic development of young learners.

This time I was more organised compared to the previous year. When the pre-service teachers completed their transcripts, I ensured that each collage was attached to the relevant transcripts. For example, the transcripts for the Green group was attached to the green chart.

5.4.2 Creating concept maps

In the following lecture, I introduced concept maps so that my pre-service teachers could demonstrate their understanding of an integrated learning approach by making connections with the meanings of the images they had selected and the concepts that were coming through. According to Butler-Kisber and Poldma (2010), concept maps help visually write down developing phenomena and make meaning. Concept maps are used to document the "inter-relationships of aspects of a design in its earliest stages, or as a brainstorming method of documenting ideas" (Butler-Kisber & Poldma, 2010, p. 6). Using this tool improved my pre-service teachers' understanding of the integrated learning approach. Concept mapping also allowed me to guide and evaluate their knowledge about making conceptual connections among the learning areas and within mathematics. Figure 5.6 below indicates how the pre-service teachers designed the concept maps using circles and boxes. Their mind maps show how they categorised the concepts and created links.

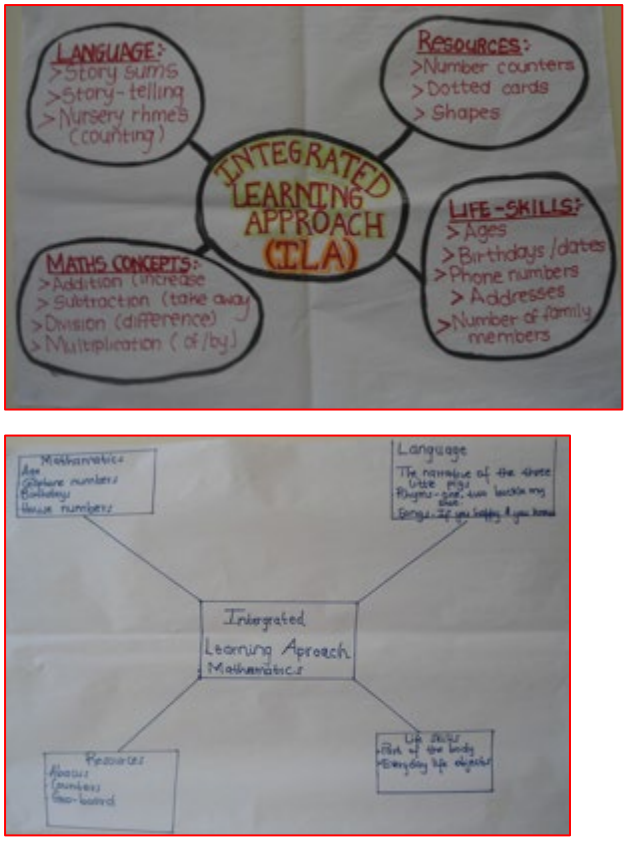


Figure 5.6: Mind maps created by pre-service teachers to explore an integrated learning approach

Creating mindmaps revealed the pre-service teachers' perceptions of and ability to use an integrated learning approach. This also boosted the spirit of cooperation that permeated the class. As they engaged in developing the concept maps, I noticed how they interacted and decided who would do what.

Journal entry - 9 May 2017

Compared to my experiences the previous year, this was the complete opposite. It was easy for me to tell my students about the reality of the schools in which they will work when they graduate. I highlighted that they might find themselves in schools with limited resources and large numbers of learners. That reality struck me, and it was not easy. But I did not just throw in the towel. I hoped that they would learn that they would need to find ways and means to deal with whatever situation they might encounter. I must say that the experience of doing the arts-based method with the small group helped me to better understand my practice.

Retrospective reflection – 2 October 2018

Unlike in 2016, this time I was beginning to gain confidence in utilising arts-based methods. I had learnt from the pilot project the previous year how I should interact with pre-service teachers. Facing the challenges of working with a large group in a crowded classroom, I was well-prepared and guided them properly. When doing the same activity with a different group, I could see that I was gaining experience and improving my own methodologies.

5.5 Pre-service Teachers' Reflections on Integrated Learning Approach

This time I wrote my reflections on one page as I considered the value of an integrated learning approach while exploring my pre-service teachers' views on this methodology. They commented that they understood it and said that a teacher should incorporate more than one learning area to teach mathematics. I appreciated their description of an integrated learning approach as "a forward movement" connecting mathematics teaching with other learning areas. It gave me hope that one day they would implement this approach in their own classrooms. I hope that the activities showed them that mathematics does not necessarily have to be 'difficult' if a variety of appropriate ways are used to teach it. Their responses were promising as they were able to give examples when they answered questions.

16 May 2017

Reflections on Integrated Learning Approach (ILA)

1. **What is your understanding of an integrated learning approach?**

Intergiated Learning Approach means teaching other subject relating to other ones like teaching numeracy and involve life skills in Language

2. **How has ILA changed your thinking about Maths?**

It showed me that maths is not only about numbers and calculations only

3. **Why is integration important?**

Help learners to understand better using diffrent methods

4. **Give one example of how integration took place in this module.**

When learning number operation we sometime use number words and that is language

16 May 2017

Reflections on Integrated Learning Approach (ILA)

1. What is your understanding of an integrated learning approach?

ILA to me means that you use more than one learning subject to teach mathematics eg Language, Life Skills etc

2. How has ILA changed your thinking about Maths?

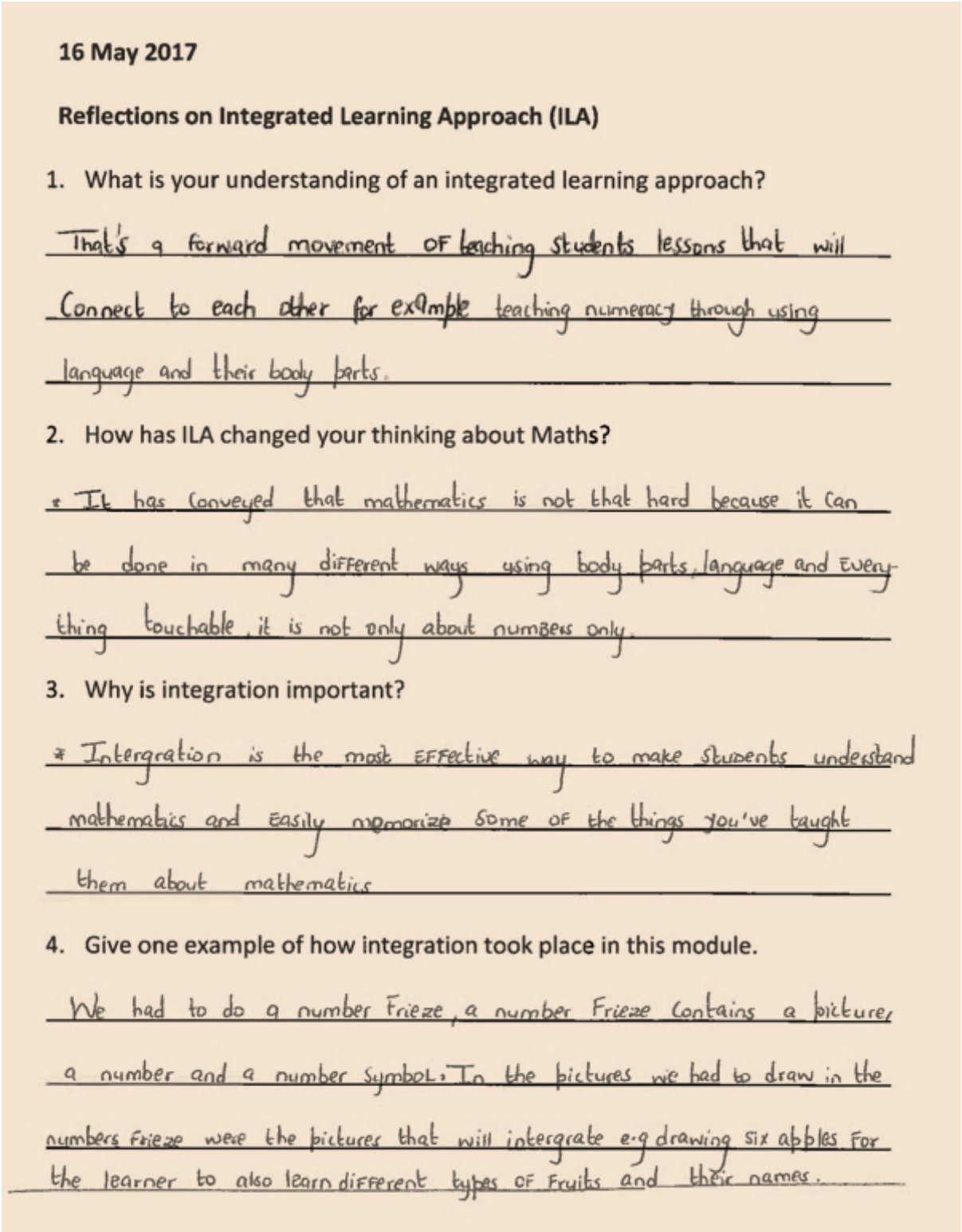
It has taught me that Maths shouldn't be taught in isolation, ILA helps children understand better.

3. Why is integration important?

It betters the understanding of children when teaching Math & it makes it simple because they are familiar with other things.

4. Give one example of how integration took place in this module.

The teacher usually intergrates Language & life skills with us when giving us tips on how to teach children mathematics.



16 May 2017

Reflections on Integrated Learning Approach (ILA)

1. What is your understanding of an integrated learning approach?

That's a forward movement of teaching students lessons that will Connect to each other for example teaching numeracy through using language and their body parts.

2. How has ILA changed your thinking about Maths?

* It has conveyed that mathematics is not that hard because it can be done in many different ways using body parts, language and Everything touchable, it is not only about numbers only.

3. Why is integration important?

* Intergration is the most effective way to make students understand mathematics and easily memorize some of the things you've taught them about mathematics

4. Give one example of how integration took place in this module.

We had to do a number Frieze, a number Frieze contains a picture, a number and a number symbol. In the pictures we had to draw in the numbers frieze were the pictures that will intergrate e.g drawing six abbles For the learner to also learn different types of Fruits and their names.

Figure 5.7: Examples of pre-service teachers' reflections on the integrated learning approach

5.6 Pre-service Teachers' Evaluation of the Module

As was mentioned in Chapters Two and Four, the evaluation questionnaires were developed by the Quality Promotion and Assurance (QPA) body and contain core standard questions. The lecturer responsible for a module obtains students' feedback online. I briefly discuss some

comments regarding the integrated learning approach that I extracted from the QPA report of this group of students. It is important to note that this questionnaire is generic to the whole university and that no questions explicitly focused on the integrated learning approach. However, the pre-service teachers mentioned the integrated learning approach in their response. The comments are presented in Table 5.5. I categorised the responses into themes that I felt captured the sociocultural features that I employed in my study. When utilising the sociocultural theoretical perspective, Samaras (2002) asserts that it is critical to consider that understanding is reconciled through social interaction. I learnt how to embrace the social and cultural influences in my pedagogy to improve my teacher education practices. The themes that stood out were: *integrated learning approach, practical [experience], humanistic and affective aspects* and *improvement*.

Table 5.5: Pre-service teachers' summary of comments

Questions	Category	Summary of comments
What aspects of the module were facilitated well?	Integrated learning approach	• *All aspects were facilitated well, especially the integration of mathematics with other subjects.* • *All aspects of the module were facilitated well because our lecturer used an integrated learning approach in class to develop our skills towards understanding the content and she explained every topic step by step.* • *Teaching us what and how we should address the lessons effectively to our Foundation Phase learners and to know and understand better about the integrated learning approach and suitable resources to use when teaching it.* • *I really enjoyed the module because I learnt things I did not know, for example, an integrated learning approach.*

		• *Playing the videos for us to see how teaching and learning occur in a Grade R classroom was enlightening.*
	Practical	• *It was easy to understand everything because there are things that were done practically.* • *Mathematics content and the practical part of the module where we were creating the number frieze, dot cards, and picture cards.* • *Making LTSMs and having tutorials.* • *Interesting approaches to introducing the content.* • *She used different strategies to assist us as different students.*
	Affective aspects	• *She was always there for us giving guidance and love as a mother and a teacher.* • *Love my lecturer … I loved this module, it was interesting.* • *I really enjoyed the module and I fell in love with children. I hope I will pass it.* • *The module was fun and enjoyable to do, and it created much love for young learners in our hearts.* • *I love …[the lecturer]. She has good qualities as a lecturer. She is patient, loving, and kind. All in all she supports us to accomplish tasks.*
What areas do you believe need to be	Improvement	• *The pacing of the module.* • *Lots of content and activities to cover which left the students feeling rushed.*

improved in this module?		• *More explanation of the theories.*

Below I present a brief evaluation of the comments.

5.6.1 An integrated learning approach

Various comments referred to the integrated learning approach, which made me realise that the pre-service teachers had learnt by observing appropriate practices. Through their observations, they could see themselves implementing the integrated learning approach practically. Mwakapenda (2008, p. 190) notes that presenting mathematics in an integrated way "enables creativity and enables creative and logical reasoning about problems in the physical and social world and in the context of mathematics itself". I also gathered that the pre-service teachers appreciated learning about the integrated learning approach, something new to them. This was evident from their reflections about this approach. They said that integration was the most effective way for learners to understand mathematics. I hope that the pre-service teachers were honest and not just trying to please me. In general, these comments made me recognise that I had planted the seeds of an integrated learning approach in teaching early childhood mathematics among this group of students. I can only hope that these seeds will grow and come to fruition in the future.

5.6.2 Practical application

Some pre-service teachers pointed out that practical work is essential in the Foundation Phase. They felt that learning by doing helped them. Mntunjani et al. (2018) argue that practical activities in mathematics lessons help in acquiring mathematical concepts. It was more comfortable for the pre-service teachers to understand certain concepts when they were actually engaged in practical exercises. I saw that this was something I needed to do more of this in my teaching.

5.6.3 Affective aspects

The comments by the pre-service teachers that I guided and loved them were touching and humbling. Samaras (2002) states that affective traits relate to cognitive development in the relationship between a student and a teacher. Clearly, it is vital that I, as a teacher educator, exhibit certain traits such as love, patience and respect. I think we often tend to ignore these, especially when we work with adult students.

5.6.4 Improvement

It is essential to understand that I can always improve my teacher education practice. I am up for this challenge, hoping that I shall help my pre-service teachers be well prepared for their teaching roles. Brüssow and Wilkinson (2010) claim that research initiatives aimed at improving teacher education practice may yield effective learning outcomes among pre-service teachers.

However, even though most pre-service teachers were positive about the module, they felt it needed some improvements. For example, they thought that the content and activities were too concentrated. They suggested that the pacing should be moderate so that they would not feel rushed. Some also commented that they needed more in-depth explanations of the theories referred to in this module.

5.7 My learning

It was pleasant to work with this enthusiastic group of pre-service teachers to cultivate an understanding of an integrated learning approach in early childhood mathematics. To achieve this, I used arts-based methods. I enhanced my own learning by creating collages using texts from magazines and newspapers to represent what I had learnt. I captured how the learning zones (LZ) and zones of possibilities (ZOP) occurred when pre-service teachers and I were open to new understandings. I constructed categories and read through the identified codes and identified themes that recurred in the data. Figure 5.8 depicts the collage I made. Figure 5.9 shows the identified themes and patterns that emerged in response to my research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?*

Figure 5.8: My collage of cut-out words representing my learning

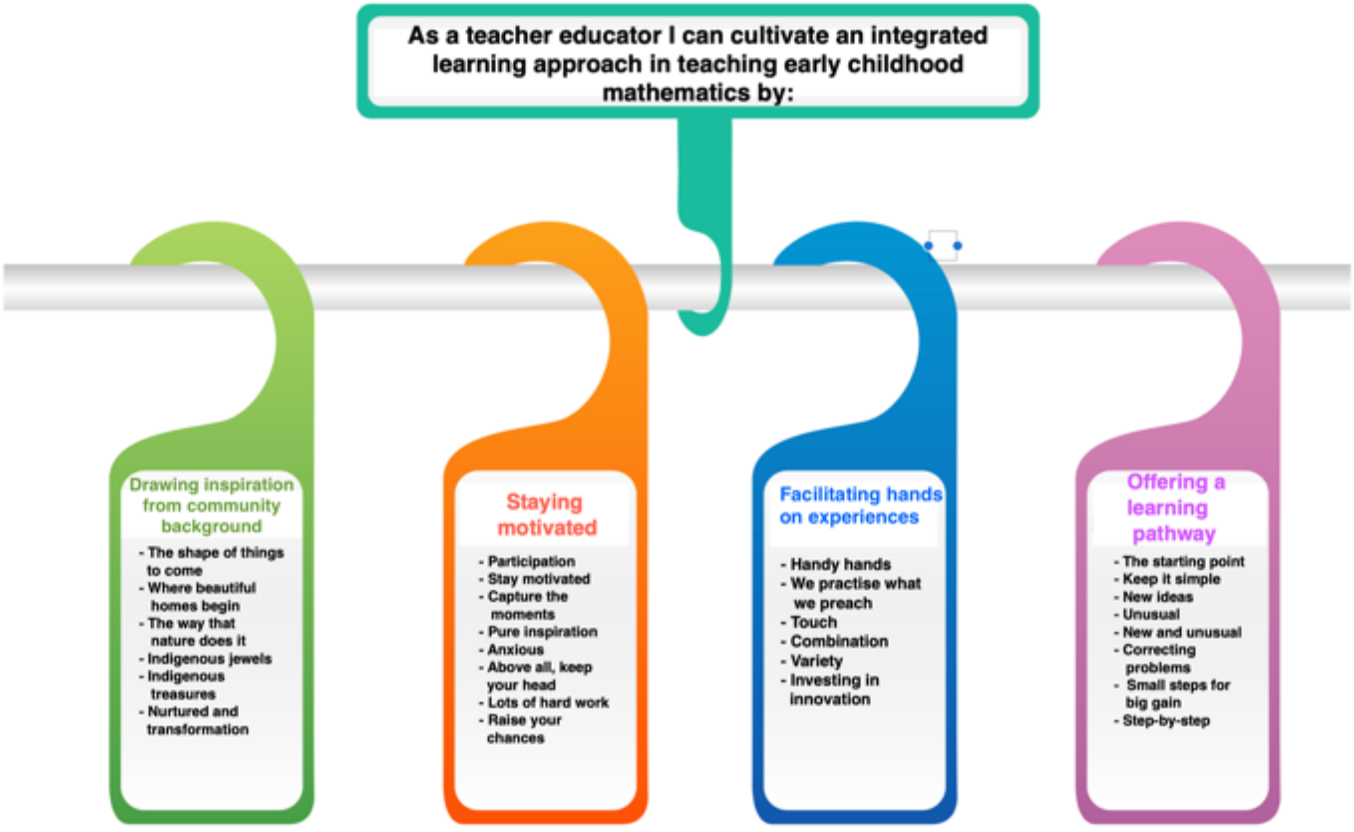


Figure 5.9: Summary of themes and codes

5.7.1 Drawing inspiration from community background

The theme "drawing inspiration from [my] community background" suggests that, as a teacher educator, I can draw from my pre-service teachers' backgrounds to cultivate an understanding of the integrated learning approach. The contexts from which my pre-service teachers came were vital as a foundation for their studies to become teachers. Acknowledging their backgrounds enabled the pre-service teachers to be mindful that learning mathematics is a natural process for young learners and should be harnessed in developmentally appropriate activities (Ginsburg et al., 2008). The phrase, "The way that nature has always done it" (Figure 5.10) resonates well with this statement. According to Ginsburg et al. (2008, p. 4), "...in the ordinary environment, young children develop a comprehensive everyday [concept of] mathematics entailing a variety of topics including space, shape and pattern, as well as numbers and operations, and comprising several important features". Therefore, in preparing my pre-service teachers for the future, I need to enhance their understanding that the environments from which young learners come can be harnessed to help them learn mathematics from a young age.

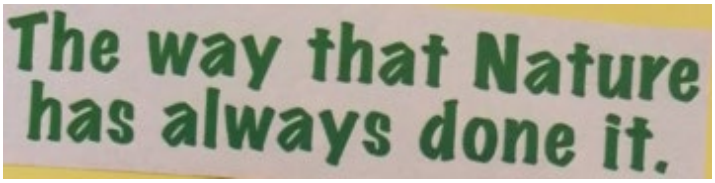


Figure 5.10: The phrase: "The way that nature has always done it"

I believe that what young people learn in their communities influences formal learning. For example, Cimen (2014) notes that various communities' practices involve unique ways of expressing numbers, counting, and numeracy. On this point, Gerdes (1998) states that, when the women in Mozambique weave baskets, even before they begin to weave, they do mental calculations that involve consideration of the decorative pattern they will create. It is also possible to connect the culture that exists in communities with the school culture. By acknowledging different cultures, pre-service teachers will be culturally responsive mathematics teachers (Nicol et al., 2013). In this context, the phrases 'indigenous jewels' and 'indigenous treasures' in Figure 5.11 below remind me of resources that can be found at home or in the community, whether these resources are tangible or intangible. For example, there are many indigenous games that mathematics teachers can use to teach specific concepts and develop language. Lee (2014) believes that the sociocultural dimension, as proposed by Vygotsky (1978), is an integral part of teaching and learning.

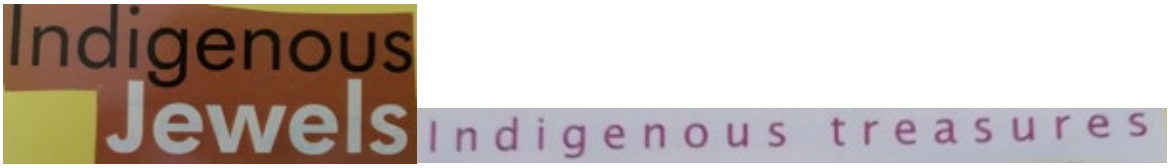


Figure 5.11: Illustrations of the phrases "Indigenous jewels" and "Indigenous treasures"

Portman and Richardson (2008, p. 55) assert that it is vital to bring the culture of communities from which learners come into the classroom because this "breaks down barriers between home and school". They further emphasise that bringing culture into the classroom "shows that the community is a good resource for mathematics". As a teacher educator, I wish to make it my mission to discover these jewels to enhance my teaching (Samaras, 2002). I thus need to be aware of the many resources that I can source at no cost from our communities.

5.7.2 Staying motivated

I was demotivated when I could not do some of the activities I had planned to do in class. This was due to time constraints and a large number of pre-service teachers. I realised that I had to stay motivated to inspire my pre-service teachers on their journey to become teachers. The self-study methodology encouraged me to improve my practice to support my pre-service teachers' learning and, ultimately, their teaching of mathematics (Schuck & Perreira, 2011). I was discouraged when I could not move around the classroom to reach students in the back. I was also frustrated that it was difficult for me to get to know such a large number of students individually. The phrases 'stay motivated' and, above all, 'keep your head' encapsulate what I needed to do in that situation. I needed to find ways to meet the needs of my students.

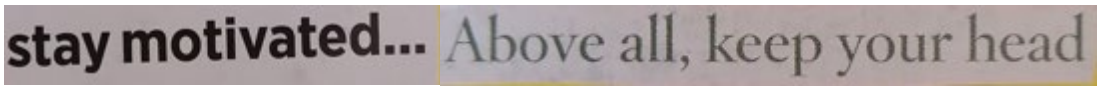


Figure 5.12: Images of the phrases "Stay motivated" and "Above all, keep your head"

I was anxious when the pre-service teachers did not grasp the integrated learning approach concept at first. It took them some time to do so, but the collages became really useful. Describing the collages' images offered them access to "symbolic meanings and representations" in their understanding of using an integrated learning approach in the teaching context (van Schalkwyk, 2011, p. 680). As the pre-service teachers interacted with one another and through group conversations, they came to uncover meaning. I was inspired by their

enthusiasm during group work and by how they communicated with one another. The phrase in Figure 5.13 below represents my feelings.

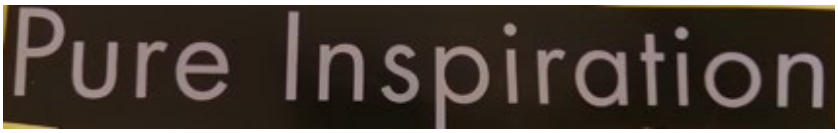


Figure 5.13: Image of the phrase "Pure Inspiration"

Butler-Kisber and Poldma (2010) suggest that students are excited when confronted with challenging visual arts-based tasks and gain confidence once they have achieved what they set out to do. I concur with this view, as using a visual media approach was both challenging and rewarding. Moreover, by modelling how to use this strategy, I was given valuable opportunities to interact with my students, and I came to know them better, which improved my relations with them.

5.7.3 Facilitating hands-on experiences

According to Bates et al. (2011, p. 332), teacher education programmes should scrutinise the objectives of mathematics content to adapt "curricular expectations that allow pre-service teachers' [to use] hands-on experiences to build their efficacy in regard to teaching mathematics". I agree with this notion, especially given the importance of hands-on experiences in young children's learning of mathematical concepts.

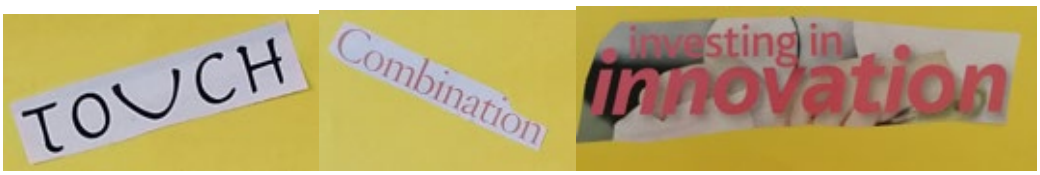


Figure 5.14: Images of the phrases "Touch", "Combination", and "investing in innovation"

The phrases in Figure 5.14 above illuminate that it is beneficial for learners and pre-service teachers to learn mathematics when represented concretely. Mntunjani et al. (2018) claim that learners can manipulate objects during hands-on experiences as they encompass visual and tactile appeal. When I teach this module again next year (in 2018), I shall think of numerous opportunities for hands-on experiences to actively engage my pre-service teachers.

5.7.4 Offering a learning pathway

To enhance teaching that will result in valuable learning, teacher educators may think about how their pre-service teachers access subject content. Ginsburg et al. (2008) maintain that a well-structured curriculum is fundamental in early childhood mathematics education. Teacher educators must guide pre-service teachers so that they can teach young learners in a meaningful way. Schuck (2011) notes that teacher educators should make an effort to move beyond teacher-centred and out-dated methods when they teach mathematics. To this end, I think it is vital to not overload pre-service teachers and allow them time to absorb the module content. This notion resonates in the following phrases:

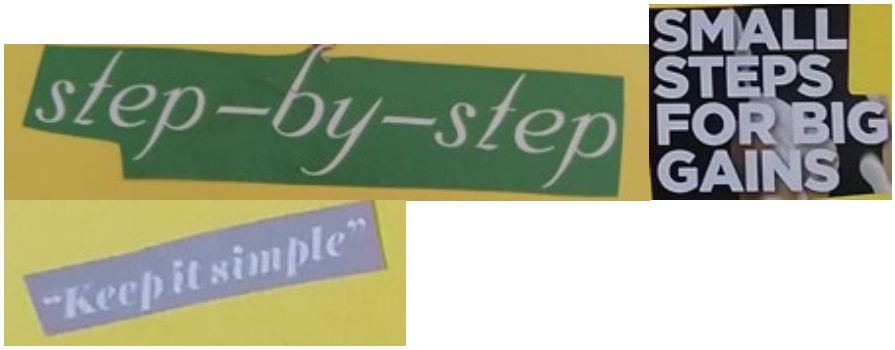


Figure 5.15: Images of the phrases "step-by-step", 'Small steps for big gains', and "Keep it simple"

It is also vital to encourage pre-service teachers to teach in a way that will "make [young children] want to think mathematically rather than in a way that will make them want to avoid mathematics at all costs" (Dewah & Van Wyk, 2014, p. 196). All this can be done using different strategies for making mathematics accessible and comprehensible.

5.8 Conclusion

I learnt that to implement an integrated learning approach to teaching mathematics takes a great deal of work. The collages and concept maps were beneficial (Samaras, 2011) as they allowed me to see how my pre-service teachers were comprehending the concept of an integrated learning approach. Their confidence increased in using this visual medium (Butler-Kisber & Poldma, 2010). I was impressed by these visual tools' power when I saw their pedagogic impact.

In this process, I learnt about myself and the pedagogy of what I was required to teach. I also realised that my pre-service teachers and I were creative, even if we were not artists. Based on my experiences, I strongly recommend that teacher educators consider engaging in self-study

research, including arts-based self-study methods. I should continually reflect critically on my practices and embrace change for my pre-service teachers' benefit and, ultimately, in service of the learners.

However, the journey on which I had embarked was not smooth sailing. I encountered many challenges when exploring this approach, but I was enjoying it. The choice of using an arts-based approach was a good one because my pre-service teachers relished the challenges. It made learning about and how to teach mathematics fun. I felt that what I had done was inspirational and an approach that I shall improve on as time progresses.

In the following chapter titled *'Boarding a boat and drifting out to luminous seas',* I recount my experiences of working with a third group of students to encourage an integrated learning approach to teaching mathematics in the Foundation Phase. I give a detailed account of these experiences and extend my exploration of this approach by discussing how I engaged this third group of pre-service teachers in additional activities to enhance early childhood mathematics teaching.

CHAPTER SIX: BOARDING A BOAT AND DRIFTING OUT TO LUMINOUS SEAS

Although our teaching intention is to provide support, motivation and guidance for our pre-service teachers, through self-study we do come to know and understand more about who we are as teacher educators.

Robyn Brandenburg

6.1 Introduction

My self-study research focused on what and how I learnt as an early childhood mathematics teacher educator with a specific emphasis on cultivating and enacting an integrated learning approach. In Chapter Five, I addressed my second research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* I explained my attempts to implement an integrated learning approach with a new group of pre-service teachers after the pilot project (as communicated in Chapter Four). In Chapter Five, I described four lessons that I presented and the activities in which the pre-service teachers and I engaged. These lessons focused on two content areas: *Numbers, Operations and Relationships* and *Measurement.*

This chapter is titled *'Boarding a boat and drifting out to luminous seas',* a metaphor that describes the direction I was moving in and the strides I took to improve my practice. A luminous ocean is a broad, shimmering expanse of seawater that appears to glow brightly at night (Nealson & Hastings, 2006). For me, it symbolises encouraging and bright possibilities for my pedagogical practice. In this chapter, I again respond to my second question (as stated above) that addressed my intent to further develop my teaching of early childhood mathematics, focusing on an integrated learning approach. I was inspired by Brandenburg, who states: "Although our teaching intention is to provide support, motivation and guidance for our pre-service teachers, through self-study we do come to know and understand more about who we are as teacher educators" (2011, p. 89). By exploring the integrated learning approach with my pre-service teachers and employing self-study methods, I discovered more about myself as an early childhood mathematics teacher educator.

I begin Chapter Six by narrating how in 2018, I engaged with 57 pre-service teachers in the early childhood mathematics module to encourage them to understand and adopt an integrated learning approach. I describe four of the eight planned lessons that I presented on the teaching

of selected mathematical concepts in the Foundation Phase to better understand an integrated learning approach. The lessons focused on the content areas *Patterns, Functions and Algebra,* and *Space and Shape*. I describe the exploration of the cultural activities in which the pre-service teachers participated. I then give an account of my pre-service teachers' feedback and evaluations, as well as my learnings.

6.2 Lesson Presentations

6.2.1 Patterns, functions and algebra

The third and fourth lessons I presented focused on patterns, functions and algebra. The Department of Basic Education (2011b, p. 9) outlines these as follows:

> "A central part of this content area is for the learner to achieve efficient manipulative skills in the use of algebra. It also focuses on the description of patterns and relationships through the use of symbolic expressions, graphs and tables, and regularities and change in patterns and relationships that enable learners to make predictions and solve problems".

In the Foundation Phase, learners work with number patterns as well as geometric patterns. Learners must use physical objects, drawings and symbolic forms to copy, extend, describe and create patterns. Focusing on the logic of patterns lays the basis for developing algebraic thinking skills (Department of Basic Education, 2011b).

How to teach Grade 1 learners to copy, extend, describe and create patterns and to be aware of patterns and number patterns in their world – 22 March 2018

By the end of this lesson, I wanted my pre-service teachers to understand how they could teach Grade 1 learners to: discover patterns; investigate, copy, extend, describe, create geometric patterns and number patterns; develop learner activities focused on geometric and number patterns; and help learners discover patterns in nature, modern everyday life and cultural patterns.

Table 6.1: Lessons on patterns functions and algebra in Grade 1

Grade	Content Areas	Lesson Topics	ILA - Maths (Integration of concepts within the mathematics learning area)	ILA – Lang (Integration with the Languages learning area)	ILA – Life Skills (Holistic Development) (Integration with the Life Skills learning area)	Sociocultural Theoretical Perspective (Vygotsky)
Grade 1	Patterns, Functions and Algebra	**Lesson 3**: Patterns - Copy, extend, describe and create patterns	Numbers (counting)	Listen to and repeat rhythmic patterns and copy them correctly	Creating, interpreting & presenting Movement – Gross motor skills *Physical development Emotional development*	Kinetic concepts linked to culturally shared systems and to developmental activities.
	22 March 2019	**Lesson 4**: Patterns around us	Space and shape Symmetry	Patterns in sounds & songs.	Plant and animals Pattern movement Laterality *Social development*	The sociocultural environment, the world of things, created by human labour.

As indicated earlier in this study report, not all the lessons I presented focused on an integrated learning approach. I introduced this lesson (Lesson 3) by asking the pre-service teachers to define a pattern. I was impressed by the precise response from a student teacher when she explained: "*A pattern is something that happens in a regular and repeated way*". I commended the student and added that when a collection or array of objects or numbers such as △□○ or 5 4 6 2 is repeated in a specific sequence, this forms a repeating pattern that can be identified and described as generalised rules or functions. For example, I asked: "*What will the function or rule of the following pattern be?*" giving the following example: △□○; △□○. One student stated that the rule of this pattern was the repetition of three geometric shapes. Another student added that the geometric shapes were in the same order where the first shape was always a triangle, the second always a square, and the last always a circle. I indicated that the answer was correct, adding that learners need many opportunities to explore patterns by copying, extending, describing and creating them. Similarly, van den Heuvel-Panhuizen, Kühne, and Lombard (2012) emphasise that various activities are essential to promote learners' capabilities to create, organise and explain patterns.

Table 6.2: An extract from the CAPS document on the topic "geometric patterns and number patterns" (Department of Basic Education, 2011b, p. 24)

TOPICS	GRADE R	GRADE 1	GRADE 2	GRADE 3
2.1 **Geometric patterns**	**Copy and extend** Copy and extend simple patterns using physical objects and drawings (e.g. using colours and shapes).	**Copy, extend and describe** Copy, extend and describe in words • simple patterns made with physical objects • simple patterns made with drawings of lines, shapes or objects **Create own patterns** Create own geometric patterns • with physical objects • by drawing lines, shapes or objects **Patterns around us** Identify, describe in words and copy geometric patterns • in nature • from modern everyday life • from our cultural heritage	**Copy, extend and describe** Copy, extend and describe in words • simple patterns made with physical objects • complex patterns made with drawings of lines, shapes or objects **Create and describe own patterns** • with physical objects • by drawing lines, shapes or objects **Patterns around us** Identify, describe in words and copy geometric patterns • in nature • from modern everyday life • from our cultural heritage	**Copy, extend and describe** Copy, extend and describe in words • simple patterns made with physical objects • more complex patterns made with drawings of lines, shapes or objects **Create and describe own patterns** • with physical objects • by drawing lines, shapes or objects **Patterns around us** Identify, describe in words and copy geometric patterns • in nature • from modern everyday life • from our cultural heritage
2.2 **Number patterns**		**Copy, extend and describe** Copy, extend and describe simple number sequences to at least **Create and describe own patterns**	**Copy, extend and describe** Copy, extend and describe simple number sequences to at least **Create and describe own patterns**	**Copy, extend and describe** Copy, extend and describe simple number sequences to at least **Create and describe own patterns**

I highlighted the Curriculum Assessment Policy Statement (CAPS) content for Grade 1, represented in Table 6.2. I explained that before they enter the reception year, young learners have already acquired various concepts relating to patterns, functions and algebra. Furthermore, I expanded that this develops when they learn repetitive songs, rhythmic chants, poems, and stories based on repeating and extending patterns. The development of patterns is described by du Plessis (2018), who explains that young learners initially experience and perceive patterns as rhythm and rhyme. Du Plessis (2018) notes that learners engage in pattern-related activities and recognise patterns in their everyday environment – and the recognition, comparison and analysis of patterns are considered an essential component of their intellectual development because they provide a foundation for the development of algebraic thinking.

I then explained that an effective way to learn more about patterns is to investigate patterns practically. When teaching patterns, Foundation Phase teachers should design activities that will enable learners to explore patterns. In all the lessons that I presented; I emphasised the use of starting with objects. Even with patterns, I highlighted that repeating patterns must be introduced to learners beginning with concrete and shifting to semi-concrete and then moving to the abstract. I presented the following table as an example in my slides. I indicated that they needed to start by showing the learners an easy pattern to follow and slowly build up to more challenging patterns. Here are some pattern examples in order of difficulty.

Table 6.3: An example of patterns

Pattern name	Example
AB	Sock, shoe, sock, shoe, sock, shoe…
AABB	Sock, sock, shoe, shoe, sock, sock, shoe, shoe…
ABC	Sock, shoe, tie, sock, shoe, tie, sock, shoe, tie,…
ABB	Sock, shoe, shoe, sock, shoe, shoe…
AAB	Sock, sock, shoe, sock, sock, shoe,…

I asked the pre-service teachers to interpret these examples. They were able to tell me that, for example, the same objects have been used to create different patterns. I noted that, as learners progress, they go into a stage of cognitive development where they are naturally seeking out the rules and patterns that exist in the world. Charlesworth (2012) states that patterning activities fit learners' natural inclinations and interests at this stage. Similarly, Venkat and Askew (2018) argue that there is evidence that learners' attention to patterns of similarity and difference requires instruction that draws attention to these patterns. I concur with this view, as it is the Foundation Phase teacher's responsibility to develop learners' awareness of patterns. I highlighted this point as I was mindful that the pre-service teachers sometimes focused on their high school mathematics challenges. I wanted them to think about their primary schooling and imagine the learners they would teach in the Foundation Phase.

The second part of the lesson (Lesson 4) focused on teaching Grade 1 learners patterns that occur naturally as well as number patterns. I explained that young children are often very interested in nature and love exploring it. Eunsook (2000) maintains that children have a close relationship with the natural environment because they understand the natural world through sensory-directed experiences. I urged the pre-service teachers to use learners' natural curiosity as an opportunity to make them aware of patterns in their natural surroundings. I added that learners should be allowed to investigate the regularities (and try to find the rules) in the patterns found on animals, insects and plants in their environment. Their attention should be on the crucial concepts related to these patterns. I projected examples of patterns on animals using slides. The student teachers seemed fascinated by these pictures. I asked them to name the animals that these patterns belong to, and they were able to identify patterns in an elephant (in the middle of the picture in Figure 6.1), a tortoise, a zebra and so forth. The students were not sure about the first picture on the left. We debated this until we agreed it was a peacock.

Figure 6.1: Pictures of patterns on animals

I encouraged the pre-service teachers to focus their learners' attention on natural patterns and suggested questions they might ask, such as the following:

- *Tell me what you see. What does it feel like?*
- *Can you see the pattern? Is it a pattern? How do you know?*
- *How can you describe the pattern?*
- *Can you explain the rule of the pattern?*
- *How does the pattern repeat or grow?*

I also gave an example of patterns on plants that I had found on the internet and explained that these are readily available and accessible. I told them to let their learners investigate different leaves, seeds, cones, or other plant parts. I said, "Let your learners notice the regularity of patterns". In some cases, symmetrical patterns can be investigated.

Figure 6.2: Pictures of plant patterns

When they explore patterns in plants, teachers may ask the questions like those above.

Next, I moved to patterns in modern, everyday life. They could explore man-made patterns that are found in the classroom and their immediate surroundings. For example, point out the patterns of windows, burglar bars, floor tiles, and buildings' bricks. All these consist of different patterns. Also, take learners outside to identify patterns in nature and connect these patterns to the patterns created by people. Patterns created by people are often inspired by patterns found in nature. I asked: "*Can you see the link between the natural and the man-made patterns below?*"

Figure 6.3: Pictures of man-made patterns

The lesson proceeded with discussing patterns on buildings and created by architecture, as depicted in Figure 6.3. I explained that it is vital for Foundation Phase teachers to let learners identify such patterns on the school premises. The following kinds of questions may be asked:

- *Is there a pattern? Why do you say so? Describe the pattern.*
- *Draw the pattern.*
- *What is the rule of the pattern? Describe the regularity in the pattern.*
- *Can you find a similar pattern somewhere else in your environment?*

I pointed out that there are also patterns in clothing fabrics. They could ask learners to bring some of their clothing with a pattern (sweater, dress, shirt, skirt) to school to identify, describe, discuss and draw the patterns. I asked the pre-service teachers about other patterns, such as ones we cannot see. Only two pre-service teachers raised their hands. One suggested that we could also find patterns in sounds and movement. I then indicated that exploring cultural patterns is an excellent opportunity for learners to learn more about patterns as well as other cultural heritages. Here, I was setting a precedent for exploring cultural artefacts that I was going to conduct as part of the study.

The rest of the lesson focused on number patterns. I projected a slide and explained that a number pattern can be defined as a sequence of numbers that follows a rule that determines how the sequence continues. For example, 2; 6; 10; 14 … the next number in the sequence is determined by the rule that 2 + 4 = 6 + 4 = 10. According to Peucker and Weißhaupt (2013, p. 32), "truly numerical counting is the corresponding level of numeral sequence". Sequences should show counting forwards and backwards with specified intervals. Number sequences consolidate and develop learners' counting skills. As learners' counting skills change and develop, so will their understanding of number sequences. As learners become more and more numerate, the number sequences they work with can be increased in range and complexity. Eventually, they must explore number patterns with an extended number range of 0 – 1 000 by the end of Grade 3. Kühne, Lombard, and Moodley (2013) outline the significance of encompassing the level of difficulty and appropriateness for different stages keeping in mind the ages of learners and their prior knowledge. Because learners use symbols to extend number patterns and number sequences, they must work on the abstract level.

In conclusion, I asked the pre-service teachers to sing the song, "If you are happy and you know it, clap your hands". The aim was to heighten patterns in sound and movement. They enjoyed singing the song and doing the actions. I then asked them to discuss activities that a teacher can use to teach Grade 1 geometric patterns on the concrete and semi-concrete levels. They had to add these activities to their portfolios.

Journal entry – 23 March 2018

The lessons on patterns, functions and algebra seemed to go very well. I noticed that the students were attentive and seemed to understand what I was presenting. But, I did not feel that good when I listened to the recording of this lesson. I am concerned that the time did not allow for proper engagement with the students. Hence, I found myself doing most of the talking and asking only a few questions. I was also disappointed that I did not capture the whole lesson on the voice recorder. I realised that the recorder got full before the end of the session. So I need to continually check to see if the recorder is always on during lessons.

Retrospective reflection – 22 November 2018

I need to be more organised, plan, and prepare lessons appropriately. I also aspire to look into integration in terms of the foundation we lay in this phase and what it means for learners as they progress to upper grades. As a teacher educator, I want to be able to articulate this for my pre-service teachers. For example, teaching young learners patterns lays the foundation for developing algebraic thinking skills. And I could further unpack this with pre-service teachers looking at different examples. As teacher educators, I sometimes think we say things hoping that the pre-service teachers understand what we are telling them. Allowing time for these kinds of discussions might be helpful.

6.2.2 Space and shape (geometry)

Lesson 5 and Lesson 6 focused on the space and shape (geometry) content area shown in Table 6.4. The Department of Basic Education (2011b, p. 10) states:

> "The study of space and shape improves understanding and appreciation of the pattern, precision, achievement and beauty in natural and cultural forms. It focuses on the properties, relationships; orientations, positions; and transformations of two-dimensional shapes and three-dimensional objects".

In the Foundation Phase, learners explore the properties of 2-D shapes and 3-D objects by sorting, classifying, describing and naming them. Learners draw shapes and build using objects. They describe the position of objects in relation to themselves and others and use appropriate vocabulary.

Table 6.4: Lessons on space and shape (geometry) in Grade 2

Grade	Content Areas	Lesson Topics	ILA - Maths (Integration of concepts within the mathematics learning area)	ILA – Lang (Integration with the Languages learning area)	ILA – Life Skills (Holistic Development) (Integration with the Life Skills learning area)	Sociocultural Theoretical Perspective (Vygotsky)
Grade 2	Space and Shape (Geometry)	**Lesson 5**: Two-Dimensional (2-D shapes)	Patterns, functions and algebra	Communication among learners, negotiating how to create shapes with bodies	Participating & working collaboratively Body movements: Jumping, playing hopscotch *Physical development Social development*	In psychological framework, the unification of nature & culture is powerfully embodied in early development .
	Space and Shape (Geometry) 26 April 2016	**Lesson 6**: Three-Dimensional (3-D objects)	Patterns, functions and algebra: 3-D objects in patterns Arranging objects from smallest to biggest	Community & negotiating creation of shapes with bodies Language vocabulary: taller, wider, round, flat, corners	Objects from the community: relate their own world to mathematical 3-D objects *Social development Emotional development*	Synthesising several influences into learner's novel modes of understanding and participation.

Teaching Two-Dimensional Shapes (2-D Shapes) and Three-Dimensional (3-D) objects to Grade 2 learners - 25 April 2018

The objectives of this lesson were for pre-service teachers to: understand and describe the concept of space and shape; discuss the strategies for teaching shapes to Foundation Phase learners; plan activities for learners to recognise and name 2-D shapes (circles, triangles, squares, rectangles); plan activities for learners to sort, classify and compare 2-D shapes in terms of size, shape, straight sides and round sides; plan activities for learners to recognise and name 3-D objects in the classroom and in pictures (ball shapes: spheres, box shapes: prisms, cylinders); plan activities for learners to describe, sort and compare 3-D objects in terms of size, objects that roll and objects that slide; and plan activities for learners to observe and build 3-D objects using concrete materials. Clements, Wilson, and Sarama (2004)affirm that the main conceptual area in the discipline of geometry is the competence to describe, use and visualise

the results of constructing and deconstructing geometric shapes.

I began this lesson by revising what we had done in the previous lessons. I used a PowerPoint presentation starting with what is stated in the CAPS document regarding space and shape, as indicated above. I explained that geometry (space and shape) is the study of shapes, relationships, and properties. According to Luneta (2014, 72), geometry is the area of mathematics that connects with "culture, history, art and design, and its interactions with these vital human constructs provide opportunities to make geometry lessons interesting and stimulating". This should make anyone very keen to learn how to use this space occupied by shapes that should be well coordinated to make the world a beautiful, natural space to occupy. It is essential to make learners aware that shapes are all around us, mainly in the form of 2-D shapes and 3-D objects. However, young children are not familiar with all these shapes in their environment as they take them for granted. It is therefore vital that Foundation Phase teachers develop learners' powers of observation in their environment as well as their mental imaging of shapes. A 2-D shape has the elements of length and breadth (width). They are all flat. Examples of 2-D shapes are triangles, squares, rectangles and circles. I showed the pre-service teachers the boxes (3-D objects) and the cut-out shapes (2-D shapes). I highlighted what is stated in the curriculum (Table 6.5) regarding this topic.

Table 6.5: An extract from the CAPS document on the topic "2-D shapes" (Department of Basic Education, 2011b, p. 27)

TOPICS	GRADE R	GRADE 1	GRADE 2	GRADE 3
3.3 **2-D shapes**	**Recognise, identifies and names two-dimensional shapes in the classroom and in pictures, including:** • Learners Symbols • Class name	**Range of shapes** Recognise and name 2-D shapes • circles • triangles • squares **Features of shapes** Describe, sort and compare 2-D shapes in terms of: • size • colour • straight sides • round sides	**Range of shapes** Recognise and name 2-D shapes • circles • triangles • squares • rectangles **Features of shapes** Describe, sort and compare 2-D shapes in terms of: • size • shape • straight sides • round sides	**Range of shapes** Recognise and name 2-D shapes • circles • triangles • squares • rectangles **Features of shapes** Describe, sort and compare 2-D shapes in terms of: • shape • straight sides • round sides **Draw shapes** • circles • triangles • squares • rectangles

For pre-service teachers to help learners become aware of 2-D shapes, I indicated that they should involve them actively by including the following skills:

Table 6.6: Activities related to 2-D shapes

Activities to enhance 2-D shapes
• **Visual skills**: Include the activities involved in the act of looking. Learners must observe, compare and sort shapes by seeing that one is the same or different. • **Tactile skills**: Include handling shapes to feel if they are the same or different. It also involves constructing with shapes and working with their hands to draw, cut-out, or paste shapes. • **Verbal skills**: Include activities enabling learners to describe the shapes, i.e., the activities involved in talking. • **Movement (kinesthetic)**: Include activities enabling learners to describe to, amongst other ways of moving, climb over and onto, crawl through, walk and run to or from and jump on or off objects while being aware of their bodies in space. • **Mental skills**: Include activities that involve learners in the thinking process; being able to recognize a shape and label it.

As the lesson progressed, I emphasised that they had to keep in mind that teaching in the Foundation Phase starts by focusing on the concrete and moving to the abstract once learners have understood the concrete experience. I indicated that one of the best ways shapes could be recognised is in the school's immediate environment. Take the learners outside to investigate and explore. Pre-service teachers should note that some of the shapes or objects in learners' surroundings will be three-dimensional. Let them examine the shape of leaves and flowers (even flowers on weeds). Ask them to look at man-made objects and see if they can identify shapes on the objects.

I further explained that play is a crucial method to teach 2-D shapes. When learners are provided with adequate time to play, their play grows in complexity and becomes cognitively and socially more demanding. Thus, the learning of shapes can also be achieved through play. I suggested that they could make a hopscotch court (as illustrated in Figure 6.4) for their school so that learners can learn about shapes while playing a game. We had a lengthy discussion on hopscotch and how they played it when they were young. They explained how they drew the squares, the rectangles and the circles. I promised that I would take them to the playing fields to practice some of the games.

Hopscotch

- A game for two to six players.
- Construct the court according to the design below. Draw it with chalk on a cement slab, paint it on a hard surface or draw the design with a stick on the ground.

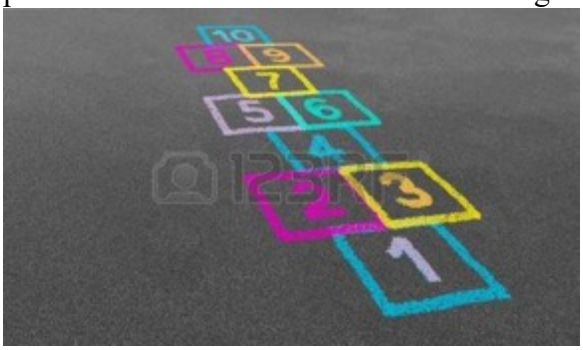


Figure 6.4: An image of a hopscotch game

Regarding teaching sorting, classifying and describing shapes, I highlighted that the main focus of space and shape in the Foundation Phase is to provide lots of sorting and classifying activities to let learners see how shapes are similar or different. Learners need to compare (i.e., look for points of similarity and differences between shapes), sort and classify them together according to specific categories or points of similarity. When sorting and classifying shapes and objects, their properties must be considered so that they can be described according to their properties.

The second part of this lesson (Lesson 6) focused on teaching three-dimensional objects (3-D Shapes) to Grade 2 learners. Wilmot and Shäfer (2015, p. 67) claim that young learners need to acquire "spatial understanding in relation to themselves (position), and then in relation to objects surrounding them (location)". I presented notes in the slides of the PowerPoint indicating that learners should not only learn the names of two-dimensional (2-D) shapes, but also get the opportunity to explore, discover, describe, sort and construct with three-dimensional (3-D) objects (in line with the CAPS document in Table 6.7). A three-dimensional object has three dimensions, namely length, width, and height or depth. Examples of three-dimensional objects are prisms, pyramids, cylinders, spheres and cones.

To help learners understand the difference between geometrical (2-D) shapes and geometrical (3-D) objects, they can explain it in the following way: 3-D objects take up space while 2-D shapes are flat. Learners can physically climb into some 3-D objects, like boxes, if they are big enough. They can put a marble into a smaller box (if it has an opening) or imagine an open space inside the 3-D object. A 2-D shape is always flat. Nothing can fit into it because there is no space inside the shape, not even an imaginary one.

Table 6.7: An extract from the CAPS document on the topic '3-D objects' (Department of Basic Education, 2011b, p. 26)

TOPICS	GRADE R	GRADE 1	GRADE 2	GRADE 3
3.2 3-D objects	**Range of objects** Recognise and name 3-D objects in the classroom • ball shapes, • box shapes **Features of objects** Describe, sort and compare 3-D objects in terms of: • size • colour • objects that roll • objects that slide **Focussed activities** • Use 3-D objects such as building blocks, recycling material etc, to construct composite objects e.g. towers, bridges etc	**Range of objects** Recognise and name 3-D objects in the classroom and in pictures • ball shapes (spheres) • box shapes (prisms) **Features of objects** Describe, sort and compare 3-D objects in terms of: • size • colour • objects that roll • objects that slide **Focussed activities** • Observe and build given 3-D objects using concrete materials such as building blocks, recycling material, construction kits	**Range of objects** Recognise and name 3-D objects in the classroom and in pictures • ball shapes (spheres) • box shapes (prisms) • cylinders **Features of objects** Describe, sort and compare 3-D objects in terms of: • size • objects that roll • objects that slide **Focussed activities** • Observe and build given 3-D objects using concrete materials such as cut-out 2-D shapes, building blocks, recycling material, construction kits, 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 **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

To explore 3-D objects in the environment, Foundation Phase teachers can take learners on a 'shape or object-walk' to explore and investigate the shapes of different objects around them. I encouraged the pre-service teachers to ask questions to guide learners to describe the various features or properties of the 3-D objects they observe. The questions should include vocabulary like the following: taller, wider, round, flat corners, points, curved, straight, solid, hollow, roll, cannot roll, and slide. Teaching 3-D objects on an abstract level, I emphasised that pre-service teachers should remember, at Foundation Phase level, the names of properties are less important than the ability to observe and discover what objects have in common or how they differ. Learners must practically sort real 3-D objects by placing them on piles or putting them together in other ways. They can complete a table as a written exercise to consolidate the practical work.

To conclude, the pre-service teachers discussed activities that a teacher can use to teach Grade 2 learners 2-D shapes and 3-D objects. They worked in groups to create a game showing integration using 2-D shapes.

Journal entry – 26 April 2018

When presenting this lesson, I tried to do a lot of modelling. I brought some learning and teaching support material to class - the things they can use in their teaching such as cut-out shapes of small charts with different colour shapes. Because I wanted to cover as much content as possible, I did not do all of the things I had planned. For example, I wanted to give the pre-service teachers time to work in groups and sort the cut-out shapes according to sides (straight or curved), or any category such as colour, size, or thickness and discuss the properties of each shape. Time and the large numbers prevented me from allowing for this interactive setting in my class. At the same time, I really need to consider other suitable methods for a large class situation.

Retrospective reflection - 9 February 2019

In the future, I shall try to balance the activities that pre-service teachers will do in class and those they can do independently. I shall make sure that I can keep track of those. I think what is also important is to let them start the activities in class to guide them, hoping that they will not struggle as much when they work on their own. This will also prevent them from redoing the activities. It is a challenge, but I will see what works and what does not. It is an ongoing learning process of trying different methods. It also does not mean that what works with the one group will work with the next group. I need to be open-minded all the time.

6.3 Exploring the Integrated Learning Approach Through Cultural Artefacts

After the lesson on patterns, I asked the pre-service teachers to bring cultural artefacts to class − for example clay pots, beadwork, jewellery, or clothing. Björklund and Ahlskög-Bjorkman (2017, p. 106) argue that "artefacts come to be important, both for visualising different ideas and for providing the children with new challenges to develop their ideas". Therefore, I felt it would be appropriate to use artefacts[12] in my efforts to cultivate integrated learning approach concepts among the pre-service teachers.

[12] The work on cultural artefacts activities presented in this chapter has been published in an article: Kortjass, M. (2019). Enriching teaching through artefacts: An Early Childhood Mathematics teacher educator's self-study project. *Educational Research for Social Change, 8*(2), 70-85.

Figure 6.5: Grass place mats

I showed the pre-service teachers the artefact that I had selected (Figure 6.5) as an example to stimulate their ideas on how they could link Mathematics, Language, and Life Skills using cultural artefacts. I did this to model what I would ask my pre-service teachers to do (Samaras, 2010). My artefact was a place mat made of grass called *ikhwani*. Grass is woven into a rope and stitched into a circle to make this type of mat. A hot plate would be placed on such a grass placemat in many African communities to protect the table. We discussed the mathematical link and argued that it was a geometric, circular pattern that extended naturally from the inner centre to the outer circle as the place mat was shaped. I demonstrated how, in terms of language, new vocabulary could be applied and acquired. For example, *ikhwani* is a type of grass used to make place mats, floor mats, brooms, garden chairs and tables, and so on. The pre-service teachers understood that their future learners could do craft work as part of the Life Skills learning area. The creative arts approach might be employed to develop their learners into creative, imaginative individuals with an appreciation of the arts (Department of Basic Education, 2011a). It was also a revelation that mathematics applied to their cultural environments and that the integrated learning approach could be employed as a creative and exciting teaching methodology (Gerdes, 1998).

Grass mats are cultural artefacts like clay pots and beadwork that are made by people from different cultures. In the Foundation Phase, we introduce patterns by talking about man-made patterns we find in the immediate surroundings. We also help learners identify patterns in nature and connect the patterns found in nature to patterns made by humans. Often patterns created by people have been inspired by patterns found in nature. The pattern of the grass mat was inspired by the spider web. It is important to note that we do not need fancy materials to accomplish great things. On a flippant note, we can “make a silk purse out of a sow’s ear”.

Exploring cultural patterns is an excellent opportunity for learners to learn more about patterns and the artefacts that other cultures cherish.

For the artefact activity, the pre-service teachers had to present and discuss the various artefacts they had selected and brought to class. I divided the pre-service teachers into six groups and asked them to choose two artefacts that they were going to discuss and present to the class. I asked them to describe their artefacts, such as the patterns on them and how the artefacts linked with the Mathematics, Language and Life Skills learning areas. The purpose was to provide them with the opportunity to think about and articulate their understanding of cultural artefacts for teaching according to an integrated learning approach. This compelled them to work collaboratively. Teamwork resonates with the sociocultural way of teaching because it embraces the power of working together. I was mindful of Adamu's argument that "learning is believed to occur faster and more thoroughly when it is presented in meaningful contexts, with an experiential component" (2003, p. 4). I thus underpinned my teaching with this philosophy and encouraged my students' learning through real-life connections. The artefacts they selected included beadwork, jewellery, and textiles.

The majority of the pre-service teachers spoke IsiZulu as their home language, and I had noticed how they struggled to present in English. I thus allowed those who preferred to present in IsiZulu to do so. The presentation and interpretations of some artefacts are presented in the next sub-sections.

6.3.1 *Izigege* (ceremonial garments)

Figure 6.6: Izigege

One group presented a garment known as *isigege* (*plural – izigege*) (Figure 6. 6). This item is customarily worn by young girls, especially during ceremonial occasions in the Zulu culture. The garment is beaded in various colours. Pre-service teachers linked this object to mathematics by referring to the different shapes such as circles and triangles and the patterned colours. They highlighted number skills as they argued that these skills could be developed by counting the number of colours and the number of different shapes and learning about basic geometric shapes could also be visually enforced. Pre-service teachers also noted that the garment could help facilitate vocabulary enrichment by using and learning words to describe the patterns, listing the colours, or telling stories about the artefacts. They mentioned that learners could develop handwork skills in the Life Skills learning area by being given opportunities to string beads and create their own artefacts as part of the creative arts programme. They also stated that learners could learn about traditional Zulu events such as *umemulo* [coming of age ceremony] and *umkhehlo* [pre- wedding ceremony].

6.3.2 Necklace worn by Indian women

Figure 6.7: Eastern necklace

The object depicted in Figure 6.7 is a necklace typical of the jewellery worn by Indian brides on their wedding day. Its pattern is repeated in teardrop and floral shapes. Links were made with mathematics by referring to the geometric patterns and the different colours that follow a particular sequence. The pre-service teachers argued that learners could acquire new vocabulary and the correct spelling of words such as jewellery, Eastern, and necklace. They mentioned that knowledge of, and respect for, different cultural heritages were also represented by this traditional jewellery piece. Learners could learn about traditional Indian culture in the Life Skills learning area.

6.3.3 *Ucu* (symbol of love)

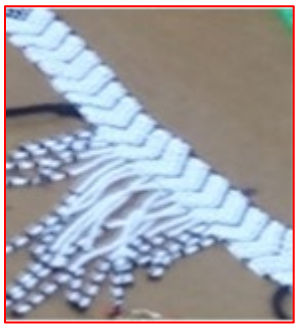


Figure 6.8: Ucu

The artefact depicted in Figure 6.8 is known as *ucu*—a symbol of love. When a young woman gives *ucu* to a young man as a sign of her love, this marks the start of a relationship between them. The string of white beads in a pattern that is trimmed with a blue braid epitomises mathematics. Explanations or stories related to the significance of *ucu* also relate to the language learning area. An understanding of Zulu beadwork that contains hidden messages is relevant to the life skills programme. For example, the pre-service teachers indicated that learners could learn that white is a symbol of love and purity. Black beads are rarely used in *ucu* because black is the colour of sorrow and despair.

6.3.4 Other cultural artefacts

Figure 6.9: Other cultural artefacts

Other cultural artefacts that were presented by the students are depicted in Figure 6.9. These objects included textiles, necklaces, and bracelets that people wear during traditional African events. The students understood that by exploring the shapes and meanings of these artefacts, they went on a journey of exploring how people interact with them every day of their lives. This experience acknowledged culturally responsive mathematics education, which is a way to address the diverse needs, interests and backgrounds of students (Nicol et al., 2013). After discussing the artefacts and using them as examples of how to teach through an integrated learning approach, the pre-service teachers began to open their minds to new teaching and learning avenues.

Journal entry – 18 April 2018

I saw that the students were growing and developing in their understanding of the integrated learning approach. It was rewarding to observe that they could link mathematics with language and life skills when presenting their artefacts. But, I was angry with one of the groups when no one came to present. I did not get myself to think about why they did not come to present. I just felt that they were lazy or maybe disrespectful. I don't know if I was hard on them. I understand that they were first years and that English was an issue for some of them, but I wanted to believe that I had created an encouraging space for them to speak freely. When I moved around to the groups, I noticed that they could voice their opinions and ask questions. When they presented, some students used both English and IsiZulu. Using IsiZulu was understandable as most of the names of the artefacts were in IsiZulu. In the future, I need to encourage my students to speak in IsiZulu if they are not confident enough to use English.

Retrospective reflection – 27 February 2019

I need to be more sensitive towards the students and not take things for granted. I think in the case where students were reluctant to present, maybe I could have found out from them what the problem was. I now realise that I should have politely asked them. Sometimes as teacher educators, we think we know our students. This is a lesson for me to always strive to get to know my students better. As I reported in Chapter Four, it was easier to interact with the students when there were not so many in the class. I should make an effort, even though there are challenges. I need to think about how I can provide encouragement to support their success and identify those who need individual attention.

6.4 Pre-service Teachers' Evaluation of the Module

This group of pre-service teachers evaluated the module by answering the Quality Promotion and Assurance (QPA) evaluation questionnaire. As explained in Chapter Five, this questionnaire comprises core standard questions. I retrieved the university system generated QPA report to get a sense of how the pre-service teachers reviewed the module. I developed the categories based on the students' responses. When creating these categories, I considered the sociocultural approach because, according to Samaras (2002), an individual's learning is related to the social and cultural world in which they grow. I have captured some of the pre-service teachers' responses under the categories: *concept, practical, personal attributes,* and *improvement,* as summarised in Table 6.8 below:

Table 6.8: Pre-service teachers' comments on the module

Questions	Category	Summary of comments
What aspects of the module were facilitated well?	Concepts	• *Everything was facilitated well because we all understood the concepts that we were being taught.* • *Multiplication* • *Basic operations* • *I am happy with those [concepts] I was taught. I think they are fine for first year students.* • *All the concepts. The lecturer has so much experience and can transfer the knowledge well.*
	Practical	• *Our lecturer tried by all means to make us understand, because we had examples, tutorials and practicals.* • *She would also ask us to bring items like clay pots, any thing made by hand including beads. That was to teach us about patterns and so forth.* • *She showed us practically, how we could work with learners.* • *Lecturer demonstration was phenominal.*
	Personal attributes	• *The lecturer explained everything with patience.* • *Our lecturer showed us courtesy in the lecture room.* • *She was really a good teacher and working with her was enjoyable because she is kind and always happy.*

		• *I think that if our lecturers continue to teach us this way we will be the best teachers for tomorrow.*
What areas do you believe need to be improved in this module?	Improvement	• *More lectures* • *There are no areas needs to be improved, it's only me who must improve my interpersonal skills.* • *It should have more practical work than paper work.* • *It would be useful to maybe to watch videos on children before commencing on the module as we struggle to identify with children.*

I present a brief evaluation of the comments below:

6.4.1 Concepts

Acquiring mathematical concepts is essential in the Foundation Phase to allow for a basis for future learning. Schuck (2011) believes that teacher education needs to focus on pre-service teachers' learning of the concepts and develop approaches to teaching them. The student teachers indicated the concepts they learnt in this module when they responded to the question, *What aspects of the module were facilitated well?* They stated that the concepts were suitable for first year students. It was pleasing to read the comment that said I was able to *transfer the knowledge well*. It gave me confidence that, just like I strive to improve my practice, my pre-service teachers will hopefully share that knowledge with their learners.

6.4.2 Practical

The importance of engaging in practical activities to teach early childhood mathematics was accentuated by the pre-service teachers' evaluations. They highlighted that I certainly tried to make them understand when I taught them by providing relevant examples and engaging them in tutorials and practical activities. Alderton (2008) articulates the importance of pre-service teachers and their learners for engaging in practical and exploratory work in mathematics to develop a relational understanding of it. I have gained insights on how I could challenge my

student teachers by providing opportunities to "demonstrate competence with mathematical tools, methods and content at the primary level" (McGlynn-Stewart, 2020, p. 177). I am motivated to continue exploring more ways to actively engage pre-service teachers to become effective early childhood mathematics teachers.

6.4.3 Personal attributes

Creating a positive classroom environment by fostering good relationships between teacher and learner is an influential factor in teaching and learning. Nicol et al. (2010) echo the comfort level that my pre-service teachers spoke about when asked about the mathematics education course's most remarkable aspects. I believe that these aspects are created by teacher educators who exhibit certain personal attributes. The pre-service teachers perceived me as a lecturer who is kind, patient and someone who displays courtesy in the lecture room. Although there was no explicit question about the lecturer, the pre-service teachers felt that teacher educators should facilitate particular teaching and learning environments. I am in agreement with Nicol et al. (2010) about pre-service teachers being aware of their lecturers' "interests in them as individuals, their emotional engagement with the course content, and their feelings about math and teaching math" (p. 240). In improving my practice, I also want to inculcate a sense of morality and integrity in my profession and support my pre-service teachers to be the best they can be in their classrooms one day.

6.4.4 Improvement

As a self-study researcher, I always seek ways to improve my practice. Schuck and Brandenburg (2019) reveal that there are benefits in receiving an honest evaluation of practice because it challenges and supports improvement. Concerning the question: *What areas do you believe need to be improved in this module?* the pre-service teachers felt that there was a need for more lectures and practical work. They also indicated that they had difficulty relating to young learners, and think it would be beneficial for them to watch videos at the beginning of the module. I will be considering these issues next time I teach this module. I am learning and getting to know my pre-service teachers to shape their development.

6.5 My Learning

In this chapter, I have so far described the various data sources used to inform this study, such as transcriptions of my pre-service teachers' cultural artefacts, lesson presentations and my journal entries. In this section, I discuss my learning using all these sources and I also explain

how I created a collage to assist me in making meaning of the data. Butler-Kisber and Poldma (2010, p. 2) appropriately describe my visual arts-based engagement with the data:

> These new, arts-informed modes of inquiry mediate different kinds of understandings grounded in direct experiences . . . expand the possibilities of diverse realities . . . increase voice and reflexivity in the research process . . . and create more embodied and accessible research results.

The generated data allowed me to gain an in-depth perspective on the process of analysis and interpretation of the data. I was able to classify and categorise the data according to themes. I used an inductive approach to address my research question. I also elucidate how I used a collage (shown in Figure 6. 10) to make sense of my data. The collage I created helped me discover what I was learning through a process of "zooming in and zooming out" (Chang, 2008, p. 128). According to Butler-Kisber and Poldma (2010), visual inquiry is used to generate insights and understand phenomena. Taking a sociocultural stance, I then developed the following themes: Have Fun; Nurture with Nature; Super Seeds; and Tried and Tested.

Figure 6.10 : My collage representing my learning

6.5.1 Have fun

The theme 'Have Fun' emerged because I wanted the pre-service teachers to enjoy engaging with mathematics. This was important for me at the time because mathematics is often referred

to as “a difficult subject” that is “abstract and not enjoyable.” It was likely that many of my students had had negative experiences with mathematics and were not positively inclined towards my classes from the beginning. They had made comments such as “We do not like mathematics” and “We came to do Foundation Phase because the maths here is not difficult”. I knew it would be crucial to challenge the Foundation Phase pre-service teachers as they not only had to acquire skills to teach mathematics to learners in the Foundation Phase, but they also needed to be equipped and knowledgeable as teachers. Laridon et al. (2005) believe that interweaving sociocultural contexts in a mathematics classroom can foster interest, a positive attitude, and enjoyment. Thus, teaching early childhood mathematics using an integrated learning approach should engender an element of fun in the classroom. I was delighted to see the pre-service teachers enjoying the artefact activities.

6.5.2 Nurture with nature

The tangibility and presence of the artefacts evoked meaning and feelings, which prompted interaction and engagement in a way that something more abstract might not have done. Samaras (2002) highlights the importance of incorporating pre-service teachers’ contexts and cultures in teacher education practices. The integrated learning approach allows opportunities for activities that encompass “cultural practices such as counting, measuring, comparing, classifying, playing, locating designing and explaining” (Laridon, 2005, p. 135). Pre-service teachers could relate to the artefacts because they could see and touch them and tell stories about them, and, in this way, they were empowered to understand how the integrated learning approach functions. As noted by Samaras (2002), the nurturing setting promotes learning and builds the self-concept.

6.5.3 ‘Super Seeds’

With the caption ‘Super Seeds’, the seeds’ visual image makes me understand what I was learning about the pre-service teachers’ growth during the module. I was worried initially, but their improvement in the second assignment and the portfolio they developed gave me confidence that the seeds were falling on fertile ground. Using alternative methods, such as those for integrated learning, may help my students do the same with their prospective learners (Nicol, 2011). According to Samaras and Freese (2006), self-study “provides fertile ground for investigating and developing your knowledge about teaching with evidence that is immediate and personal”. I was optimistic when I saw the students smiling and relaxed when they were doing various classroom activities.

6.5.4 'Tried and Tested'

The theme 'Tried and Tested' represents my engagement with different groups of students in employing the integrated learning approach. I piloted this approach with the first group of pre-service teachers in 2016. I implemented it with the second group of pre-service teachers in 2017 and continued its implementation involving the third group in 2018. Boaler et al. (2016) argue that mathematics teachers should use different methods, visuals, and manipulatives to enrich students' understanding of mathematical concepts. Focusing only on teacher-centred methods that emphasise rules and procedures is disadvantageous to students because they promote conventional and unconnected learning (Boaler, 1998). I am now aware of the challenges and how I shall do things differently in the future.

6.5.5 Summary of my learning

I observed that the pre-service teachers became excited and enjoyed learning how mathematical concepts could be illuminated through their interaction with artefacts. I discovered that they were also able to link the Mathematics, Languages and Life Skills areas when they presented their artefacts. They were also able to associate mathematics with the real world and their own life experiences. However, I realised that I had to guide them to open their minds and focus more on mathematics and less on their presented artefacts' traditional aspects. In this process, my own mind became clear about the amount of work and the time required to plan every classroom approach—whether it involves pre-service teachers or Foundation Phase learners.

I value the insights that I gained from working with the pre-service teachers in activities involving cultural artefacts. For example, I learnt how vital and symbolic an Eastern necklace can be to an Indian bride. I uphold my Vygotskian style by being open to collaborative learning with my pre-service teachers. I realise that planning activities that enhance students' creativity is fundamental and requires a lot of thought. Therefore, I need to plan my future lesson activities well in advance. I am also aware that culture is now interpreted in many ways by modern young people. Fasick (1984) notes that the youth culture is different from the culture of older generations in that young people put more emphasis on things such as clothes, popular music sports, and digitally connecting with peers, which suggests a distinct culture of their own. I shall need to think carefully about culture and engage in conversations with students of all races and backgrounds about what culture means to them.

6.6 Conclusion

This chapter explored more opportunities to cultivate an integrated learning approach in teaching early childhood mathematics. I gave an account of the four lessons I had presented. I showed how I had used a collage to elucidate my learning from the lessons on cultural artefacts. I acknowledge that I had learned an enormous amount from my pre-service teachers as I had engaged in the various activities. I appreciated that the learning of early childhood mathematics should not be seen as an isolated activity. Through integrated activities and resources, the pre-service teachers learnt from one another and I learnt from them. It was important to be cautious in the classroom when the pre-service teachers got carried away during their presentations about cultural artefacts, as they tended to focus on the traditional aspects and not on linking mathematics with other learning areas. However, on a positive note, their ability to recognise and apply mathematical concepts based on diverse cultural objects was inspiring. I am now convinced that presenting alternative ways of learning mathematics will stimulate pre-service teachers' interest in teaching it appropriately one day.

In the following chapter titled '*Watching the ebbing tide'*, I describe my engagement with pre-service teachers in extra-mural activities. I highlight the memory drawing activities and the games we played to enhance integrated learning.

CHAPTER SEVEN: WATCHING THE EBBING TIDE

Teaching is often a profession in which feelings and motivation play an essential role. If we wish to promote teacher learning, we will have to take their [students'] thinking, feeling and wanting into account

Fred Korthagen

7.1 Introduction

In the preceding chapter, I addressed the second research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* I elaborated on my efforts to explore an integrated learning approach with the third group of pre-service teachers. In Chapter Six, I described four lessons that I had presented and the activities in which my pre-service teachers had been involved. These lessons focused on two content areas: *Patterns, Functions and Algebra;* and *Space and Shape.* Furthermore, I recounted how we had explored an integrated learning approach through cultural artefacts. I learnt that teaching and learning early childhood mathematics should be an all-encompassing activity that connects both social and conceptual understanding of mathematics. To incorporate culture in early childhood mathematics teaching, I asked the pre-service to discuss cultural artefacts (objects with cultural meaning). I got to understand pre-service teachers' capabilities of using their cultural artefacts to grasp mathematical concepts. The pre-service teachers were able to relate to the cultural artefacts because of the tangibility that these artefacts embodied. In this manner, the artefacts enriched their understanding of an integrated learning approach.

This chapter is titled '*Watching the ebbing tide',* a metaphor for letting go of my apprehensiveness while exploring an integrated learning approach using arts-based methods. I again addressed the question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* At the beginning of this study, I was uncertain how these practices would work. By working with different groups of pre-service teachers, I learnt about the possibilities that an integrated learning approach and arts-based methods may have for creating a better understanding of mathematics. These experiences allowed me to extend my practice to explore other means of engaging pre-service teachers in early childhood mathematics teacher education. In the present chapter, I address my second question once more to improve and enrich my practice. I explain how I attempted to explore an integrated learning approach in teaching early childhood mathematics for pre-service

teachers. I drew on proposals by Korthagen (2017) who perceives that "teaching is often a profession in which feelings and motivation play an essential role. If we wish to promote teacher learning, we will have to take their [students'] thinking, feelings and wanting into account" (p. 391). I concur with this notion and aspire to consider it in my teacher education practice.

The chapter begins with a description of my initiation of engaging pre-service teachers in extramural activities. I then go on to describe the memory drawings activities we did and my learning from them. This is followed by a summary of my discoveries based on the memory drawings. I then describe the board game activities the pre-service teachers engaged in, the mathematical skills associated with playing board games, and my learning based on these activities. I conclude this chapter by elucidating my thoughts and understanding based on my encounters with various inventive methods to teach early childhood mathematics in the teacher education context.

7.2 Extramural Activities

Because of time constraints due to a comprehensive prescribed curriculum, I felt the need to engage pre-service teachers outside the classroom to explore an integrated learning approach. Because there was a great deal of content to cover in a one-semester module, I could not do additional activities as part of my research in the first semester of 2018. I, therefore, invited my pre-service teachers to attend extramural activities in the second semester. The activities were conducted over eight weeks. I met with the student teachers once a week for two hours. Twelve of the group of 57 pre-service teachers volunteered to participate. The group involved 10 females and two males. Ten were Black and two were Coloured students. Their ages ranged from nineteen to twenty-three. Unlike me, they had been schooled after the year 2000 in the post-apartheid era. Therefore, they were exposed to a different prescribed school curriculum from me.

Extramural or extra-curricular activities take place beyond the school curriclum and are optional for students and learners. In exploring an integrated learning approach, I wanted my students to experience mathematics learning in a transformative way. During the extramural activities, my pre-service teachers and I participated in memory drawings and played different board games. According to Marais (2011), extra-curricular activities range from clubs for cultural and recreational activities to sports activities in which students and learners partake

during regular school hours, lunch breaks, or after school. Hagger and Chatzisarantis (2012) note that such activities stimulate students' participation in an encouraging environment and inspire them to succeed in more ways than one. By engaging my students in extramural activities, I anticipated that I could enhance their interest in excelling in early childhood mathematics teaching. Hagger and Chatzisarantis (2012, p. 196) argue that the teaching approaches and motivational strategies that teachers espouse cultivate "desirable outcomes beyond the classroom, such as engagement in extra-curricular activities". In my attempt to improve my pedagogy and taking a sociocultural standpoint, I was drawn to explore the value of extramural activities. Taking a sociocultural perspective encouraged me to consider how I could facilitate collaborative learning in diverse environments. I reckoned that providing a space for my pre-service teachers to interact socially and work collaboratively would enhance their understanding of the integrated learning approach. In my view, this demonstrates Dockett and Perry's (2010) belief that social interaction in a schooling system creates opportunities for innovation and problem solving because such connections also reinforce mathematical thinking. I believed that the same could be achieved in early childhood mathematics teacher education.

7.3 Memory Drawings[13]

Early learning experiences can influence teaching practices. To illustrate, Nicol (2011, p. 45) clarifies that many pre-service teachers have experienced learning mathematics as "a series of rules for solving complicated problems and seeing teaching mathematics as explaining procedures for solving such problems". In contrast, though, teachers should view learning mathematics as a unified development process during which connections are formed. This is in line with Schuck and Perreira's (2011) argument that mathematics is related to tangible aspects and connected to our everyday lives. In seeking to adopt and encourage an integrated approach, I wanted to show the interconnectedness of mathematics and our lives.

The memory work self-study method is a method that embodies evoking memories to understand a phenomenon in a research project. It helps individuals visualise and make meaning of past events in their lives (Samaras, 2011). By engaging my pre-service teachers in

[13] The section on memory drawings has been published in a book chapter: Kortjass, M. (2020). Re-envisioning Early Childhood Mathematics education: Learning through memory drawing. In C. Edge, A. Cameron-Standerford, & B. Bergh (Eds.), *Textiles and Tapestries* (pp. 1-14). EdTech.

memory recall activities, I was hoping to learn about their early learning experiences of mathematics to improve my teacher education practice. O'Reilly-Scanlon (2002, 74) explains that what people recall and how they recall incidences in their lives create the essence of who and what they are at present. I anticipated that the memory work method might help me better understand my students and their thinking about mathematics teaching and learning. Samaras (2002) believes that the way pre-service teachers were taught has an influence on how they will teach. Therefore, I wanted to acknowledge and learn from my students' negative and positive learning mathematics experiences in their early years of schooling.

Memory drawing provides a creative space for critical reflection and re-examination. Mitchell (2008) notes that drawing has been used with pre-service teachers in South Africa to study different phenomena. According to Pithouse-Morgan et al. (2019), memory drawing can be used as a self-study method to explore early memories of school. Furthermore, memory drawings can help teachers and teacher educators attend to practice related to learning apprehensions (Pithouse-Morgan et al., 2019). I therefore encouraged the use of memory drawings to recall lived experiences of learning mathematics as young children.

The pre-service teachers and I drew pictures and added captions that represented our early experiences of learning mathematics. Before I met my pre-service teachers for the first session of extramural activities, I did a drawing that portrayed an early experience of mathematics (I described and presented this memory drawing in Chapter Three as part of my personal history narrative). My picture signified the disheartening experience of learning the long division concept when I was in Grade 3.

I introduced the memory drawing activity concept by having a conversation with my students about learning mathematics in the early years, and I shared an unhappy memory of this process with them. I told them how frightened I had been of submitting my long division task because I had known that my answer was incorrect. To avoid a beating, I had put my exercise book on the pile of marked ones to avoid my shame. I asked the students, "*Why do you think it is important to have conversations about our negative experiences?*" One student said, "*So that we don't repeat the mistakes that our teachers made with our own learners*". I agreed and added that we could also try to emulate valuable experiences. When Samaras (2002) asked her pre-service teachers to describe their "most positive and negative experiences in their schooling and how they thought critical events affected their teaching", similar responses as those offered

by my pre-service teachers were forthcoming. For instance, students frequently remarked that they made every effort to do the opposite of what discouraging teachers had done when they were taught (Samaras, 2002).

Following this discussion, I asked the pre-service teachers to think back about their experiences that might have aided or impeded their early years of learning mathematics. I modified Allender and Allender's (2006) questions based on their exploration of "the relationship between their education as children and the kind of teachers they have become" (p. 14). I had devised two questions to stimulate their thinking: "*What do you remember about mathematics learning as a child in primary school*?" and "*How did your learning of mathematics as a child allow or hinder your grasp of mathematical concepts*? I highlighted that I was not expecting them to draw 'fancy' or highly artistic drawings. Pithouse-Morgan et al. (2019) stress that even simple stick figure drawings can help adults evoke school memories. To begin the exercise, I showed the pre-service teachers an example of the drawing I had done beforehand. I indicated that my picture was simple as I had drawn stick figures. I gave the pre-service teachers 10 to 15 minutes to do this activity.

I then asked them to tell us about their drawings. A few volunteered. I was influenced by a South African study by van Laren (2014), which revealed that pre-service teachers' drawings allowed them to reflect on their own life experiences, which made it possible to show them the value of integration using drawing activities. At our first meeting, I was pleasantly surprised by the pre-service teachers' enthusiasm to discuss their early learning experiences of mathematics. There was no hesitation. They just did it. By looking at their smiling faces and their body language, which was very responsive, I think they had fun doing the drawings. I audio-recorded and transcribed the conversations.

In our discussion, it was interesting to note that there were similarities, especially about the issue of corporal punishment and how that had made them feel. They reported that they had received lashings with 'the stick' when they could not grasp mathematical concepts. It was demotivating for them as young learners to start the day receiving corporal punishment. Moyo, Khewu, and Bayaga (2014) define corporal punishment as the type of discipline that involves inflicting pain on a person's physical body. They also argue that corporal punishment can be more than physical and could result in emotional and psychological harm (Moyo et al., 2014). In the South African context, during apartheid, corporal punishment was executed regularly.

According to Govender and Sookrajh (2014), discipline in the form of corporal punishment was used to extort outputs and obedience from learners and the daily use of corporal punishment in schools created fear of teachers.

Our discussion revealed that most pre-service teachers remembered mathematics as involving memorisation, 'talk and chalk', and paper-based exercises. As Goodell (2006) remarked, it appeared that these experiences did not promote a deep understanding of mathematical concepts. Only one pre-service teacher mentioned having a very encouraging teacher who engaged them actively. She stated that her classroom was full of resources to help them in their learning of mathematics. Delaney (2010) argues that when teachers use resources, learners can become more engaged and enjoy discussions.

The following images and excerpts are a selection of the memory drawings by the pre-service teachers. Of the 12 memory drawings, I selected four presented by the students who had volunteered to share their drawings. I use pseudonyms to protect their identities.

The first four pictures (Figure 7.1 – Figure 7.4) show no concrete objects or any type of resources in the classrooms. What is evident is how fearful the learners were of their teachers when they were learning mathematics in primary school. The first example (Figure 7.1) depicts a tearful learner facing a teacher holding a stick.

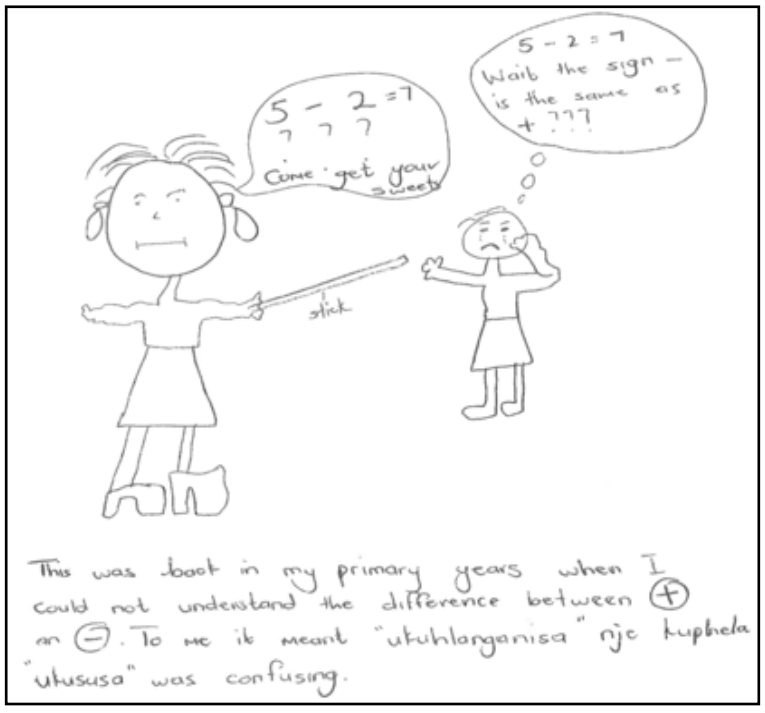


Figure 7.1: Nano's memory drawing of a learner getting a hiding

When Nano was in Grade 1, she had problems differentiating between addition and subtraction. According to the Department of Basic Education (2011a), learners should develop an understanding of basic operations of addition, subtraction, multiplication and division, which are the foundations of mathematics teaching and learning. Thus learners' mastery of calculations is based on a clear understanding of these operations. Nano stated that, after learning about addition, their teacher introduced the subtraction concept. According to Nano, subtraction (*ukususa)* was confusing for her as she understood only *ukuhlanganisa* (addition). When they were given subtraction sums, instead of subtracting, she would add. As she arrived at incorrect answers, the teacher would say, "Come get your sweets!" – meaning getting a hiding. Nano's drawing (Figure 7.1) shows this memory of learning mathematics. It is an expressive drawing as the child is in tears, and the adult (the teacher) is wielding a cane (or stick). The picture captures the pain Nano felt when she was beaten. The drawing also validates Phewa's (Pithouse-Morgan et al., 2019, p. 70) description of 'the stick', which was "the enemy of every learner at school". Phewa argues that learners would have been scared in such situations even if they had not done anything wrong (Pithouse-Morgan et al., 2019). It must have been a traumatic experience for Nano as a child. In my opinion, it would not have been possible for this young child to grasp the concept of subtraction as she was experiencing pain and fear.

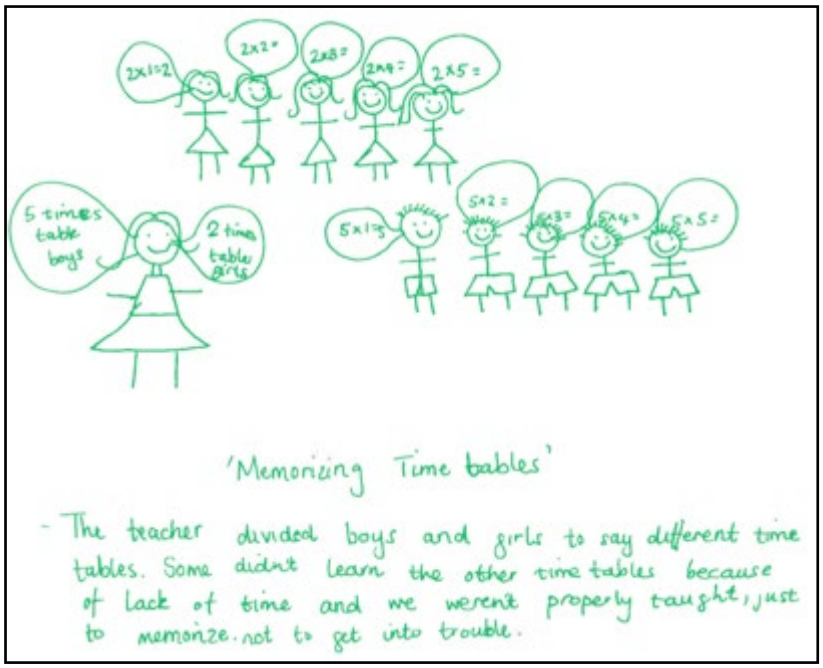


Figure 7.2: Sane's memory drawing of boys and girls memorising times tables

Sane (Figure 7.2) highlighted that the teacher made them recite times tables every morning. The memory drawing depicts the division of boys and girls and the times tables they had to repeat. According to Tahir (2010), young learners do need to learn and use times tables to learn basic mathematics. However, Sane indicated that they had to memorise times tables to "not get into trouble" (i.e., be beaten). This statement concurs with Phewa's (Pithouse-Morgan et al., 2019, p. 70) account of how most learners at a school in South Africa tried not to make teachers feel upset as this resulted in awful repercussions. In my view, knowing the times tables is necessary for proficiency in mathematics. However, how teachers help learners to acquire this capability needs to be motivational rather than frightening. Discussions with the student teachers revealed that the experience of memorising times tables was predominantly discouraging for them, as exemplified by Sane's drawing, which highlights the use of corporal punishment to achieve this objective.

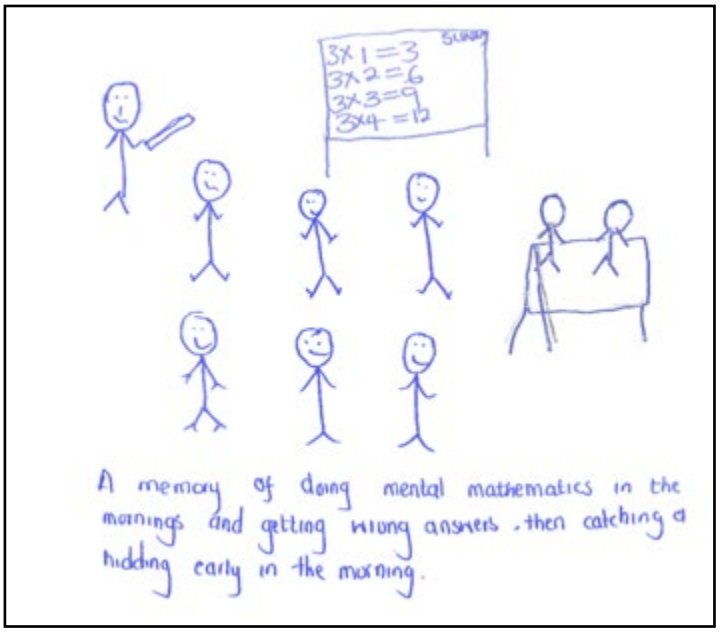


Figure 7.3: Mihle's memory drawing of learners doing mental mathematics

"Catching a hiding early in the morning" for getting incorrect answers stands out in Mihle's memory drawing (Figure 7.3). Mihle also stated that young learners feared mathematics because they were given a beating for not getting it right. Having experienced corporal punishment myself, I can imagine how demotivating this was for young learners who had to start a day with a hiding. In most South African schools, mathematics is typically taught in the morning. Mihle's drawing illustrates that mathematics was a fear-provoking subject because it was associated with punishment. She highlighted that very few learners in class understood

mathematics, and those learners stood out as the "bright learners". In Mihle's drawing the stick figures of the learners are the same size as the teacher. What distinguishes the teacher from the learners is that the teacher is carrying a cane. This emphasises the fear young learners experienced when teachers applied corporal punishment at the drop of a hat. Therefore, to improve my teaching of early childhood mathematics, I resolved to support my students by leaving fear out of the equation. As Brady and Bowd (2005) point out, fear of mathematics can emanate from pre-service teachers' prior experiences of punishment at the primary school level.

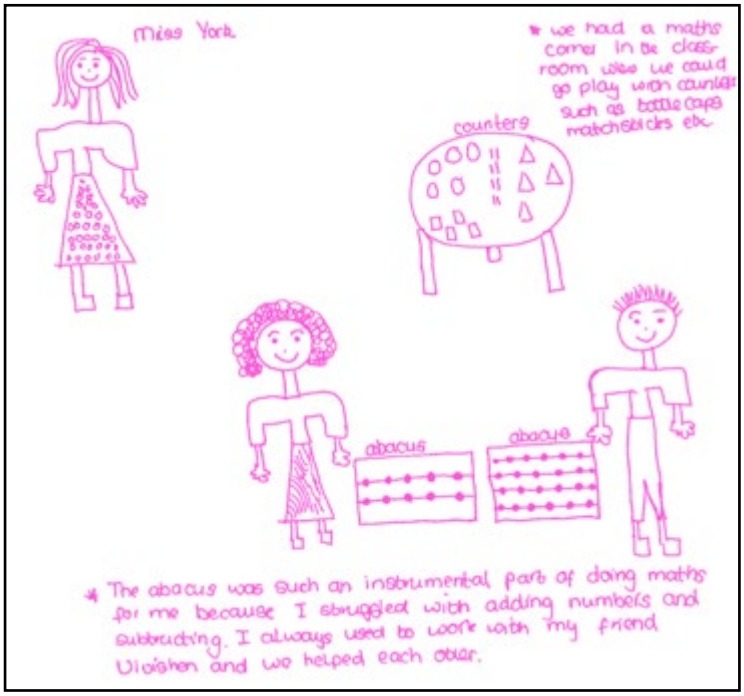


Figure 7.4: Zukiswa's drawing of learners using an abacus

Only Zukiswa's drawing depicted a positive experience of learning mathematics. She indicated that the use of resources, particularly the abacus, was instrumental in her mathematics learning. Zukiswa said that learners worked collaboratively to learn mathematical concepts. Her drawing (Figure 7.4) shows that the mathematics corner was equipped with concrete teaching aids. Zukiswa did not mention the use of the stick when learning mathematics. Her drawing presents the teacher and the learners with smiling faces and learners working together using an abacus. For me, Zukiswa's illustration portrays an optimistic and encouraging learning environment that is a valuable foundation for mathematics learning in the early years. She mentioned that even though she struggled with addition and subtraction, working with her friends made things a bit easier. Brady and Bowd (2005), who conducted their study in Canada, found that few

teachers had enjoyed primary school mathematics. After that, they had experienced real problems with mathematics when they had reached high school. Observing Zukiswa's enthusiasm gave me confidence that it is possible to enjoy learning mathematics. Her drawing motivated me to create a mathematics classroom full of resources and allow my pre-service teachers to work together positively.

Journal entry – 6 September 2018

I was pleased to see the students when they attended the extra-mural activities. When we discussed how we had learnt mathematics in primary school, my pre-service teachers were open and shared their experiences honestly. I am presuming that it was because there were few of them. They did not hesitate to draw pictures with captions representing their early learning mathematics experiences and writing short paragraphs about these experiences. I was surprised that the students, who were more than 20 years younger than I was, had experienced similar problems when learning mathematics to what I had experienced.

Retrospective reflection – 15 March 2019

The conversation I had with my pre-service teachers regarding the teaching and learning of mathematics was enlightening. Reflecting on these experiences made me question how I prepared my pre-service teachers to teach mathematics to young learners. I need to be consistently aware that I should make mathematics accessible and create a safe learning environment where my pre-service teachers will not fear mathematics or inspire fear in their young learners one day.

I should never take anything for granted. Reading old and new articles on mathematics learning has made me realise how problematic and persistent the issue of the acquisition of mathematical concepts has been all these years – in fact, the words *procedural*, *boring*, and *impeding acquisition* came to mind.

Teacher educators and teachers of mathematics should take certain steps to curb this problem. I have been encouraged by scholars such as Goodell (2011); Laridon, Mogari, Nkopodi and Mosimege (2009); Nicol, Archibald and Baker (2013); Pereira (2011); and Schuck and Brandenburg (2019), who have made great strides towards reforming the teaching and learning of mathematics. These scholars have sought to create positive and encouraging environments for learning mathematics and adopting inventive methods to achieve this goal.

7.4 My Learning from Memory Drawings

I read and re-read the text data and colour coded the words and phrases of the paragraphs the students had written and our conversations' transcriptions. I also scrutinised the drawings and colour coded them, thus making connections with the text data. I used the colours blue, red, purple and green for the different codes, as illustrated in Table 7.1. I then constructed categories and read through the codes and created the themes that recurred in the data. I begin this section by providing examples of the codes and categories.

Table 7.1: Codes and categories emerging form the memory drawings

Colour codes

Categories

Blue	**Red**
Weren't properly taught	Get a hiding
To memorise	Catching a hiding early in the morning
Getting wrong answers	Come get your sweets (hiding)
Mental mathematics/arithmetic	Stick
Struggled with adding and subtracting numbers	
Could not understand the difference between + and – confusing	

Purple Scared to ask the teacher Not to get into trouble Sad whenever the lesson was about to start	**Green** Always worked with my friend Helped each other Grouped for counting Could go play with objects Mathematics corner

The following table summarises the themes that emerged as well as my learnings.

Table 7.2: My learnings from memory drawings

Activities	Themes	Learnings
Memory drawings	Mathematics is too abstract	Maths was abstract, paper based, chalk and talk A lot of rote learning Some sections that were found problematic, e.g., addition, subtraction and division
Discussion of memory work	Corporal punishment	Punished for making mistakes Teachers always using sticks in the classroom Starting a day with a hiding
	An emotionally unsafe learning environment	An environment not conducive to learning To generate discussion related to pre-service teachers' experiences of learning mathematics Learners always fearful
	Co-learning	Learners helping each other Learning together Play with objects Mathematics corner

7.4.1 Mathematics is too abstract

My early schooling experiences as captured in my memory drawing (see Chapter Three) and those of my pre-service teachers, indicate that most of the teachers who taught us in primary school employed teacher-centred approaches when teaching mathematics. I explained how I could not grasp the concept of long division when I was in Grade 3. It also came out in the pre-service teachers' discussion that primary school teachers did not use physical objects when teaching mathematics. Only one pre-service teacher acknowledged using an abacus for addition and subtraction. For the pre-service teachers and myself, mathematics was mostly abstract and involved memorisation, rote learning and a 'talk and chalk' approach.

After the memory drawing activities, as I reflected in my journal about these experiences, I became more aware of an imperative need to debunk the notion that mathematics is difficult and abstract. Björklund and Ahlskög-Bjorkman (2017) argue that mathematics must be taught in a manner that allows for hands-on and prior experiences before it is learnt abstractly. Thus, the memory drawing activities reinforced my responsibility to make a conscientious effort to make mathematics hands-on and understandable by exploring an integrated learning approach. I concur with Allender and Allender (2006), who note that many teachers and teacher educators whose own schooling experiences were negative are passionate about improving their practice. I shall thus aim to provide meaningful experiences for my pre-service teachers and strive to improve my practice by exploring an integrated learning approach in all the mathematics modules that I teach to connect mathematics and the everyday world.

7.4.2 Corporal punishment

Historically, corporal punishment was an integral part of most South African schools (Morrell, 2001). Teachers used corporal punishment for different purposes. The use of 'the stick' was not part of the prescribed curriculum but to control learners regarding obedience and their academic school performance. Govender and Sookrajh (2014) give an account of learners attesting to corporal punishment being inflicted on them because of their inability to spell words correctly, failing to write neatly, or having a torn exercise book. In most schools, corporal punishment was the norm (Govender & Sookrajh, 2014).

Corporal punishment had a damaging impact on education. Morrell (2001) notes that, due to criticisms of this practice, the democratic South African government abolished corporal punishment in 1996. According to Moyo et al. (2014), corporal punishment was superseded by

what was referred to as the Alternatives to Corporal Punishment (ATCP) discipline strategy. The ATCP discipline strategy emphasises the need for positive relations between teachers and learners, recommends disciplinary measures such as verbal warnings, detention, demerits, community work, and small menial physical tasks (Moyo et al., 2014). However, this discipline strategy has not been well received by some South African teachers. Moyo et al. (2014) contend that teachers feel that the government trivialises learner discipline problems in schools.

I was shocked to learn that my pre-service teachers had experienced corporal punishment in their early years of school, just as I had many years before. I was aware that teachers still practised it, but did not realise the severity of this problem, especially after so many years of it being abolished. Payet and Franchi (2008) observe that schools in post-apartheid South Africa have frequently denied the use of corporal punishment, whereas learners have disclosed the constant use of it. Unfortunately, the use of corporal punishment has repercussions for the education of young learners. It is noted by Govender and Sookrajh (2014, p. 2) that "regular beatings of children can lead to their impoverished vocabulary and diminished cognitive ability". Furthermore, corporal punishment has harmful effects on learners' integrity and self-esteem (Payet & Franchi, 2008). Also, the pre-service teachers' memories made me think that another negative consequence of corporal punishment is that it creates an emotionally unsafe learning environment.

7.4.3 An emotionally unsafe learning environment

Learners become emotional and feel unsafe if they are punished or ridiculed for not grasping mathematical concepts. For example, Nano's memory drawing of a learner getting a beating (Figure 7.1) demonstrates how emotionally taxing it was when she was punished for not being able to do subtraction. Likewise, Brady and Bowd (2005) shed light on a study conducted among pre-service teachers at a Canadian university. They recount that some mathematics teachers tend to be "insensitive and uncaring" and that some even humiliate learners in front of their peers when they do not grasp difficult concepts (Brady & Bowd, 2005, p. 38). Correspondingly, in the South African context Phewa (Pithouse-Morgan et al., 2019) illuminates that she found it hard to approach a teacher when she encountered problems that affected her academic performance. This, in my opinion, is indicative of a harmful practice that prevents learners from achieving success if the learning environment does not feel safe and conducive to learning. More importantly, teachers need to show that they care for their learners. Payet and Franchi (2008) give an account of a South African survey that found that learners in

underprivileged schools felt that their teachers did not care about their learning difficulties nor did not understand them. Samaras (2002) claims that there needs to be an affective relationship between teacher and learner as it is associated with cognitive development. Therefore, in my preparation of pre-service teachers to teach mathematics to young learners, I must emphasise the significance of creating a learning environment in which learners will feel emotionally secure.

Bailey (2017) feels strongly that schools need to be safe spaces for teachers and learners. Schuck and Pereira (2011) believe that teacher educators should consider both the affective and the cognitive sides of learning and teaching mathematics because they are intricately linked. They argue that most mathematics educators and teacher educators overemphasise the cognitive aspects of learning mathematics at school (Schuck & Pereira, 2011). Therefore, I believe that also focusing on the affective domain when teaching mathematics may contribute to an emotionally safe learning environment. The work done by Schuck and Grootenboer (2004) in Australia on the affective domain highlights its significance in comprehending mathematics teacher education. Thus, I have to manage the learning of mathematics in the teacher education context by interacting with my students to create an emotionally safe environment so that they could emulate this practice one day. As I work on improving my practice, I endeavour to take cognisance of the affective domain because it involves the fundamental caring aspect that is necessary for creating a safe environment. This aspect is congruent with the integrated learning approach and the sociocultural perspective. It emphasises the holistic view of acquiring knowledge and bringing the real world into the classroom (Adamu, 2003).

7.4.4 Co-learning

I was inspired when I discovered that Zukiswa had learnt together with a friend and that they had helped each other to grasp mathematical concepts. Samaras (2002) asserts that the Vygotskian sociocultural perspective allows pre-service teachers to develop their understanding by interacting with others. She refers to how individuals learn with others and through joint undertakings (Samaras, 2002). The memory work activity allowed me to learn from my pre-service teachers. As I moved forward with my work as a teacher educator, I acknowledge that I have learnt a lot and am still learning from working with pre-service teachers. I embrace learning as a two-way process and hope to engage my pre-service teachers more intensely in the process of co-learning.

Designing group activities to provide pre-service teachers opportunities to learn together seems to be crucial in early childhood mathematics teacher education. According to Trauth-Nare, Buck, and Beeman-Cadwallader (2016), education is a social and interactive phenomenon that fosters relationships among people. I aim to create opportunities for my pre-service teachers to learn collaboratively towards an understanding of an integrated learning approach in mathematics teaching. McGlynn-Stewart (2010) reports that students' positive reflections indicated that working with their peers collaboratively could be both efficient and helpful. Samaras (2002, p. 123) highlights the importance that pre-service teachers should "experience collective cognition to construct knowledge in partnership with others in coursework". I observed how the memory work activity developed collaborative learning when the pre-service teachers shared their mathematics learning experiences. My goal now is to set high expectations for them and myself. I believe that engaging in collective activities will enhance mathematics learning, especially when it occurs using an integrated learning approach.

7.4.5 Summary of my learning from memory drawings

Memory work activities afford teachers and teacher educators opportunities to reflect on how they were taught and how they learnt so that they will think about the operational practices that will be beneficial to their learners. Drawing activities are particularly appropriate for Early Childhood teachers when they explore childhood memories. Foundation phase pre-service teachers are expected to expose learners to creative arts. They learn different art forms to develop their fine motor skills, creativity and other knowledge and skills. This helps them understand the value of creative arts to engage learners to participate in creative activities (DBE, 2011b). The introduction of these creative activities is essential in refining and controlling gross and fine motor skills.

The memory drawings helped me to gain a better understanding of my negative experiences and my pre-service teachers' insights into their encounters with mathematics so that I can, in the future, instil optimism in my learners. Korthagen (2017, p. 393) points out that in teacher education reflection is an essential foundation of teacher learning. The memory drawing activity made me more conscious that I need to consider pre-service teachers' thinking and feelings about teaching and learning. I am also aware now that I must take into account my pre-service teachers' prior knowledge and experiences. I hope that they will emulate this in their classrooms one day.

In some respects, I realise that not much has changed in the post-apartheid schooling system regardless of the South African government's efforts to improve and transform education. During the apartheid era, the education system was "racially and ethnically fragmented, dysfunctional and unequal" (Cross, Mungadi, & Rouhani, 2002, p. 172). One of the design features of curriculum reform in South Africa was to promote a learner-centred pedagogy (Harley & Wedekind, 2004). Correspondingly, Mwakapenda (2008) asserts that the new South African curriculum offers teachers and teacher educators opportunities to view mathematics in ways that present this subject as a discipline that has connections within itself and with other disciplines. I thus assumed the pre-service teachers would have learnt mathematics as set out in the current prescribed curriculum. On the contrary, most of them reported that their primary school teachers had used teacher-centred methods and had encouraged rote learning. Such experiences resemble what Pereira (2005, p. 70) noted in the United States of America about how "unexciting," or "uninspiring" the learning of mathematics had been for his pre-service teachers when examining their personal experiences. Negative experiences of learning mathematics raise opportunities for teacher educators to learn and embark on using innovative and appropriate pedagogies.

7.5 Playing Board Games with Pre-Service Teachers

Our discussions on memory drawings made it clear that both the pre-service teachers and I felt the importance of talking about these experiences so that they would not be repeated in our classrooms. These discussions were meaningful. I appreciated that if I did not address these negative experiences they might have an undesirable effect on my work as a teacher educator. Sharing their experiences allowed me to understand my pre-service teachers' struggles when they had to master mathematics, and it showed me how I could improve my practice. In the extramural activity sessions that followed, I responded to the pre-service teachers' memory work by engaging them in playing different board games. According to Davis and Maistry (2017), games are educational and develop an active learning environment that promotes students' motivation and curiosity. I wanted to stimulate my pre-service teachers' in mathematics teaching by using games to enhance their learning.

I applied for and received funding from the University Capacity Development Programme (UCDP) at my institution funded by the Department of Higher Education (DHET). The main focus of the UCDP is on academic staff and student development. Through the UCDP funding, I was able to purchase the different board games that we played. As mentioned above, I worked

with 12 pre-service teachers who had volunteered to participate in the extramural activities project.

It was a remarkable experience to engage my pre-service teachers in playing board games with the goal of considering the significance of games in the learning environment. Bragg (2012) argues that games have specific mathematical cognitive objectives, are enjoyable, and can engage players' interest. They are governed by a set of rules and require skill and strategy (Bragg, 2012), and are associated with recreation, competition, enjoyment, and many other similar and related philosophies (Pradhan, 2018). When used effectively, games can also assist teachers in creating a teaching environment that is conducive to learning. My aim was to model these activities to inspire my pre-service teachers to teach mathematics in a fun and exciting manner.

During the extramural activity sessions, we played the following board games: *scrabble*, *chess*, *Ludo,* and *30 Seconds* (Figure 7.5). I now provide a brief description[14] of each game and explain what transpired during the game playing sessions.

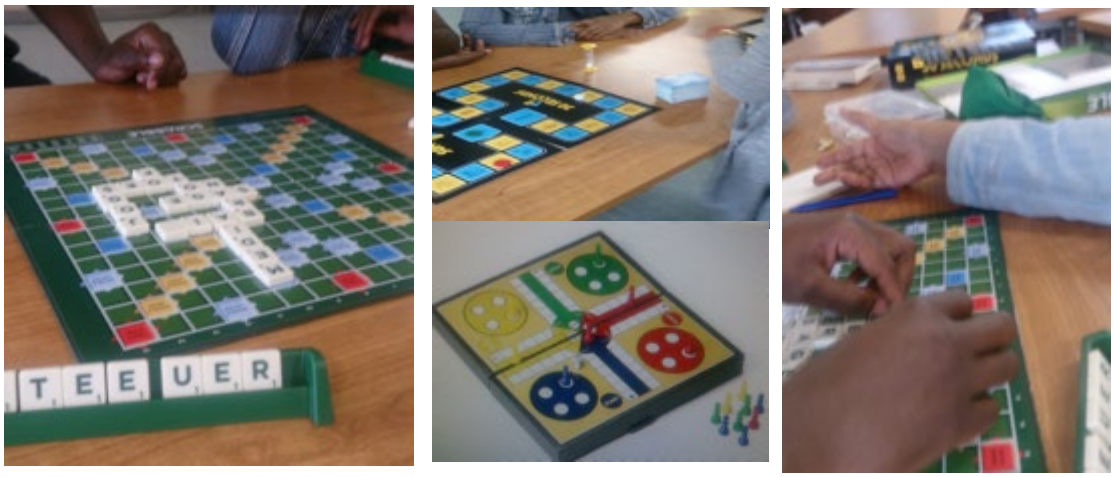


Figure 7.5: Pre-service teachers playing board games

[14] The pictures and the descriptions of the games were sourced from the Internet:
https://en.wikipedia.org/wiki/Chess
https://za.pinterest.com/search/pins/?rs=ac&len=2&q=board%20games&eq=board%20game

Scrabble

Figure 7.6: Scrabble board game

Scrabble is a word game in which two to four players score points by placing tiles onto a game board to form words. Each tile bears a single letter and the game board is divided into a grid of squares. The tiles must form words that, in crossword fashion, read left to right in rows or downward in columns, and be included in a standard dictionary. In an English language set, the game contains 100 tiles, 98 of which are marked with a letter and a point value ranging from 1 to 10 and two blank tiles. The board is marked with "premium" squares, (triple-letter/word and double-letter/word squares), which multiply the number of points awarded. At the beginning of the game, each player draws seven tiles from the bag and places them on their rack, concealed from the other player(s). The first player begins the game by placing a word on the star square at the board's centre, either horizontally or vertically. The second player and then each player in turn plays by adding one or more tiles already on the board to make new words. The game ends when all the tiles have been drawn and one of the players has used all the tiles in their rack; when all possible plays have been made; and all players have passed twice in consecutive turns. When the game ends, each player's score is reduced by the sum of their unused letters. In addition, if a player has used all the letters, the sum of the other players' unused letters is added to that player's score. The player with the highest score wins.

We started with the game of scrabble. Not all the students knew how to play scrabble. I began by describing the game and explaining how it was played. I then divided the students into two groups because I had two scrabble board games. Each group consisted of six players. As the game requires four players, I asked other students to play in pairs. In the beginning, I focused on getting them to form common words as they appear in a standard English dictionary. I

reminded them that words such as nouns, adjectives, and adverbs were allowed. I moved between the two groups, guiding them. One group grasped the game quickly. So, I spent more time with the other group who was struggling a bit. They sometimes made unpermitted words such as proper nouns, for example, Toyota. They also battled with placing a complete word parallel to a word already played so that adjacent tiles also formed whole words.

The next time we played, I also took part and paired with one student. While we played, I emphasised that they should try to get a high score. I explained that they needed to consider the value of the letters they were using and the premium squares onto which they formed each word. For example, if I had letter 'm' which has a value of three, and letter 'f' with a value of four, I should try to place these letters on premium squares so that that letter or word can be doubled tripled.

I observed that the students' English vocabulary improved with every game. The scores were rising, showing that they were now strategising and thinking carefully when composing the words. They were developing new strategies and mathematical calculations by considering placing the tiles in double or triple word or letter score squares on the scrabble board. They were also using their tiles with high letter scores wisely. Before, they would just make words and did not think about the highest score that they achieve. The pre-service teachers tried very hard to use all the tiles. As they played continuously, few tiles remained at the end of the game, which showed that they were gaining confidence. The pre-service teachers enjoyed themselves, cracking jokes as they were playing. Interestingly, I also found myself enjoying this time with the students.

Chess

Figure 7.7: Chess board game

Chess is a board game for two players. It is played on a square board comprising 64 smaller squares with eight squares on each side. Each player starts with sixteen pieces: eight pawns, two knights, two bishops, two rooks, one queen, and one king. Each piece type moves differently, with the most powerful being the queen and the least powerful the pawn. The goal of the game is for each player to try and checkmate the king of the opponent. Checkmate means the king is vanquished as he can make no further move. It ends the game. During the game the two opponents take turns to move one of their pieces to a different square of the board. One player (White) has pieces of a light colour while the other player (Black) has pieces of a dark colour. There are rules about how pieces move, and about taking the opponent's pieces off the board. If a move is made which attacks the opposing king, that king is said to be 'in check'. The player whose king is 'checked' must make a move to remove the check. The options are: moving the king, capturing the threatening piece, or moving another piece between the threatening piece and the king. If the player whose king is in danger cannot do any of these things, it is checkmate, and the player loses the game.

Chess was the second game that we played. Only one student knew how to play chess. The other students had heard of this game but had never played it. In teaching this game, I started by describing the names of the pieces. I then did a demonstration by playing with the student who knew the game. As we were playing, I would explain the movement of each piece. When playing chess, I noticed that some students were not very keen as they found it complicated. I remember seeing one student taking notes while I explained the different pieces' names and how they could move. After playing for a while, the students asked to play the scrabble game. Realising that they wanted to play scrabble all the time in the sessions that followed, I made it a point to teach them a new game and then give them time to play scrabble. I wanted them to learn how to play other games so they could teach them to their learners for the acquisition of a range of mathematical concepts. I played with the students all the time.

Ludo

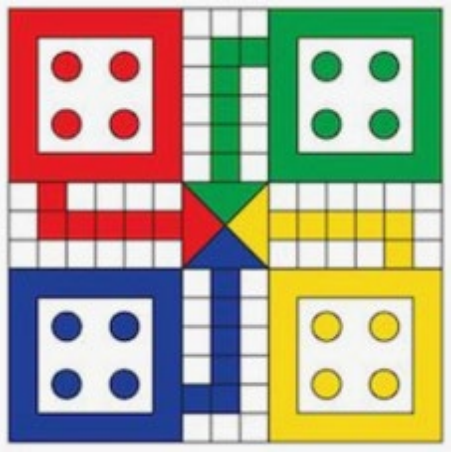


Figure 7.8: Ludo board game

Ludo is a strategy board game played by two to four players. Each player is assigned a colour and has four tokens. In this game, the players race their four tokens from start to finish according to the roll of a single dice. At the beginning of the game, each player's four tokens are out of play and staged in the player's *yard* (one of the board's large corner areas in the player's colour). Each player rolls the dice and the highest total begins the game. When able to, the players will enter their tokens one per turn on their respective starting squares and proceed to race them clockwise around the board along the game track (the path of squares not part of any player's home column). There are no 'safe' squares on the game track, which protects a player's tokens from being returned. A player's home column squares are always safe as no opponent may enter them. When reaching the square below his home column, a player moves tokens up the column to the finishing square. Rolling a single dice controls the tokens' swiftness, and entry to the finishing square requires a precise roll from the player. The first to bring all their tokens to the finish wins the game. The others often continue to play to determine second, third, and fourth place finishers.

The *Ludo* game was the third game that I played with the students. Two students knew how to play *Ludo*. They reminisced about how they had enjoyed playing this game when they were children. I divided the students into three groups. The two students and I taught the students in each group. The other students were more interested to learn how the game was played than playing it themselves. I noticed that some students were bored. They felt that it was for young children than for adults. However, they played anyway. I emphasised that even though we might not play it often, they needed to learn it to teach their learners how to play it one day.

For me, the exposure and the mathematical skills they acquired and could teach their learners one day were crucial.

30 Seconds

Figure 7.9: 30 Seconds board game

The *30 Seconds* board game was the last game I taught my pre-service teachers. As its name suggests, *30 Seconds* is a quick-thinking, fast-talking description board game based on general knowledge. It requires two or more teams. The game consists of 240 cards (2 400 names), 1 game board, 1 thirty-second timer, 1 dice (numbered 0, 0, 1, 1, 2, 2) and 4 playing tokens. Members of each team take turns to pick a card and describe the names on the card to their teammates (not the opposition) in 30 seconds. The person describing what is on the card cannot say the actual names on the card (or their derivatives). However, the names can be described in singsong, humming and in any order they choose. Their own team members have to guess and figure out these answers from what is described. Each team must roll a dice that only has 3 numbers (0, 1 or 2), where the number rolled will be subtracted from the number of correct answers a team member gets. Then, the team moves a turn on the board according to the number of correct answers. The game's objective is to see who will get to the finish line first, which will be dependent on fast thinking and the ability to give descriptions.

None of the students had played the *30 Seconds* board game or even heard of it. The content of this board game is based on names and topics that many people will be familiar with, such as names of celebrities and famous people from film, music, sport, politics (only a few), places, songs, bands, books, TV, movies, shops, brands, etc. Some names are more obscure than others, but most will be known by the average person in the street.

The students were interested to learn the *30 Seconds* game. However, this game was challenging for them. I noted that some were not familiar with the content that is perceived to be general knowledge. For example, a card will list names or terms such as: *The SPCA, Naomi Campbell, Milan, Ray McCauley,* or *Cry The Beloved Country.* It was difficult for a student who had never read about supermodels or seen them on TV to know about Naomi Campbell. I reckoned that some struggled and some were better at the game because they had had different schooling experiences and backgrounds. Some of them came from rural areas where they were not exposed to the mass media or current affairs. As a result, we played this game only once.

The choice of games was not arbitrary. I chose these games because they link well with the integrated learning approach. For example, in the *scrabble* game, the letters on the tiles used for making words relate to the Language learning area. The numbers representing the score values in each letter connect with mathematics. The words that are formed characterise our real-life situations. The game of *chess* relates to language regarding the vocabulary and spelling of each piece (e.g., knight, pawn, etc.). The way the pieces move correlate with mathematics. For example, the bishop moves diagonally. Regarding the Life Skills learning area, learning about history and wars exemplifies how to avoid weaknesses in one's own position and how to create and exploit such weaknesses in an opponent's position. The different shapes, squares, triangles and circles on the *Ludo* board are representative of the content area 'space and shape' in mathematics. Communication and turn-taking when playing this game relate to the Language and Life Skills learning areas. The *30 Seconds* game connects with mathematics in terms of the limited time available to give an answer. The use of language in providing descriptions of the words on the cards and the names of TV series, movies, people, countries, etc., links with the Language and Life Skills learning areas.

7.6 Benefits of Playing Board Games

There are many advantages to incorporating games when teaching pre-service teachers. Nkopodi and Mosimege (2009) believe that some of the skills, such as problem solving, may be very basic, but they aid in the development of mathematical concepts. Pre-service teachers need to experience such activities for them to see that it is doable. Hopefully, one day they will involve their learners. Fletcher (2012) argued that he considered amending sports programmes to create a particular pedagogy for pre-service teachers. However, Ramani et al. (2012) warn that playing board games can be challenging because it requires relatively advanced social and emotional skills.

I believe that games improve problem-solving skills as such skills are developed as students think through strategies, think ahead, and evaluate their choices or moves. According to Charlesworth (2012), games can also be related to cultural customs. Board games provide an excellent way to teach mathematics (Charlesworth, 2012). Games also offer opportunities for developing social skills such as cooperation and following rules. As noted by Samaras (2002), I understand that our students' social context is changing. I thus tried innovative ways to stimulate my pre-service teachers' interest in learning mathematical skills. Nicol (2011, pp. 45-46) claims that "when introduced to alternatives to ways they previously learnt mathematics, many teacher candidates worry that they do not yet have the necessary mathematical knowledge or teaching experience in order to teach differently". I felt the same about my pre-service teachers and sought to provide them with positive experiences to learn mathematics.

The literature (Nkopodi & Mosimege, 2009; Ramani, Siegler, & Hitti, 2012; Charlesworth, 2012; Davis & Maistry, 2017) on games discusses some mathematical skills that could be enhanced through playing board games. These are summarised in Table 7.3.

Table 7.3: Mathematical skills associated with playing board games

Game	**Mathematical skills**
Scrabble	Exercising addition and subtraction skills Spelling skills, letter recognition and reading Strategising, evaluating probabilities Positive effects on cognitive abilities
Chess	Improves concentration and memory Enhances reading and mathematics skills Fosters logic, critical thinking and creativity
Ludo	Number concept development – counting, numerical estimation and number comprehension Reinforces concepts of grouping, colours and shapes Creative ways of solving problems
30 Seconds	Counting, adding, subtracting, timing, values, vocabulary

Other skills

Taking turns, basic skills such as adding, tallying up scores, mental agility – exercising the brain

Social benefits, helps foster communication, builds self-confidence, a way for students and teachers to expand the repertoire of patterns, decision making and logical reasoning, deductive skills.

Fletcher (2012) focuses on the Teaching Personal and Social Responsibility (TPSR) curriculum framework, which he drew from Hellison (2003). This framework emphasises social and emotional development through physical activity. In my quest to improve my practice using games, I invented the term "playing games for understanding mathematics" (PGFU) to convey my approach, which is informed by Fletcher's "teaching games for understanding" (TGFU).

Journal entry – 6 September 2018

I was delighted to see the students attending all the extramural sessions. They seemed very interested, which made me happy and hopeful that something good would come from these activities. I felt like I was able to reach out to them. I understood their struggles and got to know them better. I was pleased to observe the comradery that developed as the students were learning from each other. The spirit of teamwork drew them close together. I saw this when one student struggled to form words in the scrabble game and how the others helped him. They taught each other. When he improved, one student commended him. I was excited to see them having fun, laughing and cracking jokes. For me, this collaboration was exceptional. We got close, and even when we met outside this space in corridors, we would chat a bit. I'm hoping to continue with these activities and involve more students and more games.

Retrospective reflection – 3 May 2019

The more I interacted with the students in extramural activities, the more I realised how sensitive I need to be. It is essential that each student enjoys the games and feels comfortable choosing the games they want to play. I honestly believe that incorporating games can inculcate some optimism in pre-service teachers. In the future, hopefully, the Foundation Phase learners' levels of mathematics will have developed when they finish primary school

because they will have been taught by teachers who are positive, caring, and make every effort to make mathematics fun.

7.7 My Learning from Playing Board Games with Pre-Service Teachers

I drew on my journal entries and observations about playing board games. I read and re-read the text and colour coded the words and phrases I categorised using blue, red, purple, and green. Figure 7.10 below illustrates an example of the process that I followed. I then developed the themes. Table 7.4 below captures the themes and my learnings.

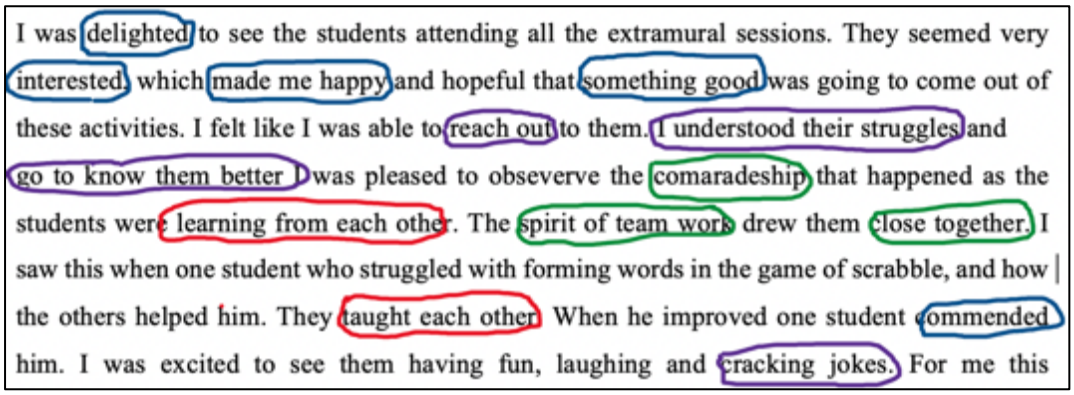
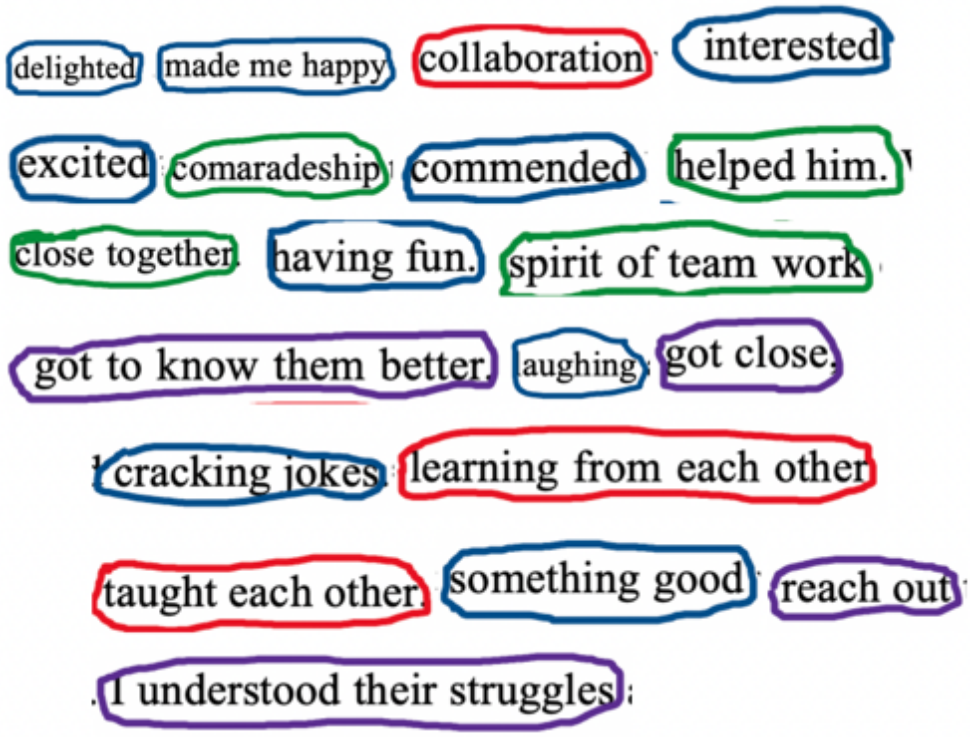

I was delighted to see the students attending all the extramural sessions. They seemed very interested which made me happy and hopeful that something good was going to come out of these activities. I felt like I was able to reach out to them. I understood their struggles and go to know them better I was pleased to obseverve the comaradeship that happened as the students were learning from each other. The spirit of team work drew them close together. I saw this when one student who struggled with forming words in the game of scrabble, and how the others helped him. They taught each other When he improved one student commended him. I was excited to see them having fun, laughing and cracking jokes. For me this

Table 7.4: Codes and categories – Board games

Colour codes



Categories			
Green	Blue	Red	Purple
comradeship	excited	collaboration	got close
helped him	interested	taught each other	reach out
close together	having fun	learning from each other	understood their struggles
spirit of teamwork	laughing		got to know them better
	delighted		
	made me happy		
	something good		
	commended		
	cracking jokes		

Table 7.5: My learnings from board games

Activities	Theme	Learnings
Playing board games: scrabble, chess, Ludo and 30 seconds	Team spirit	Spirit of teamwork Students complimenting one other Helping one another Close together Comradery
	A playful atmosphere and enjoyment	Creating space for making learning fun Excitement Cracking jokes Laughing Delightful Teacher educator enjoying this time with pre-service teachers
	Co-construction of knowledge	Peer collaboration Peer teaching Learning from each other
	Knowing pre-service teachers	Getting close Reaching out Understanding their struggles Getting to know them better

7.7.1 Team spirit

By engaging my students in different board games, I created a conducive learning space outside the formal learning environment (classroom). At our first meeting, I explained to the pre-service teachers that the extramural activity sessions were informal. At the beginning of our discussion, I used both English and IsiZulu so they would feel comfortable. It was inspiring to see how the pre-service teachers exuded team spirit. As they played games, they helped and complimented each other. I remember noting in my journal how the spirit of teamwork drew them close together. In light of the sociocultural perspective through which the embodiment of pedagogy is strongly activity-based, I saw myself as a mediator and not a dispenser of knowledge (Laridon et al., 2011). We played together, laughed and cracked some jokes. When communicating with each other, the pre-service teachers used both English and IsiZulu. An avenue was created for the pre-service teachers to express themselves freely and comfortably using their preferred language. Laridon et al. (2011) argue that language is an essential feature of culture and is used when playing games. The integrated learning approach demonstrates that language is used when teaching mathematics.

7.7.2 A playful atmosphere and enjoyment

The theme "A playful atmosphere and enjoyment" exemplifies the teaching of mathematics in a fun way. According to Pradhan (2018), games are connected with recreation and enjoyment. However, Schuck (2009, p. 119) argues that "having fun in the mathematics classroom" should not be at the expense of developing deep conceptual understandings. The Foundation Phase classroom demands a playful atmosphere. Hence, Ramani and Eason (2015) claim that pre-service teachers need to be taught how to integrate play into early childhood mathematics classrooms. As the integrated learning approach focuses on making connections with real life, we as human beings learn better in a playful atmosphere. I support Ramani and Eason (2015), who assert that play and mathematics learning should be mutually inclusive, especially in Foundation Phase classrooms. As I engaged my students in extramural activities, I considered the advice of Mercer and Sams (2006) about the importance of social involvement as a critical factor for individual development. I thus developed a playful atmosphere in these sessions. I anticipate advancing the playing of games to foster a deeper conceptual understanding of mathematics and engender my students' enthusiasm.

By using games, challenging concepts can be simplified for a better understanding as learners are very interested in playing games (Pradhan, 2018). I believe that these activities can help me

establish an enhanced teacher education environment, making learning of mathematics thought-provoking. According to Davis and Maistry (2017), playing board games allows for vibrancy and interactivity that result in students becoming more engaged in lessons. Moreover, the sociocultural perspective spurs collaboration and interaction between teachers and students. Hausfather (1996) notes the importance of teacher educators understanding the interaction of the social context with cognitive development in the "construction of mathematical knowledge and understanding" (p. 7). I was also influenced by Schuck and Pereira's (2011) ideas about innovating and invigorating mathematics teaching in the teacher education field. I hope that my pre-service teachers will, in turn, help their learners to love mathematics through playing games.

7.7.3 Co-construction of knowledge

As teacher educators, we must allow our pre-service teaches to learn with others to construct their knowledge. Davis and Maistry (2017, p. 37) believe that there is a need to "move beyond constructing students as note-takers towards creating active learning environments". This notion implies that teacher educators should provide pre-service teachers with opportunities to work in groups to learn from and teach one another. According to Alderton (2008), pre-service teachers "need to engage in groups and exploratory work in order to develop relational understanding" (p. 97). If pre-service teachers are provided with meaningful contexts, they will tackle problems and use their skills to apply their mathematical knowledge. Likewise, Schuck (2011) points out that mathematics educators should understand that students acquire more mathematical skills better when they are actively involved. I thus learnt from my pre-service teachers by actively engaging with them as they were both teaching and learning collaboratively. These extramural activities offered the pre-service teachers the opportunity to be at the centre of the learning process and actively construct knowledge.

7.7.4 Knowing pre-service teachers

The importance of understanding pre-service teachers in efforts to support their learning was emphasised in this self-study research. Samaras (2002) argues that teacher educators need to understand pre-service teachers' backgrounds and experiences to assist them in their learning. As we spent more time playing board games, I got to know my pre-service teachers better. Schuck (2011) argues that pre-service teachers' sense of security and being understood can help them develop competences in mathematics. I found that learning about myself engendered a greater understanding of my pre-service teachers' learning. Kitchen (2016) acknowledged

many limitations of teacher-centred methods in teacher education by reflecting on his experiences as a pre-service teacher. This is in keeping with the sociocultural perspective, as Hausfather (1996) concedes that teacher education should prepare students to create better social environments in their classrooms. Therefore, my interactions with my pre-service teachers during the extramural activities was my way of reaching out and getting closer to them.

7.7.5 Summary of what I learnt by playing board games with my pre-service teachers

I wish to continue to provide my future pre-service teachers with informal learning opportunities outside the classroom where their learning will blossom. I discovered much about student-centred teaching and learning and the integrated learning approach by using board games. Games are useful for developing positive social attitudes and exploring critical social behaviours. Bose and Seetso (2016, p. 2) propose that "a combination of systematic instruction methods and game-based learning can increase the effectiveness of the curriculum". I am now more conscious of how such alternative ways of teaching mathematics in the Early Childhood phase can stimulate teacher educators and pre-service teachers, which is a view that underscores the integrated learning approach. If I prepared my students well to incorporate games into their mathematics teaching, they would be highly competent and confident to apply this method in their classrooms. Nevertheless, I am aware that I need to carefully consider which games are appropriate for introducing and enhancing mathematical concepts. I also need to demonstrate clearly what mathematical skills are embedded in a particular game and for what reasons the game will be beneficial to pre-service teachers. In other words, if the game strengthens mathematical knowledge and social development, it is appropriate.

7.8 Conclusion

As a teacher educator, I learnt that focusing solely on pre-service teachers' cognitive development is insufficient. In my endeavours to provide my students with meaningful experiences of learning and teaching mathematics, I need to be consciously aware of my objectives so that I do not revert to my own teachers' teaching methods. By modelling innovative and appropriate practices, I hope that my pre-service teachers will be better equipped to teach their young learners in fun and child-friendly ways.

The sociocultural theoretical perspective allowed me to venture into self-study methods that sought to evoke my memories and students' learning and improve my practice as a teacher

educator. I shall thus continue to engage in memory drawing to encourage my students to consider their future learners' social and cultural backgrounds so that these young children can gain formative experiences of learning mathematics. My goal is to incorporate my pre-service teachers' daily lives into my teacher education practice to enhance mathematics activities and understanding of mathematical concepts. I hope to build on this self-study by offering my future pre-service teachers opportunities to reconsider their early learning of mathematics and re-envision their own future teaching practices.

Through this self-study, I understood more about effecting change to better understand mathematics teacher education and my own practices as a teacher educator. Dinkelman (2003) maintains that self-study promotes knowledge production and development to help create change in teacher education courses and pedagogy. I frequently reflected on my practice and thought about guiding pre-service teachers to better understand mathematics. My future challenge will be to help my students create their own innovative teaching methods and support them in their learning. I shall continue to enrich my practice and abilities to improve my pedagogy through self-study, memory drawing, and integration, which I think are practices that support one another. As I share my efforts and successes, I hope that others who intend to improve their pedagogy through self-study will also explore arts-based methods, memory drawings, and integration to help pre-service teachers interrogate their schooling experiences. I believe that in this manner, those understandings will impact and improve pedagogy.

In the following chapter titled '*Putting my head under the water'*, I describe my critical friends' role and contributions throughout my study. I bring to light my collaborations with different groups in diverse spaces. I explain how I presented my self-study research as a work in progress and uncovered my learning in the process.

CHAPTER EIGHT: PUTTING MY HEAD UNDER THE WATER

The agentive mind is not only active in nature, but it seeks out dialogue and discourse with other active minds… We learn an enormous amount not only about the world but about ourselves by discourse with others.

Jerome Bruner

8.1 Introduction

The purpose of this self-study research project was to improve my teacher education practice by exploring an integrated learning approach in an undergraduate early childhood mathematics module at a higher education institution. In Chapters Four, Five, Six and Seven, I revealed how I planned and explored the integrated learning approach with different groups of pre-service teachers. I described the activities in which I engaged the pre-service teachers to address the research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* I highlighted my significant learnings by elaborating on how these learnings influenced my teaching and future plans. I learnt about the value of enacting change to improve my practice. I discovered that my initial formal learning of mathematics was, in some ways, similar to those of my pre-service teachers. We learnt mathematics in a fragmented way that did not stimulate our interest. I also learnt that corporal punishment was regularly applied and created a climate of fear in many schools. As I continuously reflected on my practice, I sought ways to help my pre-service teachers understand the teaching of mathematics in early childhood better as my aim was to support their learning.

This chapter is titled *Putting my head under the water,* which is a metaphor that signifies my feelings when I was presenting my work to colleagues who were, for the sake of this project, my critical friends (CF). When you swim and put your head under the water, you cannot breathe or see clearly, but you can swim much more efficiently in this position. Presenting my work to be critiqued by colleagues was not an easy thing to do, but, at the same time, I could learn by listening to advice from other people. As Bruner states, "the agentive mind is not only active in nature, but it seeks out dialogue and discourse with other active minds… We learn an enormous amount not only about the world but about ourselves by discourse with others" (1996, p. 93). In my quest to become an agent of change, I embraced opportunities for conversation and discourse with others to learn even more.

This chapter addresses my third research question: "*What can I learn about cultivating an integrated learning approach (ILA) from working with critical friends?"* I begin by describing the critical friends portfolio. I explain my interaction with different people in various spaces to learn and improve my teaching the early childhood mathematics module to pre-service teachers. I elucidate my critical friends' contributions throughout my study. Further, I explain how I presented my data and findings to various groups during my research project. I conclude this chapter by revealing my learnings from my engagement with critical friends.

8.2 My Critical Friends Portfolio

I constructed a portfolio as part of my self-study methodology, which I refer to as the "Critical Friends Portfolio" (CFP). According to Samaras (2011), a critical friends portfolio helps the self-study researcher use opportunities to articulate goals, decide on inquiry, and document development collaboratively with colleagues whose criticisms are valued. Self-study researchers use such a portfolio to collect evidence of presentations and comments from trusted colleagues. Samaras (2011, p. 90) writes that a portfolio "helps the researcher to reflect upon your research focus over time, and with the support of your peers, it can assist you in considering and sorting out the dilemmas you notice in your teaching". These interactions with critical friends need to happen regularly.

Moreover, the role of critical friends is an integral part of establishing trustworthiness. Schuck (2002) claims that critical friends' importance in interpreting data and evaluating the different viewpoints that surface when pre-service teachers and colleagues are involved cannot be overemphasised. It was thus necessary to continually share my work and make it public by including critical friends. I received invaluable support from critical friends whose opinions I respected. Their input challenged my thinking and renewed my hope of improving my teaching practice.

I presented my work to a group of people comprising colleagues in teacher education and other higher and early childhood education stakeholders. Schuck and Brandenburg (2020) explain that critical friends may be from the same or different disciplines, or they may be colleagues and peers at different phases in their profession. I began by presenting my work to such friends when I started developing my research proposal, which was just after I had registered for my doctoral studies in 2016. I audio recorded the discussions and transcribed them at a later stage.

As Lovin et al. (2012) highlight, while self-study is mainly a personal inquiry, there is much gain from working with others who can help researchers look at their work from different viewpoints. Correspondingly, Ritter and Hayler (2019) argue that critical friends facilitate an openness to review and advance understandings for improving teacher education practice. Samaras (2002) claims that Vygotsky's sociocultural theory helped her to understand her ideas about learning through interaction with others. During my self-study journey, I presented my work at national conferences as well as to a self-reflective research support group at the institution where I work. Instead of giving names to the critical friend (CF) participants, I use CF 1, 2, 3, etc. Table 8.1 below summarises the different platforms where I presented my work.

Table 8.1: My presentations to critical friends

Date	Presentation	Critical Friends (CFs)
18 May 2016	University of Zululand (UniZulu) Teaching and Learning Conference	CF 1 to CF 3
24 June 2016	Self-reflective research support group	CF 4 to CF 9
22 October 2016	South African Educational Research Association (SAERA) National Conference	CF 20 to CF 25
26 May 2017	Self-reflective research support group	CF 10 to CF 12
11 May 2018	South African Research Association for Early Childhood Education (SARAECE) Conference	CF 34 to CF 35
18 May 2018	Self-reflective research support group	CF 13 to CF 16
23 October 2018	SAERA Conference	CF 26 to CF 29
10 May 2019	Self-reflective research support group	CF 17 to CF 19
24 October 2019	SAERA conference	CF 30 to CF 33

8.3 Self- Reflective Research Support Group Meetings

I joined the self-reflective research support group after registering for my doctoral studies. This group was located at my university, but researchers from other local universities also attended. The self-reflective research support group has been meeting monthly for several years to provide support and feedback to researchers who are using self-reflective methodologies. My supervisor, who is the Chair, introduced me to this group. She worked in collaboration with two other mentors who supported us as self-study researchers and early career academics. I realised early that my journey might be fraught with difficulties, but I was not alone because I was working with critical friends. According to Schuck and Pereira (2011), critical friends offer opportunities to disrupt our thinking in a non-threatening way. My view is that their role is to point out the 'blind spots' we have or the vital issues that we may have missed. I received advice and comments from critical friends when I presented my work while it was in progress. In the following section, I elaborate on my interaction with critical friends from the self-reflective research support group meetings.

Table 8.2: Engagement with critical friends at the self-reflective research support group meetings

Critical Friends	Engagement with Critical Friends
CF 4 to CF 9	Self-reflective research support group meeting 1 (24 June 2016)
CF 10 to CF 12	Self-reflective research support group meeting 2 (26 May 2017)
CF 13 to CF 16	Self-reflective research support group meeting 3 (18 May 2018)
CF 17 to CF 19	Self-reflective research support group meeting 4 (10 May 2019)

8.3.1 Self-reflective research support group meeting 1 (24 June 2016)

I presented my work for the first time at a self-reflective research support group meeting on 24 June 2016. During this time, I was at the proposal stage of my research project and piloting an integrated learning approach with the first group of pre-service teachers (described in Chapter Four). I was nervous at the start of my presentation. However, I soon felt at ease when I read the group members' welcoming body language when I was presenting. Some were nodding

their heads, showing that they agreed with what I was saying. Their positive reception gave me confidence. This presentation was crucial as I was still developing my proposal about exploring the integrated learning approach in teaching the early childhood mathematics module. I was hoping to get some direction to establish whether I was on the right track with what I had planned. Samaras (2011) contends that critical friends are navigators who help redirect you to reach your final destination. She states: "They perform the role of a GPS [global positioning system] navigator for your writing" (Samaras, 2011, p. 103). I was optimistic that the critical friends were going to direct on the right path.

In my presentation, I stated that my primary expectation of exploring an integrated learning approach was to improve my teaching practice in early childhood mathematics teacher education. I anticipated that an integrated learning approach might stimulate pre-service teachers' thinking to see connections among all the learning areas and the mathematics learning area. I referred to a pioneering pedagogic approach used in Finnish schools called "phenomenon-based learning" (PBL). I highlighted that, in applying this approach, teachers choose topics that connect to their learners' background knowledge and personal experiences (Strauss, 2015). Phenomenon-based learning is not aimed at replacing conventional subject-based teaching, but at broadening children's view of the world and understanding of themselves. I argued that, by exploring an integrated learning approach in the early childhood mathematics module, I was going to select topics that would focus on integrating concepts and ideas across learning areas to ensure knowledge and skills acquisition. Therefore, I argued that my pre-service teachers needed to be equipped with the knowledge and hands-on experiences of how integration across learning areas could be operationalised.

I highlighted the four aspects of integration: integration of concepts within the Mathematics learning area where the numbers aspect, for example, can be integrated with the content area of patterns or geometry; integration of Mathematics with the Language learning area; integration of Mathematics with the Life Skills learning area; and connection making (which refers to a holistic view of learning areas and subject content). I highlighted that Foundation Phase teachers teach all three learning areas: two languages (Home and First Additional), Life Skills, and Mathematics. The Language learning area is the foundation of all other learning areas. The Life Skills learning area cuts across subjects that should support and strengthen other core Foundation Phase learning areas. I explained that learners and pre-service teachers should be guided to see the interconnectedness and interrelationships among the learning areas. To

improve my practice in preparing pre-service teachers for an integrated learning approach, I opted for a self-study research approach. I explained that I intended to use three self-study methods: arts-based self-study method, personal history narratives, and a developmental portfolio. I was optimistic that these self-study methods would help me study how my personal history and lived experiences influenced my teaching.

I described how I would document everything that I thought would generate data and enhance the research's trustworthiness. One way to do this was to augment the data in the developmental portfolio with my reflections in the critical friends portfolio. I indicated that I would reflect on my interactions with the pre-service teachers and the execution of the activities by creating collages and concept maps and developing learner activities to assess my students' understanding of an integrated learning approach. I informed the audience that audio recordings would be made to access lessons and discussions with colleagues and enhance my knowledge of the study participants' perspectives. I explained that I would be able to provide detailed analyses and interpretations of my experiences as a teacher educator.

After my presentation, I received comments and questions.

Questions and Comments (CF 4 - 9)

Critical friend (CF) 4 asked whether the integrated learning approach was an established approach or an experimental approach in South Africa. My close perusal of the relevant policy documents helped me articulate that an integrated learning approach is emphasised in the current prescribed curriculum for the Foundation Phase, the National Curriculum Statement (NCS): Curriculum Assessment Policy Statement (CAPS), especially in the early grades. I expanded that this approach aimed to ensure that learners understand the connections among the different learning areas. A critical friend further validated this point. CF 5 said:

> *It [the integrated learning approach] is one of the values underpinning the CAPS curriculum.*

Another critical friend raised the issue of language. Her concern was that all pre-service teachers were taught in English, even those who might teach in IsiZulu medium classrooms. Also, though this is not significant at this stage because the curriculum and the B.Ed.

Foundation Phase programme has now been revised to accommodate the language issues, my response alluded to the focus of integration. CF 6 asked:

> *When you talk about language, which one are you referring to? Is it not important which language they use?*

My response was that the language of learning and teaching (LoLT) at the university was English. Pre-service teachers are placed at various schools when they have completed their degrees. Moreover, it is only in the Foundation Phase (Grade R to 3) that IsiZulu is the medium of instruction for IsiZulu home language speakers − from Grade 4 the medium of instruction is supposed to be English (or Afrikaans in a minimum number of schools). I stated that the university policy at the time determined that I should teach in the language of learning and teaching, which was English. I highlighted that the B.Ed. curriculum was structured in such a way that there was no IsiZulu medium module. I explained this as follows:

> *This is unlike the Post Graduate Certificate in Education (PGCE), where we had two groups for the Mathematics module, the English and IsiZulu groups. The PGCE focussed on the methodology, on how to teach. Students had to choose between English and IsiZulu. But, in the case of the B.Ed. programme, there is only English. Since we are in the process of re-curriculating, we will soon be implementing a new B.Ed. programme. So, we are working on that, and we will have an IsiZulu class. I could let students develop games and other activities in IsiZulu.*

CF 7 was also concerned about the language issue. He offered the following comment:

> *When you are in a classroom situation, especially in the* Foundation Phase*, obviously [the learners'] mother tongue should be used. Especially when you say they will have to make models as teaching aids. So, you will be telling them what things they need to collect. It would be interesting if you could allow them to use their mother tongue if they wanted to. Especially because the sociocultural theory underpins your study.*

In my view, which is what I explained the CFs, if pre-service teachers' home language is IsiZulu they have an advantage because they are trained in English and teach in IsiZulu. However, at the time it appeared that I had to scrutinise the language issue and devise some strategies to accommodate language diversity in my exploration of an integrated learning approach. Dimitriadis and Kamberelis (2006) argue that language is used in all contexts to

explain concepts and manage thinking and that is why code-switching works well in certain situations. At this point, I realised that the language would be a thorny issue and that I would have to consider it carefully.

A discussion ensued about the types of knowledge that I would focus on and what I would want the pre-service teachers to acquire to adopt and operationalise an integrated approach to learning. Regarding this issue, CF 8 asked:

> *What is knowledge for teacher education and what is knowledge for the Foundation Phase classroom? They are not the same thing – if we talk about practice. We also have that experience. They [pre-service teachers] have the perception that they must be taught those activities that [they were taught] in their childhood. They must understand that you are not in Class 2 anymore; you are a 2nd year student at university. It is an enormous challenge for the teacher educator to meet their expectations."*

I explained that I would focus on both the student teachers' knowledge and the knowledge required for the Foundation Phase classroom. Thames and Ball (2010, p. 223) claim that, as we explore our teaching, "we find that teaching well requires an abundance of mathematical skills and *usable* mathematical knowledge – thus mathematical knowledge in and for teaching". I shared an experience when I introduced something different to pre-service teachers. It had occurred when we had done the four basic operations (addition, subtraction, multiplication and division) and I had given them speed tests to develop *their* knowledge and not what was required for young learners. I had also introduced them to activities appropriate to their developmental level. For instance, I had given them sums with high numbers, explaining that these were not for Grade 1 but for them as pre-service teachers to solve. We had never done this in this module because its focus was only on how to teach.

At one point, the critical friends enquired if the activities in the eight lessons I had presented were part of the curriculum. I explained that the activities supported the prescribed curriculum and had been presented to enhance an integrated learning approach. However, I had to admit that I had not given the students enough time to reflect on whether that had obtained a sound understanding of what I had been trying to teach.

The aspect of theory and practice came up. The critical friends were interested to know if my pre-service teachers would have something to fall back on if they failed mathematics at the end of the year, while my focus had been on an integrated learning approach. The point was that these pre-service teachers had to pass their academic year. I pointed out that I would dedicate only a few lessons to the integrated learning approach and that my students would be able to draw on classwork aimed at an adequate coverage of the curriculum. I also sought to work interactively with them, so that what they would learn would be both theory and practical. In this regard, CF 9 said:

> *You learn all this theory after school, but the moment you get into a tense situation you revert to how you were taught. I was wondering if they had something to fall back on.*

This question prompted the suggestion that it might be useful to do some memory work with the student teachers to recall and compare their pre-school experiences or their experiences in Grades 1 – 3. I indicated that I would incorporate this into my research. Also, as a proponent of the integrated learning approach, I acknowledged that I needed to articulate my personal history and practical experiences and understand my development.

During the conversations, the critical friends advised me against using phrases such as 'teacher training'. They suggested using terms such as 'teacher development in education' and 'preparing pre-service teachers' instead. Another important recommendation was that my voice needed to be heard and not only those of the pre-service teachers. However, I also had to be careful not to overwhelm the lessons and disregard the pre-service teachers' views, which did happen in a few instances, as I acknowledged earlier (see Chapters Five and Six).

In closing, I expressed appreciation for the guidance that I had received from my critical friends.

8.3.2 Self-reflective research support group meeting 2 (26 May 2017)

I presented my work for the second time to the self-reflective research support group. My presentation's title was '*Beginnings of an integrated learning approach: My personal learning of mathematics'.* I aimed to examine my lived experiences of cultivating an integrated learning approach (ILA) as I taught the early childhood mathematics module. I explored my own lived experiences to inform my work as a teacher educator in this field. In this section, I report only

on the feedback I received from my critical friends after my presentation (and not on the presentation). The intention of this is to avoid repeating what I discussed in Chapter Three. I presented information on how I experienced childhood games and how mathematics was integrated into our games. In this presentation, I focused on the following games: *amagende* (the stone game), the three tins game, and hopscotch. I briefly referred to indigenous knowledge systems and ethnomathematics and highlighted the notion of mathematics as a social activity.

I explained that, according to Gerdes (1998), the sociocultural perspective includes ethnomathematics, which also falls within indigenous knowledge systems. Ethnomathematics is about recognising people's everyday experiences, particularly in their culture. Gerdes (1998) argues that culture represents different groups of people sharing patterns of behaviour and particular knowledge regarding language, religion and other social habits. Nkopodi and Mosimege (2009) argue that, for a long time, subjects like mathematics and the sciences have been associated with Western cultures. However, according to Cimen (2014, p. 524), "ethnomathematics is not only at the implicit level of just a composition of ideas, but it is also explicitly practised in reality, and [has been] and still [is] being presented by different cultural groups". Much that we refer to as mathematics is commonly done by most people globally and is not culture-specific. I was able to explore the mathematical concepts that we imbibed when we were playing and compare what we had learnt with the mathematics taught in the early childhood mathematics module.

Questions and Comments (CF 10 - 12)

Self-study researchers encourage and support one another through collaboration. Samaras and Freese (2006, p. 50) argue that "learning, thinking, and knowing arise through collaboration and re-appropriating feedback from others, which aligns with the sociocultural theory". I thus shared both positive and challenging experiences with my critical friends when I was presenting my exploration of an integrated learning approach. The comments I discuss here stemmed from my presentation at the second self-reflective research support group meeting.

CF 10 commented on the resemblances of the different communities who were living in different racially segregated areas during apartheid. She said:

"It is interesting to see similarities with the Coloured community. We played the same games. Only they were indigenous games. We would have what we called the 'gunu' ('ingede'). The 'gunu' ('ingede') was the one that we would throw away. It is just amazing how the games that we played all around were called by different names. It is lovely when you make those types of links. The hopscotch game – all those shapes, length, trying to make more mathematics skill of estimation – how to run and so on".

It was encouraging to receive such a positive comment and made me feel optimistic about my study. Even though I was looking at my personal history, I was thinking about how I could involve my pre-service teachers in indigenous games. A further comment about similarities in terms of an integrated learning approach was raised by CF 11, who stated:

There are a lot of similarities in terms of the approach to education and using methodologies that are rooted in play. Mathematics forces you to learn abstraction. Concrete approaches should result in abstraction ... Education actually means bringing out what you already know but did not know you know.

This observation validated what I had been emphasising in my lectures about the importance of using concrete objects when teaching learners in the Foundation Phase. This view is supported by Maasepp and Bobis (2015), who contend that mathematics should be taught by using concrete materials for it to be relevant to and engaging for learners. Regarding this point, CF 12 added:

I really like the idea of concretising. I think you have something to learn when you draw on ethnomathematics. I think you need to be pushing it even further.

It was liberating to hear how other people from different communities also played the same games but just gave them different names. Nkopodi and Mosimege (2009) note that, when people take part in any sport, they engender communication, vocabulary and mathematical proficiencies. Furthermore, they assert the following:

"The important principle is that what is used from different cultures should be familiar to all cultures. If a game from one culture is to be used, then other learners who are unfamiliar with the game should first be taught how to play it" (Nkopodi & Mosimege, 2009, p. 379).

The discussions about games encouraged me to expose my pre-service teachers to these activities by getting them to play games.

8.3.3 Self-reflective research support group meeting 3 (18 May 2018)

The title of my presentation at yet another group meeting of self-reflective research was: '*Enriching learning and teaching through artefacts: An Early Childhood Mathematics teacher educator's self-study'.* When presenting my research at this meeting, I was following the paper I had presented at SARAECE conference (described in 8.4.4 below). I focus on the feedback I received from critical friends at this particular group meeting.

The gist of my presentation is as follows:

I conducted this research by asking the pre-service teachers to bring cultural artefacts and present them to class. I divided them into groups to talk about the cultural artefacts that had selected. They had to describe these artefacts by referring to patterns on them and explaining how the object linked with the mathematics, languages or life skills (see Chapter Six, one of the lessons on an integrated learning approach). I worked on the premise that mathematics teaching should reflect life, especially in the early grades. I indicated that the sociocultural context should be considered to make mathematics come alive. Thus, the use of resources that are familiar to learners and pre-service teachers is encouraged. This view is supported by Delaney (2010), who states that teachers in primary schools use tools such as physical objects or paper and pen text/drawings to help them when introducing new concepts. We call these tools artefacts. The pre-service teachers worked in groups to discuss and present the artefacts they had selected. They were able to link mathematical concepts with what was happening in their environments. I learnt that I needed to provide my pre-service teachers with plenty of opportunities for making sense of mathematics using objects from their sociocultural contexts. The pre-service teachers acknowledged that people who made such artefacts but who had had no formal education were not even aware that they were using mathematical skills. I concluded by stating that it was vital for me to continually engage in various strategies to improve understanding of early mathematics by exploring applications using an integrated learning approach.

Comments and questions (CF 13 – 16)

The critical friends were captivated by my presentation and provided positive feedback that enhanced my study. CF 13 asked the following questions:

> *Would you consider something like taking the students to a cultural village or something? Is the idea of asking them to bring things to the lesson embedded in the belief that learners should see their environment as a source material instead of taking them, for example, to a cultural village? Could it work with technology – there could be another area?*

I responded by stating that learners and pre-service teachers come from diverse backgrounds. Therefore, they need to see what is happening in their environment, whether it is rural or urban. As in any context, pre-service teachers are exposed to cultural artefacts and learn about other people. Ladson-Billings (2006) suggests that we should give pre-service teachers opportunities to engage in activities after school to interact with children in their various communities. I also argued the importance of using technology, even at a very early age, as devices like cellular phones are the communication tools of today and tomorrow, and this fact should not be denied. With time, I intend to incorporate technology into all my lessons as well.

Another critical friend was in awe, expressing that the pre-service teachers must have enjoyed the lesson. CF 14 stated:

> *You know, I wish this way of teaching mathematics could be part and parcel of the methods that are used at schools and that they will be developed right up to Matric [Grade 12]. I did mathematics up to high school. I have it on my certificate, but I always feel I could have done much better if this kind of approach was applied in our time. Now I see where the mathematics we were taught applies, but then it was just something abstract.*

The above comment provided insights that motivated me to be optimistic about my research study. I added that mathematics does not only occur in the classroom, but it is everywhere. In my view, it is entrenched in the conventional and contemporary worlds we live in, and integration is possible if only one looks and listens. CF 15 supported this view and said:

> *The principle of measuring things and a sense of connection with the materials is engrained in our lives. You are making connections of yourself with the material, and it remains throughout your life.*

CF 16 indicated that even in the Western context, mathematics is taught abstractly and out of context. She commented:

> *I taught adults who had hated mathematics at school. Then they realised, "Oh I can do that". There is a fear of maths because it's the weird concept that it is conceptual and not practical. I think it is really good to bring it to real-life contexts as mathematics occurs all around us.*

This remark echoed what Laridon et al. (2005) argue. They emphasise that, when employing the sociocultural perspective approach in our teaching, teachers and teacher educators actually become mediators instead of distributors of knowledge, which helps in the development of mathematical knowledge through a practical pedagogy.

I found that the group meetings became a safe and comfortable space I never thought existed in academic environments. Similarly, Parker, Patton, and O'Sullivan (2016) note that teachers in their study felt confident due to a safe environment where they felt positive, relaxed and comfortable when they discussed their career goals. My encouraging interactions with critical friends also both directly and indirectly influenced my thinking processes.

8.3.4 Self-reflective research support group meeting 4 (10 May 2019)

On the 10th May 2019, I again presented my work at a self-reflective research support group meeting. The title of my presentation was '*Using collages on my doctoral journey'*. My supervisor had observed that I had been working increasingly well with collages and suggested that I present a paper on how collages had helped me on my doctoral journey. According to Butler-Kisber and Poldma (2010), a collage has a way of making ideas and new views clear. I thus found collages useful when I was conceptualising my thoughts as a self-study researcher, an early childhood mathematics teacher educator, and a doctoral student (see Chapter Four and Chapter Nine). In my presentation, I emphasised these three foci, which I briefly present in the following table:

Table 8.3: The three foci of my collage presentation

The three Foci of my collage presentation	Explanation
Self-study researcher	Honesty in my reflections was essential but did not come easy.
	It was tiring and uncomfortable to put myself out there as a learner rather than as a knower. It made me vulnerable.
	The collage helped me talk about my feelings and emotions and whatever I found difficult to articulate about myself.
Early Childhood Mathematics Teacher Educator	I looked for pictures and utilised pre-service teachers' everyday experiences when I taught mathematics.
	I had to represent mathematics as an everyday practice and as embedded in lived experiences.
	The collage helped me to make this knowledge accessible.
Doctoral student	My chapters are clear – all refer to the use of collages.
	I am creating knowledge about self-study, but I'm also contributing to knowledge about integration.

In my presentation I indicated that, as a self-study researcher, it was challenging to do reflections because self-study required me to be the self in the picture. Hamilton et al. (2008) note that the cooperative component of self-study permits the researcher to focus on the self, interact with critical friends and self, and eventually enrich practice. Placing myself in the centre was a new experience. It was challenging to be vulnerable because I wanted my presentations and research project to be perfect. Therefore, interacting with critical friends was stimulating. The collages assisted me in articulating how I was feeling. For example, instead of saying what I thought, I was able to depict my emotions visually. Acknowledging that I was a learner as well as a knower made me vulnerable. Samaras and Freese (2006) maintain that

self-study research entails taking risks and experiencing vulnerability. Nonetheless, using pictures helped me talk about my feelings and emotions and explore whatever I found difficult to articulate about myself.

I noted that the collages helped me, as an early childhood mathematics teacher educator, understand and present mathematics as an everyday phenomenon embedded in people's lived experiences. In my experience, mathematics often has the stigma of being difficult and requiring cognitive conceptualisation that is not related to everyday experiences. However, Ginsburg et al. (2008) note that everyday mathematics may be learnt spontaneously through concrete and abstract backgrounds. To create the collages when visualising and formulating my key concepts, I had to look for pictures that gave everyday meaning to teaching mathematics. I was also able to illustrate connections among the learning areas in these collages and they allowed me to make knowledge accessible and achieve epistemic access.

Moreover, as a doctoral student, I was able to intellectualise the concepts I wanted to illuminate through collages. I felt at home as a student at a doctorate level because I could think conceptually. Collage making helped me to gain confidence and to progress on my doctoral journey.

Questions and Comments (CF 17 – CF 19)

I was eager to receive feedback from critical friends after my presentation. Now that I had evolved and was continuously learning to expand my knowledge through my involvement with critical friends.

CF17 was curious about our collage making process in the classroom. She asked:

> *Did your students encounter problems when creating and presenting collages?*

I explained that this exercise was not easy for the pre-service teachers at the beginning. The concept of creating collages was new to them. It took some time for them to understand how this tool worked. I responded as follows:

> *The students had no clue what I was talking about when I introduced collages to them. We first created the collages, and we created concept maps. When they were developing*

the collages, I would go to each group to assist them. I encouraged them to ask questions and also allowed them to talk about what they were doing, using the pictures to illustrate the integrated learning approach. It was not easy for them.

Another critical friend shared her experiences with her students when creating collages. She had noted that her students had connected collages with being artists. They had found it challenging to develop collages because they had felt they were not artistic enough. Poldma and Kisber (2010) explain that collage making should not be intimidating because most people can cut and glue pictures to represent a phenomenon. This critical friend's comment was a validation for me as I then realised that others had experienced similar problems. CF 18 indicated:

Some of my experiences when creating collages with the students [were challenging]. Immediately when you talk about collages, they think that it needs to be something very artistic. They don't look at the value of it in terms of generating conversations. I don't know if you had that experience that they wanted the collages to look good and artistic.

CFP 19 reflected on her experience when she worked with students doing posters. In this regard, she said:

I think it is a mind shift for students to work visually as opposed to words only, to make notes. It is not a natural thing for them. I got some of my students this semester to do posters, and they really struggled with it. I found that quite interesting because I thought doing a poster was quite easy. That resonates with me that they battled. I think with collage for me, it's that thing of people wanting it to look perfect. I think with the collage what pictures have chosen not to show. What are you not saying in the collage? It's almost like the subtext. It's something to hang that conceptual thinking around. To make thinking concrete, something tangible that you can hang your thinking around to make sense of it.

I appreciated the comments by the critical friends as they shared their experiences of using collages with students. It was encouraging to know that other colleagues had experienced what I was encountering on this journey.

8.4 Conversations with Colleagues at National Conferences

8.4.1 The University of Zululand (UNIZULU) Teaching and Learning Conference – 19 May 2016

Table 8.4: My engagement with critical friends at the University of Zululand Teaching and Learning Conference

Critical Friends	Engagement with Critical Friends
CF 1 to CF 3	UNIZULU Conference - 19 May 2016

The University of Zululand is located in the northern part of KwaZulu-Natal, South Africa. In 2016, the institution held its first teaching and learning conference. At the beginning of my studies (the proposal development stage), I received an invitation to attend a teaching and learning conference. I knew this was going to be an excellent platform for me to present my work. I then worked on an abstract of my proposal and submitted it. Working on this abstract helped me concentrate on my study's essentials and narrow it down to gain a focused perspective on what I intended to do. One important activity was to peruse literature on self-study methodologies.

My presentation's title was '*An integrated learning approach to early mathematics teaching: A teacher educator's experiences'*. I explained how I aimed at cultivating an integrated learning approach in the teaching of early childhood mathematics in teacher education. I highlighted the following: (i) It is essential that a curriculum is planned thoughtfully, (ii) that it is developmentally appropriate, and (iii) that it is responsive to the culture and language of the young learner. I drew on Cross, Woods, and Schweingruber (2009), who argue that early childhood mathematics and its improvements are vital for young learners' current and future educational success. I indicated that a sociocultural theoretical perspective underpinned my study. I would consider the sociocultural context to make mathematics a social experience through active participation and using resources that would be familiar to my pre-service teachers. I stated that my self-study aimed to improve my practice.

I also described the self-study methodology that I would utilise in this study. I cited Samaras and Roberts (2011) as follows: "Teachers engaged in self-study research are inspired to improve their practice to help pre-service teachers improve their learning". I explained that the

project would allow me to plan and use an integrated learning approach, which was the pedagogical strategy that I would explore to help my pre-service teachers consider and make links between mathematics and other learning areas. I elaborated on the arts-based self-study methods that I would employ. I gave an account of the activities that I planned to engage in with my pre-service teachers, such as collages and concept maps, to highlight the connections between mathematics, language and life skills.

I referred to the fact that my pre-service teachers were starting to link images in their collages with the concepts in the concept maps and that they were able to demonstrate these as part of an integrated learning approach. For example, in one of the concept maps, they had captured concepts such as *large*, *many*, *long* and *more* to represent measurement. They had also grouped the ideas *fun, games, play, sport* with the theme 'learning through play'. This activity showed that the integrated learning approach linked mathematics to real-life situations through games and having fun. I pointed out that these activities were a starting point for pre-service teachers to learn about mathematics in an interconnected way. I emphasised that I would continue to engage my pre-service teachers in various arts-based methods to improve my practice and their understanding of teaching mathematics in the early years using an integrated learning approach.

My reflection on the discussion with critical friends (CF 1 – CF 3)

The self-study methodology was still new to me, and hence I forgot to audio record the comments by the critical friends. I resolved not to forget this when I presented my study in other contexts. Presenting this work early in the research proposal development stage was productive. I then reflected retrospectively on the comments I had received from this diverse group.

The audience was impressed by the arts-based methodologies that I would be exploring in my study. CF 1 commented that presenting early mathematics this way was astonishing. She stated that these methodologies might provide opportunities for understanding mathematics better. As an early childhood mathematics teacher educator who was starting a self-study project, I concurred with Schuck and Brandenburg (2020) about contributing to the field by thinking about my teaching and my pre-service teachers' learning in new ways.

According to Richards (2013, p. 3) "reflection is a key component of teacher preparation". The issue around reflection was raised by CF 2 who asked if I kept a reflective journal, which I

admitted that I did not at the time. But I embraced the suggestion and mentioned that I would do so as I moved forward.

The critical friends suggested that I needed to read widely about the integrated learning approach. CF 3 highlighted that I needed to broaden my literature background of this approach in the Foundation Phase to show how the key features would inform what I would be doing in class using arts-based methods. I found these suggestions valuable and took them to heart.

8.4.2 The South African Educational Research Association (SAERA) Conference

Table 8.5: My engagement with critical friends at the SAERA conferences

Critical Friends	Engagement with Critical Friends
CF 20 to CF 25	SAERA - 22 October 2016
CF 26 to CF 29	SAERA - 23 October 2018
CF 30 to CF 33	SAERA - 24 October 2019

8.4.2.1 SAERA Conference 1 – 22 October 2016

I first presented at the SAERA conference in 2016. My presentation's title was '*Innovative strategies: Putting into practice an integrated learning approach in Early Childhood Mathematics teacher education'*. The audience received my presentation well. This was encouraging, as I would defend my proposal in a month. I had contemplated the feedback I had received from my previous presentations and had read considerably on the integrated learning approach and self-study methodology.

I explained that this self-study aimed to cultivate an integrated learning approach in early childhood mathematics teacher education, highlighting that Foundation Phase teachers teach three learning areas. I reiterated the pivotal position of language in the Foundation Phase as the basis of other learning areas. I clarified that the Life Skills learning area, a cross-cutting subject, should support and strengthen the teaching of other core foundation phase subjects, namely, Languages (Home and First Additional) and Mathematics. The mathematics learning area helps developmental processes that enhance logical and critical thinking, accuracy and problem-solving. My main point was the integration among the learning areas is vital.

I indicated that the sociocultural dimension is an essential part of teaching and learning and that my study would be premised on this notion. According to Lee (2014, p. 1041), "education systems, classroom teaching and learning are neither culture nor context-free". I would thus consider my pre-service teachers' cultural backgrounds when planning and exploring the integrated learning approach. To make mathematics a social experience, I would engage my students through active participation and the use of resources that would be familiar to them.

I explained how I had already employed the arts-based and personal history self-study research methods in the work I had done up to that point. Weber (2014) describes arts-based self-study research as a visual approach used to broaden our knowledge through an artistic medium of expression. I detailed the use of collages and concept maps to explore an integrated learning approach and referred to Samaras' (2011) explanation of personal history self-study to help explore learning experiences to inform one's teaching. I highlighted how I had tracked my earliest learning mathematics experiences even before my formal schooling had commenced.

I explained that I would generate data over a semester and stated that not every lecture would be dedicated to exploring the integrated learning approach. I recounted how I had engaged a group of 34 pre-service teachers in various arts-based activities.

I received valuable feedback from the critical friends at the SAERA conference, which strengthened my research. Some audience members wondered what I would do to ensure that mathematics content would not be lost to young learners. Likewise, Adler, Pournara and Graven (2000) caution that integration in mathematics should not occur at the expense of "conceptual mathematical knowledge" (p. 12). This point was necessary, and I needed to clarify how I would prevent this from happening.

Another issue raised was that integration had been applied ineffectively in South African schools in the Outcomes-Based Education (OBE) era, even though one of OBE principles was integration. Critics of this earlier curriculum policy, referred to as Curriculum 2005, pointed out that teachers had not been well trained and focused more on integration and not delivering subject content appropriately (Adler et al., 2000). Critical friends also corroborated this point. For instance, CF 20 commented:

The teachers focused on everyday knowledge and were complaining that the discipline knowledge, especially in subjects like Mathematics, Science and Accounting, was lacking. They were saying that these learners came to high school without the foundational knowledge of the discipline. What you are saying is essential because the integration focus must not be lost, because it is still mathematics. Mainly because these are the first years, it may look very simplistic, but students who are doing this module for the first time are training for the first time.

My experiences and the feedback I received at the conference motivated me to look deeper. I then understood that my aim should be to use different approaches to provide my pre-service teachers with meaningful experiences. According to Mathison and Freeman (1997), implementing interdisciplinary/integrated/integrative approaches should be done correctly and include hands-on experiences.

A critical friend shared her experience with regards to the sociocultural perspective. When conducting a study in primary schools in the Eastern Cape, they observed that learners were only counting in English. These learners were not able to count in IsiXhosa, their home language. CF 21 stated:

But we found out that the home culture is no longer the culture that has so much isiXhosa itself, and this is not something that we had done the study on. But, maybe because of TV and other exposure and experiences, we were surprised that children were struggling to say 'kunye, kubili, zimbili, zintathu' − they couldn't in IsiXhosa.

When they investigated this further, they understood that learners' home culture was not what the teachers expected. Surprisingly, IsiXhosa learners used mostly English when they were at home. This was contradictory to the sociocultural perspective, in the sense that the teachers were not aware of what was occurring in learners' homes regarding language development. They assumed that the learners used their home language, which was IsiXhosa, which was not the case in most instances. She alluded to the fact that sometimes, as a society, we might point fingers, but we might be surprised when investigating deeper. It is, therefore, essential to understand learners' cultural backgrounds instead of making assumptions. This finding is embedded in Vygotsky's (1978) sociocultural perspective based on the principle that

understanding is socially motivated and supported by the people we come into contact with. One cannot separate an individual's learning from the social context. '

The critical friends raised a point about how I would ensure that mathematics would not get lost (thus take a second seat to other activities) when I explored using an integrated learning approach. They asked about the principles of integration and how they would work in the classroom. It meant that I needed to explicitly guide the pre-service teachers to seek applications among the learning areas and apply them to everyday mathematics knowledge. I had to consider this suggestion and read more about the principles of integration. CF 22 asked:

> *I just want to find out if you have thought about engaging the student teachers in the principles of that. There is always this idea of working between different subjects and mathematics in this case. Have you thought about engaging that with them so that they are aware of those principles of integration and interdisciplinary links and how they could work with that in the classroom?*

A positive comment about the self-study approach was a critical angle, and it allowed me to reflect more intensely on the project's self-study foundation. I had chosen the self-study approach because, according to Samaras (2011), self-study research allows the researcher to examine her own lived practice. In this context, CF 23 stated:

> *And I think ...from the things you are picking up in your next class, you will be able to do things differently. This is not just a class where you say to the students 'integrate' or whatever, but you are also doing a study of your own practice, which makes it different from the way integration has been taught where it has just been a teacher teaching.*

This comment made me think about improving my implementation of this approach. Samaras and Roberts (2011) maintain that teachers who are engaged in self-study research should be inspired to improve their practice to help pre-service teachers strengthen their learning. They affirm that "self-study teacher research is designed to encourage teachers to be agents of their reform initiatives while working collaboratively with school colleagues" (Samaras & Roberts 2011, p. 43). I welcomed a motivational comment by CF 24, who stated:

It will be interesting that, while they are still in training, those types of things are taken care of, and with your practice, they can see and you are able to say to them, 'Listen, as much as you are comfortable with certain aspects of a learning area, as a teacher you are obligated to have a balance in a classroom'. But the problem is that in our training we don't do that. Thus, what you are doing is actually showing them the reality of what they will have to do when they go to schools.

A critical friend suggested that I videotape the pre-service teachers while engaging in class activities to address the integrated learning approach. She noted that this would help them and me to reflect on our practices. I responded that I did a lot of continuous reflection during the data generation process. I used various data generation practices to stimulate my thinking about my personal history and current practice as a teacher educator. I felt that my data sources were sufficient at this stage, and I would consider using video for future research. CF 25 stated:

What is missing? I think to make students reflective while they are still in training.

The comments and the questions I received based on my presentation were invaluable. It validated what Samaras (2011) affirms as the significance of critical friends helping one gain a new perspective and understand one's study. A positive comment from a critical friend related to the fact that it was a self-study project allowed me to engage in an in-depth reflection.

I was encouraged by these comments as they motivated me to strengthen my study through critical reflection and the use of the integrated learning approach across the curriculum. These comments illuminated how the pilot study helped me fully understand my role as a teacher educator who aspired to encourage my pre-service teachers to implement an integrated learning approach. I learnt increasingly from my experiences, and I started doing things differently as the semester progressed. Samaras (2010) argues that Vygotsky maintained that we learn with others and that mental processes can be enhanced if we understand the tools that support thinking. I was not just telling the pre-service teachers to use the integrated learning approach, but I also studied my own teaching practices and methodology.

8.4.2.2 SAERA Conference 2 – 23 October 2018

The title of my presentation at the SAERA Conference held on 23 October 2018 was *'Making an integrated learning approach tangible: A teacher educator's self-study'*. A summary of my presentation was published in a self-reflective methodology newsletter published in May 2019.

In this paper, I described how I had used various arts-based methods such as memory drawings to recall my experiences of learning mathematics in the early years of schooling. Nicol (2011, p. 45) notes that many pre-service teachers experience mathematics as "a series of rules for solving complicated problems". They also see teaching mathematics as "explaining procedures for solving such problems". I highlighted that it was not surprising that some Foundation Phase learners had a limited understanding of mathematics when they finished primary school, which is a point that is endorsed by National Education Evaluation Development Unit (NEEDU) (2012) and Fleisch (2007). It could be because they were taught by teachers who themselves had had negative experiences in mathematics.

In line with the SAERA conference theme '*Making education more relevant, responsive and authentic*', my presentation focused on making mathematics tangible and accessible through an integrated learning approach. I reported on my learning as a teacher educator utilising a self-study research approach. I explained that I aimed to help pre-service teachers enjoy, value, and explore mathematics and teaching it in a positive and integrated way. I illuminated how I had engaged my pre-service teachers in memory work using pictures and drawings with captions to represent their early experiences of learning mathematics (see Chapter 7). They also wrote short paragraphs about these experiences. I highlighted that most of the pre-service teachers had experienced teacher-centred teaching styles in their encounters with mathematics. In fact, my students thought mathematics was abstract, paper-based with 'chalk and talk' deliveries and involved corporal punishment to 'encourage' learning.

I also referred to the board games my students and I had played such as *Scrabble, chess, Ludo* and *30 seconds* (see Chapter Seven). I argued that these games had stimulated reading and mathematical skills (such as addition and subtraction), mental agility, and social skills, which helped foster communication, self-confidence, and logical and creative thinking among my pre-service teachers. I urged that it was essential to regularly engage pre-service teachers in activities that would develop their mathematical competences and understanding of mathematical concepts. I also stated that mathematics teacher educators should adopt a humanistic approach and create environments where mathematics is made accessible to build self-confidence and develop a positive attitude towards mathematics.

My experience of presenting at the SAERA national conference was an encouraging one. Even though I was nervous at the beginning, I became more relaxed as time went on. The colleagues exhibited an attentive response through their body language and facial expressions. I recall seeing one member from the audience nodding her head when I was presenting. I gained confidence and was encouraged by this experience.

Questions and comments (CF 26 to CF 29)

As I continued to engage with critical friends, I saw the importance of their input and learning by interacting with them. I developed as a self-study scholar and embraced opportunities to practise self-study methods with support from critical friends who validated or challenged my findings.

CF 26 shared her experience of learning mathematics. Her concern was about the methods used to teach mathematics. She stated:

> *I learnt to hate maths because of such experiences of having teachers in the Foundation Phase who focused on maths and not on how I was learning. I also see how teachers now continue to teach in the same manner. They are continuing the bad trend of making the subject appear 'evil', like one of those subjects that are out to get you. To ensure that you get pre-service teachers to engage in such activities is actually a wonderful thing. To get them to reflect on their past in terms of how they learnt mathematics so that they then engage in their future now that they know how they were taught so that they know how to teach. I think your study is well placed since mathematics is one of the problematic subjects currently.*

I liked the comment that my study was "well-placed". It confirmed the need to improve my teacher education practice in the Foundation Phase. CF 27 alluded to the fact that the Foundation Phase was essential but that it had been neglected for some time in South Africa. She said:

> *It is also vital because these are Foundation Phase teachers. Because mostly the focus is on high school teachers and they are knowledgeable in mathematics. What about Foundation Phase teachers who are supposed to teach all subjects? And yet, if they had such bad learning experiences and they are confused, they have knowledge gaps themselves. So, what are we expecting them to teach in primary schools? They go to*

schools with a negative attitude towards maths because of their early learning experiences. I think this is really a good study. And I'm sure those 12 students now also have teaching methods because, in as much as you learnt from the process, they also learnt how they could make their classroom fun and maths fun.

The above statement corresponds with Baker, Bitto, Wills, Galanti, and Eatmon's (2018) notion that specialised pedagogical content knowledge is required to have a sound understanding of mathematics content at all levels. Working with Foundation Phase pre-service teachers showed me their apprehension and negative attitude towards mathematics because they felt that they were not specialists in the subject.

Another colleague commented on the role games could play as the pre-service teachers had enjoyed this so much. CF 28 uttered:

I think the use of games is a sound learning tool because the students enjoyed it. The idea of this form of learning is important because they don't have to try to work out these concepts. But actually, those concepts are enabling to make decisions to think critically and to use those principles without actually being aware that that's what they are doing. Some elements of learning happen, as time goes so quickly, and they are having fun. I'm sure you will see positive results. One of the things you are trying to do is to get rid of their fear.

This comment alluded to how games provided an exciting way to teach mathematics. Davis and Maistry (2017) argue that learners' curiosity is harnessed by incorporating games in lessons. I observed how my pre-service teachers enjoyed playing games, which made me believe that it would be advantageous to integrate this activity into my early childhood mathematics teacher education practice.

I appreciated a comment by CF 29 about an integrated learning approach, and that games addressed the aspect of social development. She said:

I'm just thinking that, in as much as we are thinking of teaching, conceptual development also occurs. But this approach also addresses another aspect that sometimes we lose sight of, which is social development. Because as they play, they

develop self-confidence, conflict management, and socially they develop. It is important to take cognisance of learners' emotional intelligence, considering the violence in schools. So, through playing, they develop all those skills which are needed in this day and age.

This comment was in keeping with Pradhan (2018), who argues that games are useful for improving a social mindset and developing essential social behaviours. Similarly, Charlesworth (2012) maintains that games provide prospects for developing learners' communicative skills such as teamwork and obeying rules.

I gained new perceptions during my engagement with conference audiences. As Taylor (2014) suggests, the sociocultural perspective promotes the idea of learning with (and from) other people and making sense of personal experiences collectively. I thus acknowledge the importance of the co-construction of knowledge, co-learning, and that learning is a social activity. The sociocultural perspective argues that individuals never produce much on their own and that interaction with other people is an integral part of education. This was validated at this conference. I received support from colleagues whose opinion I respected, and they renewed my hope of enhancing my teaching to make mathematics tangible and accessible.

After the conference, I considered advancing this study by giving my pre-service teachers opportunities to reflect on the games we had played and how they might bring them to the level of young learners. Another colleague raised this point. As edgy and uncomfortable as it might be to put oneself 'out there', colleagues in the form of critical friends may provide the necessary support practically and beneficially. For me, this engagement was an activity that allowed critical friends and me to exchange knowledge that enhanced my intrapersonal skills (Samaras, 2002). In my pursuit of improving the teaching and learning of early childhood mathematics, I needed to consistently think about numerous opportunities for my pre-service teachers to gain more tangible experiences.

8.4.2.3 SAERA Conference 3 – 24 October 2019

My presentation at this SAERA conference was titled '*Going beyond boundaries by creating collages on my doctoral journey'.* I had presented a similar paper at a self-reflective group meeting. I then modified it to align with the conference theme, '*Beyond boundaries: Exploring possibilities through research and innovation'.* I, therefore, received feedback from a different

group of critical friends. Below, I summarise my reflections on this presentation, which I submitted for publication in a self-reflective methodologies newsletter early in 2020.

This paper focused on how creating collages helped me conceptualise my ideas of an integrated learning approach, as a self-study researcher, an early childhood mathematics teacher educator, and a doctoral student. I elucidated my struggle with the use of "I" in my self-study project. Through the collages, I explained myself and my concepts as I could clarify what was in the collages without advancing myself as a person. The collages enabled me to talk about my thoughts and emotions and whatever I found difficult to articulate about myself. Engaging with the audience boosted my confidence to push the boundaries in using arts-based and other self-study methods. The audience asked questions and offered comments in thoughtful ways that made me feel less nervous. I learnt that I needed to be more explicit in articulating my research process and highlight the reasons for using particular self-study methods to respond to my research questions. When I did this, it allowed me to broaden my work's credibility and validity (Samaras, 2011).

Questions and comments (CF 30 – 33)

The first critical friend in this group was curious about the process of self-inquiry. CF 30 commented on how collages were more regularly used as a teaching tool. She asked:

> *Collages actually are becoming a more popular form of expression and I use it in my teaching, especially if students are not well versed in new ways/things. I want to know more about the process of self-inquiry that you are looking into…Did you first have the words? Did the pictures provoke the emotions, or did you have emotions and then started to look for pictures?*

This was a thought-provoking question. For me, the pictures helped me to describe my feelings. Richards (2013) concurs with this view about art's ability to conjure feelings that are not easy to explain. I elaborated that when I was looking for pictures, thoughts and feelings stimulated my search. I would then select appropriate images and use them in the collage.

CFP 31 clarified my point, adding that people interpret pictures differently. She commented:

> *The meaning doesn't have to be literal—different interpretation. The images – you maintain the feeling that speaks through the picture.*

CF 32 (My supervisor**)** was also among the group at this presentation and elaborated on the process I had followed when creating collages. She stated:

> *An important element that perhaps Makie could talk about, is how she went from the process of intuitively creating the collage to then explaining to other people and recording herself explaining. In that process of explaining, she began to realise what it was she had depicted in choosing the images. That process of voicing what you created is very important.*

She also added that I had recorded myself explaining the collage and then transcribed everything. That transcription became the basis for the writing of thesis chapters. Santori and Hennessey (2019) share the same sentiments and report on how they gained a wealth of information through "listening to recordings of the research meetings and analysing the transcripts" (p. 10).

Another interesting comment by CF 33 was how male mathematics teachers would mortify girls in a classroom:

> *Maths historically was a subject that not everybody liked. Also, with maths, it was gendered. Our teachers openly embarrassed us, saying that girls were stupid when it came to maths. But interestingly, in your thesis, you are using a very playful and democratic method to open your own learning about how to teach maths. I find that fascinating. How the method of collaging is breaking that barrier − the playfulness of learning maths, the playfulness of teaching maths.*

The critical friends validated the arts-based process of self-inquiry that I had used. My interaction with critical friends prompted me to think deeply about how I had worked together with my pre-service teachers in my attempts to improve my own teacher education practice. I was motivated by their comments as they affirmed that the work I had been doing might have positively impacted my pre-service teachers.

8.4.3 Self-reflective methodologies special interest group (SIG) symposia

Self-reflective methodologies SIG symposiums have been presented at the SAERA conferences for the past five years. A few months before the conference, my supervisor, the SIG convenor, invited self-reflective researchers to contribute ideas and participate in the seminar. She encouraged especially those who were going to present at main conference to join in SIG symposia. The sessions have been very well attended over the years as they are dynamic and thought-provoking. Thus, I reflect on my presentations at the self-reflective methodologies SIG symposia held in 2018 and 2019.

Table 8.6: Summary of my presentations at self-reflective methodologies SIG symposium

Symposia	Seminar titles	My presentation
Symposium 1 23 October 2018	Making education more relevant, responsive, and authentic through memory-work	Memories of learning mathematics in primary school
Symposium 2 24 October 2019	Exploring possibilities through methodological inventiveness in self-reflective research	Using metaphors in conceptualising and structuring my thesis chapters

8.4.3.1 SIG Symposium 1 - 23 October 2018

Seminar title: Making education more relevant, responsive, and authentic through memory-work

My presentation: Memories of learning mathematics in primary school

I used a memory drawing to recall my childhood experiences of learning mathematics. This picture represented my long division struggles when I was in primary school (see Chapter Three). Remembering this episode made me think of the teaching methods used in South African schools to teach mathematical concepts to learners. By reflecting on commonly used techniques, I realised that both teachers and teacher educators had often failed to meet learners and pre-service teachers' needs. As we prepare pre-service teachers to teach mathematics in the Foundation Phase, we need to be aware that we should make mathematics accessible and create a learning environment where learners feel safe. Allender and Allender (2006) emphasise that teachers need to be humanistic. To ensure humanistic education, we must create

an environment where learners are not scared of their teachers. Mathematics is a subject many learners fear, but it is even worse when associated with punishment when you are still young. Punitive practices should be eradicated and replaced with kindness, support and appropriate teaching and learning methods.

8.4.3.2 SIG Symposium 2 - 24 October 2019

Seminar title: Exploring possibilities through methodological inventiveness in self-reflective research

My presentation: Using metaphors in conceptualising and structuring my thesis chapters

I described how the metaphors that I would use would be associated with water. These metaphors would represent my feelings and what I was discovering as I conceptualised and structured my thesis. I explored Badley's (2018) idea that academics should make attempts to capture their intended audience's attention by employing metaphors in the titles of books, chapters, and articles. For example, I entitled the first chapter of my thesis '*First steps into unknown waters'*. This metaphor evokes an image of the first tentative steps I took when piloting an integrated learning approach study in early childhood mathematics teaching. The project thus commenced with a pilot study. I was trying something new, and as I progressed, I felt as if I was *testing the waters*. Hence the title of Chapter Four is '*Getting my feet wet'.* It was a challenge to implement an integrated learning approach in the year following the pilot study because of the large number of pre-service teachers in my class. I felt as if I was drowning and just trying to *'keep my head above water',* which is Chapter Five's title.

I clarified how, throughout this journey, I presented my research to trusted colleagues in different contexts. Receiving feedback from critical friends felt like I was *Putting my head underwater* (Chapter Eight). You cannot breathe or see clearly in this position, but you can swim much more efficiently. This mirrors my mixed feelings when receiving feedback from critical friends. As Schuck (2011) suggests, for critical friendship to be useful, one needs to be open to feeling uneasy and vulnerable while appreciating the invaluable role played by the feedback given. As I worked on completing my thesis, I used the metaphor '*Watching the rainbow after the rain'* for the last chapter. It epitomises my feelings of achievement, enthusiasm and gratitude.

8.4.4 The South African Research Association for Early Childhood Education (SARAECE) Conference – 11 May 2018

SARAECE is a research association that promotes research and research development in the field of Early Childhood Education, including teacher education and development for this phase. It aims to provide an academic forum in South Africa to develop and disseminate research in Early Childhood Development (ECD) and Early Childhood Care and Education (ECCE).

The title of my presentation at this conference was '*Enriching learning and teaching through artefacts: An Early Childhood Mathematics teacher educator's self-study'.* This part of the study aimed to explore the use of artefacts as part of an integrated learning approach (ILA) in the early childhood mathematics module.

I worked on the premise that mathematics teaching in this phase lays the foundation for learners' later understanding of major mathematical concepts (Tsamir et al., 2011). Therefore, I emphasised the importance of building an awareness of the vital role that mathematics plays in real-life situations, including learners' personal development. I defined an artefact as an object made by a human being, typically one of cultural or historical interest. According to Allender and Manke (2008, p. 20), the study of artefacts reveals that the products that make up our material culture embody the full range of what is taking place in the world. As I explained earlier in this chapter, I presented the detailed work in the previous chapter (Chapter Six). I had conducted this part of the research by engaging pre-service teachers in group work to present and discuss the cultural artefacts they had selected. In their discussion, they had to:

- Describe their artefacts;
- The pattern on each artefact; and
- How the artefact linked with the Mathematics, Language and Life Skills learning areas

Table 8.7: My engagement with critical friends at the SARAECE conference

Critical Friends	Engagement with Critical Friends
CF 34 to CF 35	South African Research Association of Early Childhood Education (SARAECE) national conference

Questions and Comments (CF 34 – 35)

The critical friends expressed their appreciation that I had indigenised (or Africanised) the curriculum. However, there were also concerns about limited cultural diversity. One critical friend commented that the lesson on artefacts might have prioritised particular cultural heritages while marginalising others. She wondered what could have transpired in my class, had there been Coloured or White pre-service teachers as well. CF 34 stated:

> *Something that troubles me is when you have limited cultural diversity. You have your students from the Zulu culture and the Indian culture, and they have a strong cultural heritage. But if there were Coloured students like myself or White students, what would they have brought?*

This comment tempted me to be defensive, but I calmed down. The the feeling of discomfort, forced me to listen. I learnt that I needed to listen carefully to what my critical friends said to improve my practice. This comment encouraged a new perspective, and I realised I should ensure that all my pre-service teachers are included in the lessons I present in the future. Another possibility to promote cultural respect would be to task my pre-service teachers to research and bring an artefact that is not used in their own culture.

A positive comment from another critical friend stated that she liked the self-study aspect "as a layer on top" of what I had been doing. This comment suggests that the cultural perspective may be an excellent approach to accommodate cultures that may have been ignored previously. CF 35 made the following comment:

> *There is more appreciation for the artefacts that are still alive for various cultures and those that need to be brought in. Because if we look at our classrooms and our learners, the children's contexts are diverse. So, in terms of you as a teacher educator preparing for these kinds of things, whether you are Indian, or black, or Coloured, you actually, generally, have a set of diverse learners that you are teaching.*

The critical friends also made me aware of potential conflicts that might arise in our classrooms about culture, which is always a sensitive issue. Questions such as: "*What is culture?*" and "*Whose culture are we talking about?*" made me aware of the challenges I might come across when dealing with issues of culture. Doing something new, such as exploring object inquiry

and using arts-based methods, may induce vulnerability. I have noted elsewhere (Kortjass, 2019b) that when one abandons one's comfort zone, one learns from a position of vulnerability, even though it can be frightening.

I thus recognised that there needs to be an appreciation for all cultural heritages. Cultural sensitivity does not mean inclusion or exclusion, but it is trying to bring all cultures together and understand the value of diversity. Some artefacts just appeal to you as a teacher educator or a student, so these are quite important. I learnt to listen to comments and take them to heart, and that I need to consistently check my motives and practices to 'practise what I preach'. As a teacher educator involved in self-study research, I acknowledge and accept that I am in a delicate position, both as a researcher and a teacher who works with pre-service teachers for an entire semester (Samaras, 2011, p. 150). I need to be aware of my different roles and be genuine in constructing my understandings and discoveries.

8.5 My Learning

Feedback from working with critical friends equipped me with alternative viewpoints that contributed to my research and enhanced my insight. Moreover, a deeper understanding of the integrated learning approach became possible through the essential feedback that I had received from critical friends. They offered suggestions on improving my practices as a teacher educator of the early childhood mathematics module. I realised that it was essential to continually reflect on my methods and explore new strategies. Schuck and Russell (2005, p. 115) suggest that, when self-study researchers reflect on what critical friends say, it can lead to improved changes in their practice. For example, I had to reconsider my lesson plans and embark on techniques geared explicitly towards teaching pre-service teachers about mathematics teaching in the Foundation Phase. By using the integrated learning approach, I hope to improve the teaching and learning of this subject, not only for the benefit of my pre-service teachers, but also in the interest of the pedagogies they will adopt as teachers in the Foundation Phase.

To illustrate what I learnt from critical friends, I developed a collage (Figure 8.1). This collage is a conglomeration of the images presented in the collages I had created throughout this study.

Figure 8.1: Collage depicting what I had learnt from critical friends

8.5.1 Read extensively

In the collage, the picture of the books and files with the text "New" exemplifies that I need to continue reading significant texts. The word "Myself" illustrates that, while the study was about myself, it was also an investigation that was pitched at the doctoral level. I understood that my reading should be broad and deep at this level because I needed to know and understand the essence of the critical concepts that I explored. Moreover, I should critique myself and others to be able to say, "*This is what I am contributing to this particular field of study*". I had to learn that integration was perceived differently in various contexts, even though not all these perceptions applied to my study. Adamu (2003) highlights the constructivist view of learning, which denotes a holistic notion of learning. I had to justify why I was using a particular concept and be aware of the body of literature about it and its proponents. I also needed to provide reasons why some ideas were appropriate while others were inappropriate for my study. A critical friend's question about the principles of integration made it clear that I needed to

understand other scholars' views of integration to identify gaps or applicability to my study. I needed to know that what I was trying to contribute to theoretical knowledge was also applicable in practice in the Foundation Phase. All these were clarified by critical friends.

8.5.2 Learning from other people

The word "learning" in my collage depicts that I learnt from (and in collaboration with) other people. The image of the people on a lifeboat is a metaphor for companionship on this journey. I acknowledge that I was not alone on this journey that was fraught with challenges and uncertainty. Sometimes, it was hard to remember that because I was getting these messages about what an academic and a doctoral student should be: a scholar who produces knowledge independently. However, the sociocultural perspective debunks this concept to a large extent. Samaras (2002, p. 75) affirms that "individual learning and the social context are not separate. Learning does not occur in isolation and depends on interactions with critical friends". The picture of the survivors in the lifeboat affirms that I was with other people, but shows that I also felt quite vulnerable as I was not on safe, dry land anymore. What if I was pushed out of the lifeboat? The importance of co-learning and learning as a social activity is emphasised by this image. It does not matter how much we know, or think we know, there is always feedback that can help us learn something new. We should look forward to that feedback as an exciting opportunity for learning rather than seeing it as something negative that threatens our sense of confidence. However, it is hard to arrive at that space − but the sociocultural perspective comforts us that individuals never produce knowledge entirely independently. There is always interacting with other people which is an essential part of learning.

8.5.3 Improving my practice

By collaborating with other people, I was pushed in a new direction. In this context, the phrase 'the right blend' resonated with my work during feedback sessions when I engaged with critical friends. I learnt to listen to comments and to take them to heart. I gathered that I needed to consistently check my motives and practices to "practise what I preach". I realised that I should blend all these experiences to improve my practice in the future. As a teacher educator involved in self-study research, I acknowledged and accepted my dual position as a researcher and a teacher educator who had worked with pre-service teachers for four semesters (Samaras, 2011). I needed to be aware of my different roles to be genuine in constructing my understanding and my discoveries to improve my practice.

I learnt to be open-minded when I received criticism from my colleagues. I understand now how critical friends "can broaden each other's zone of possibility in understanding their practice" (Samaras, 2011, p. 77). Schuck and Russell (2005, p. 13) state that "critical friendships are valuable if they encourage us to reconsider [the] aims and purposes of practice and create the space and opportunity . . . to be nourished". The discussions with critical friends gave me another way of looking at myself and my work. If I was down and overwhelmed by the magnitude of the tasks I had set myself, I was still able to rise like a balloon, have a look at what I had accomplished or what I had missed, and I try again.

8.6 Conclusion

The process of participating in self-study research is not as easy as it may appear. It entails questioning and challenging yourself, visiting and revisiting what you have discovered, and openness and deep reflection. But I found that this process was always rewarding. I deeply valued the feedback that I received from my critical friends while my work was in progress, and I shall appreciate their inputs for as long as I live. Loughran (2004) contends that a significant benefit of self-study research is that it encourages collaboration with others. Similarly, Schuck (2002) states that critical friends' role is vital in assisting the researcher with the checking and interpreting the data. Feldman (2003) maintains that teacher educators need to ensure that they are not blinded by how they create their stories and that they should take note of feedback from critical friends. Therefore, I monitored my research regularly by referring it to critical friends who offered different viewpoints and perspectives that challenged and strengthened my work. I embraced their constructive critiques, which challenged and channelled my thinking.

All in all, I was fortunate in that I could learn from and with others. I presented what I had done and felt that I had achieved, and my critical friends commented on how I could I have done it better or still improved on it. My journey was about learning to teach pre-service teachers in the best way possible.

In the following chapter titled '*Swimming with the tide',* I describe my engagement with my fellow doctoral candidates in the group supervision meetings. I further reflect on the discussions I had with my supervisor. Finally, I highlight my learning from these interactions.

CHAPTER NINE: SWIMMING WITH THE TIDE

It is this notion of having both the *critical* and the *friend* that makes the process [of critical friendship] so powerful.

Sandy Schuck

9.1 Introduction

The feedback provided by critical friends discussed in the preceding chapter revealed possibilities to improve my practice as an early childhood mathematics teacher educator and in my self-study research. I embraced valuable suggestions that guided my thinking about 'good teaching'. In essence, I highlighted the importance of learning through interaction with others. Critical friends helped me check, interpret, and analyse the data in ways that enriched my understanding. By working with critical friends, I discovered a support structure that enhanced my knowledge and focused my research project.

This chapter's title is '*Swimming with the tide',* which is a metaphor that signifies how I welcomed and followed the suggestions and ideas of my critical friends. In this chapter, I describe my engagements with my supervisor and fellow doctoral candidates and reflect on what I learnt from them. They all acted as critical friends in a positive and informative way as they helped me develop as a self-study scholar. Schuck (2011, p. 72) asserts that it is the "...notion of having both the 'critical' and the 'friend' that make[s] the process [of critical friendship] so powerful". These words inspired me to engage in in-depth discussions with critical friends about my work, no matter how uneasy it made me feel at times. My engagement with my fellow doctoral candidates was reciprocal and ongoing. Alderton (2008, p. 101) affirms that "the role of colleagues as critical friends should be viewed as mutual exploration rather than confrontation". I was honoured to have a consistent relationship with my fellow doctoral candidates we built over several years. I was very comfortable in my relationships with them and never felt that I needed to defend my position. They guided me on how I could improve my practice as an early childhood mathematics teacher educator, and, with their assistance, I was able to develop thought processes and my writing as a self-study scholar.

This chapter also addresses my third research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with critical friends?* I commence by explaining the group supervision meetings we (my fellow doctoral candidates and I) had with our research supervisor. I describe the activities we engaged in during these meetings. I then

discuss the consultations I had with my supervisor on a one-on-one basis. To conclude this chapter, I examine my learnings from these interactions.

9.2. Supervisory Support Group

Table 9.1: Engagements with critical friends during supervisory support group

Critical Friends	Engagement with Critical Friends
Fellow doctoral candidates: **Mandisa, Thelma Bridget, and Refilwe**	Supervisory Support Group

My supervisor organised supervisory support group discussions with her doctoral students at a similar level of study. These conversations were held once a month and were relatively informal. Kathleen would provide lunch (mostly pizza) and tea/coffee. We were also members of the self-reflective research support group (see Chapter Eight). I received permission from my fellow doctoral candidates to include their names and comments in my thesis.

In most cases, our supervisor facilitated the discussions based on a topic that she had circulated to us before the meeting. Sometimes we had to prepare short presentations on specific aspects of our studies. Three activities and conversations that took place at this forum that I shall discuss here were: *A three-minute presentation, My writing now,* and *The museum in my office.*

9.2.1 Three-minute presentation – 24.03.2020

At a certain point, our supervisor tasked us to present our studies in three minutes, using a poem and an image as creative modes of expression. I reflected on what I had done so far at that stage of my research and addressed the task as follows:

Table 9.2: My three-minute presentation

Three-minute presentation
I wrote a Pantoum poem that reflects what my study aims to achieve. I'm sharing my reflections on cultivating an integrated learning approach to teaching mathematics in the Foundation Phase. I'm sharing my reflections on cultivating an integrated learning approach to teaching

mathematics in the Foundation Phase. Here, I'm reflecting on what I have already done. I have interacted with and learnt from critical friends. I'm at the beginning of my journey, first as a researcher, then as a doctoral student and as an early childhood mathematics teacher educator.

I'm cultivating this new approach along with my students. As I said, I'm reflecting on what I have learnt from critical friends and the PhD cohort which is a self-reflective research support group, and what I presented at a conference. So, I'm combining all of that, and I'm looking at what I have learnt throughout the whole process.

One of the things that I have learnt is that while I want to explore an integrated learning approach to teaching mathematics in the Foundation Phase, it must not be at the expense of disciplinary knowledge.

Throughout this journey, the 'I' as a self-study researcher has to be emphasised. For example, in my presentation at the SAERA conference and our cohort meetings, I always say 'my students', and 'my colleagues' instead of focusing on me. I struggle with the 'self' and 'I' as I am generally not self-centred. So, I have to challenge myself, disrupt myself and think deeply about what I'm doing.

My interaction with critical friends is helping me a lot. I'm doing a lot of reflection. I'm also now reimagining, and through this whole process, I am learning. If you look at that picture [projecting an image of a red arrow representing 'Self' and the phrase: 'Take the next step'], that is what I now need to do to be able to move forward. I see 'myself'. This is a new concept for me, and I need to do a lot of reading. Because I need to be rigorous in doing a doctoral study. I need to read a lot to see what I am contributing to scholarly knowledge and how it will contribute to teaching mathematics in the Foundation Phase. I also need to be organised, as you can see by the files in this picture [projecting an image of a man carrying large files].

Figure 9.1: An image of a man carrying large files

Questions and Comments

The questions and comments based on my presentation incited new ideas and required me to deliberate on what I had been discovering. For instance, Refilwe asked*:*

> *But I wanted to see the action of 'disrupting yourself'. When was this? Was it by yourself or through interacting with others?*

Schuck (2002) claims that teacher educators involved in self-study need to develop a deeper understanding of teacher education in general, which means going beyond examining their practices. I explained my process of managing my interactions with colleagues and pre-service teachers to engender learning in teacher education. I replied:

> *I interact with others, like when I'm receiving feedback from you and other people I interact with. Whatever I taught in my class, I reflected on it and wrote about it in my journal. I felt a need to challenge myself.*

Thelma commented on my response, as she also had the same concern as Refilwe. She stated:

> *On the one hand, you are holding on to disciplinary knowledge. It's like a new approach, but you mustn't lose knowledge of mathematics. I wondered where that disrupting happens, but now you have explained what you are thinking about your practice.*

This comment resonated with what Thames and Ball (2010) refer to as mathematical knowledge for teaching mathematics. However, they also suggest that conventional content knowledge is not enough for the practical handling of mathematical tasks. The comment also demonstrates how stimulating my involvement with critical friends was. Samaras (2011, p. 75) urges that self-study researchers should "not be mistaken that critical friends are just buddies", and my fellow critical friends thus both challenged and constructively supported me. This made my journey as a teacher educator, a researcher, and a doctoral student more challenging and more enlightening.

Kathleen added*:*

> *The challenging and disrupting might resonate with Mandisa's conflict as a college lecturer in that you want to take the sociocultural educational approach, and there is a perceived conflict with mathematics. The maths is seen as here on its own, 'pure'. And maybe there is no solution to that. It's a constant process, negotiating between the maths person and the holistic sociocultural integrated person and the other maths people out there.*

I concurred with this statement, noting that I would always need to navigate between the sociocultural principles and mathematics learning through dialogue with critical friends. As I relentlessly examined my teaching practices, I found that I needed "an abundance of mathematical skill and *usable* mathematical knowledge – mathematical knowledge in and for teaching" (Thames & Ball, 2010, p. 223). To improve my learning, I had to devise new pedagogic strategies. Pereira (2005) argues that a better understanding of mathematics does not happen haphazardly but requires inventive ideas and purposeful planning. My challenge was to explore an integrated learning approach in early childhood mathematics teaching to improve my practice. My critical friends guided me to persevere and make meaning of my inquiry.

I concluded my three-minute presentation with the pantoum poem that captured my learning at that point.

A pantoum poem based on my reflections

Reimagining with critical friends
Cultivating an integrated learning approach
Not at the expense of disciplinary knowledge
Challenging and disrupting myself
Interaction with critical friends

Not at the expense of disciplinary knowledge
A lot of reflection
Interaction with critical friends
Reimagining

A lot of reflection
Challenging and disrupting myself
Reimagining
Cultivating an integrated learning approach

I chose to compose a Pantoum poem as a research artefact. Because I did not see myself as a poetic person, the concept of creating poetry both scared and fascinated me. Before starting my doctoral study, I was a member of the Early Career Academics (ECAs) team and worked with university mentors on a New Scholarship project. These mentors ran a series of workshops using creative analytic practices to explore ideas for supporting and developing ECAs (Masinga et al., 2016). That is when I started learning about different poetic styles.

The poem I created was a 'found poem'. Found poetry is a poetic style created by taking words, phrases, and sometimes whole passages from other sources and reframing them by making changes in spacing and lines or adding or deleting text, thus imparting new meaning (Furman, Lietz & Langer, 2006). To compose the Pantoum poem, I used words and phrases from my first presentation at the SAERA conference. My poem expresses the importance of collaboration in research, especially for novice self-study researchers. Working with other people on the New Scholarship project helped me gain more profound knowledge about arts-based and collective self-study. The mentors who were the leaders of the project helped us through learning and developing as self-study scholars. They planted seeds of wisdom. For me, wisdom is the reward of experience and should be shared. Through these experiences, I realised that personal experience is a valuable source of knowledge in self-study research (Samaras, 2011).

The above poem's central theme is 'sharing' as sharing ideas and information played a crucial role in this exercise and created a robust collegial relationship among us as developing academics. My colleagues from the Early Childhood Education discipline and I were able to work together to create a collage (see Chapter 1). As we endeavoured to inspire our pre-service teachers in this discipline, we felt that it was essential to use innovative strategies to improve our practices. I envisioned myself employing arts-based media in my teaching to motivate my pre-service teachers and, eventually, this is what I accomplished.

9.2.2 My writing now

In this exercise, which was required from time to time, Kathleen wanted us to think deeply about our writing and writing spaces. She encouraged us in our struggles and to deal with the self-doubt that tended to flood us. Our discussions revealed that writing as a process had never been taught to any of us at school. Alfaki (2015) highlights that the intricacies of academic writing have to be acquired through considerable practice. Also, Cloutier (2016) reports that most academics have not been taught formally on scholarly or other writing forms. The writing exercise aimed at getting our 'writing muscles' going. Table 9.3 is an example of an activity that Kathleen wanted us to do in preparation for a discussion about our writing journey.

Table 9.3: A writing exercise

Please take 30 minutes to do this piece of free writing (following the guidelines below) and send it to me by Friday 4 August.

My writing now

It is useful to reflect on where you are now - as a writer. By reflecting again in 6 months or a year's time, you will be better able to see your writing 'journey' on your own and with the group.

Where are you up to? Give yourself about 30 minutes and try and write freely for about 500 words.

The following prompts are to provoke your thinking - you don't have to answer them all.

a) Reflect on your writing now.

1. Where and when do you like to write/ have you written?
2. What materials and locations do you find most conducive to writing?
3. Why do you write? And how do you write?
4. With whom have you shared your writing? What kinds of help/responses do you value?
5. Are there pressures in your life that force you into writing silence?
6. Are there impulses that help you, push you to write?
7. Which writers do you admire? Have any particularly influenced your own writing?
8. How might you improve your writing conditions?
9. What do you like most about writing?... and about what you have written?
10. What are you aiming for now? What are you hoping for?
11. What have you valued most in our group meetings? How has belonging to our group informed the way you are writing?

Kathleen emphasised that these writing exercises would be useful even if we could not use the text in our theses. She indicated that it would help reflect on where we were at specific points (the 'now') as a writer. She said:

> *By reflecting again in 6 months or a year's time, you will be better able to see your writing 'journey' on your own and with the group.*

The following table presents my responses to the writing exercise.

Table 9.4: My responses to a writing exercise

My responses to a writing exercise

1. Where and when do you like to write/ have you written?

I write in my home office, usually in the morning before I do anything else.

2. What materials and locations do you find most conducive to writing?

When reading scholarly articles, I write notes (filling in the reading record), reports related to my discipline and articles for publication.

3. Why do you write? And how do you write?

I write because it is part of my work. I think I am improving my writing skills. I don't spend as much time as I did before when writing a piece of work. I make progress when I write, leave that piece of writing and go back to it later. In that way, I can see my mistakes and also, I'm able to come up with more ideas. This means that I need a bit more time to spend on writing.

4. With whom have you shared your writing? What kinds of help/responses do you value?

I share my writing with my friend, who is also my colleague. She always gives me constructive feedback and asks provocative questions so I can enhance my thinking about what I'm writing.

5. Are there pressures in your life that force you into writing silence?

There are no pressures in my life that force me into writing silence. The space I use for writing is conducive for this activity.

6. Are there impulses that help you, push you to write?

Some impulses help me, push me to write. I have a routine for writing in the morning, and I do it consistently.

7. Which writers do you admire? Have any particularly influenced your own writing?

Sandy Schuck, Anastasia Samaras and Robert Nash. They use simple language.

8. How might you improve your writing conditions?

I think by reading more and writing more. As Henning, Gravett and Van Rensburg so adequately put it: "Good reading precedes good writing" (2002 p. vii). And reading precedes good writing…

9. What do you like most about writing?... and about what you have written?

As a self-study researcher, I can now write about my own experiences and feel confident. Before I struggled to use 'I'…

10. What are you aiming for now? What are you hoping for?

Writing my chapters for my dissertation and scholarly articles.

11. What have you valued most in our group meetings? How has belonging to our group informed the way you are writing?

It keeps me on my toes. It is motivating also to see people who are ahead of me, and this makes me strive to get there myself and work even harder.

Writing exercises like these helped me reflect on my writing to think about how I could improve. I acknowledged that I needed to allocate more time to writing. I first wrote drafts and went back to improve on them. Doing this improved my writing. In that way, I was able to see my mistakes, and I was also able to develop more ideas. In the beginning, writing felt intimidating, but I soon learnt that adhering to good academic practice was not as complicated as it appeared at first. I was inspired by many scholars whose writings I found accessible, such as Sandy Schuck (2002; 2009), Anastasia Samaras (2002; 2011), Robert Nash (2004), Robyn Brandenburg (2011), to name just a few.

9.2.3 The museum in my office

Another exercise inspired by our supervisory meetings was called "The museum in my office/life". In this exercise, we had to present and describe some items in our offices, or our lives, that motivated us to progress in our doctoral studies. I exhibited the pictures of the following items from my office: an electric fan, a poster with an adage: '*Life* is not measured by the breaths we take but by the *moments* that take our breath away', an antique clock with Roman figures, a vase in earthy colours with dried flowers, and a plant in a ceramic pot with coloured shapes. My reflective writing about this 'museum' focused on the plant in a ceramic bowl.

Table 9.5: My presentation of "The museum in my office"

The Museum in my Office

For everything, there is a season!

Figure 9.2: The pot plant in my office

There is an appropriate time for everything!

I am at the very beginning of my journey as an early mathematics teacher educator. I'm venturing into arts-based methods. I never thought of myself as an artist and thought these methods would be for artistic people. However, now that I am involved in using arts-based methods as a teacher educator, I have transformed how I comprehend teaching and learning – especially of mathematics – in teacher education. As a self-study researcher, I know what is expected of me, as I have learnt from various experiences. I had this problem of focusing on "me" and "I". As I reflected on my experiences at first, I struggled to be the 'the centre of attention'. But as a self-study doctoral student, I am learning about rigour and making efforts to contribute to the body of knowledge and debates about the concept that I want to explore within the integrated learning approach philosophy. In this process, I am working with critical friends. It is crucial on this journey as they are guiding me and giving me feedback. I am looking forward to the next semester.

The plant in this vase is called the "money plant". It is believed to bring luck with money. It reminds me of growth and development, which I want to achieve by engaging in this study. I have given parts of this plant to my colleagues as a token of our collaborative attempts to grow. It inspires me when I see that it is growing, but I still have to feed it by giving it water and nutrients. In the same way, my colleagues and I work with and support one another. What I like about this pot is the colours and the geometric patterns that are symmetrical. They make me think of mathematical patterns.

Questions and Comments

After my short presentation, my colleagues and supervisor offered some comments and asked a few questions. I found these very motivational.

Bridget:

> *I would like to ask you if you can't somewhere relate the different patterns of the pot to the various parts of your life. You are talking about the different aspects of your life. Now, you spoke about geometry, which we can see on the left and this one on the front here. But then the one on the right seems to have almost a flower. And maybe you see that as representing something you are discovering.*

Bridget's statement linked with Gerdes's (1998) notion of how mathematics is applicable in our daily lives. It suggested that I try to connect the sociocultural aspects of mathematics teacher education to my learning in this self-study project.

Mandisa linked the integrated learning approach with the integrated elements of the plant:

> *You talk about integration – the plant does not need the pot only. It also needs the soil that it is growing in, the air, space, the light and water. All those are integrated together.*

The above comment pleased me because it denoted how I was being nurtured on my doctoral journey, just like I cultivated the plant in my office.

Kathleen explained that there was no right or wrong way to do these writing activities, but they were stimuli for some learning opportunities. She said:

> *You could also see the plant and the pot as the integration of the natural world and the world of mathematics. But this is mathematics that is represented in very colourful ways that link with the sociocultural perspective. These patterns, I presume, were created by people, which has sociocultural significance.*

Many insightful ideas flowed from our discussion. This engagement with a small group of critical friends allowed me to learn informally as I was working on my self-study project. Thelma acknowledged this notion as well:

> *It is really a case of letting yourself go, letting your thoughts just go. Sometimes we are so constrained because we want to be so correct. Look at this discussion now.*

Kathleen added:

> *You are talking about breaking off the pieces of the plant and giving them to other people. This could be a metaphor for teaching. Giving pieces of yourself to your students and helping them grow in new ways and new places. Although it is a 'money plant', money doesn't always have to be seen in terms of actual cash. It can be seen in terms of richness, education and sharing.*

Responding to why I chose the metaphor: *For everything, there is a season,* I made reference to the different stages of my doctoral journey and developments along the way. I stated that plants grow well in particular seasons. That is why we have different fruits in different seasons. Mandisa validated this, indicating that she liked this metaphor. She stated:

> *It's a nice explanation of where you are – a season in your doctoral journey. You journey through different seasons.*

In my opinion, the critical friends in this group validated and enriched my thinking during my work in progress. These sessions were a wealth of constructive and plausible viewpoints, and I was inspired to forge ahead.

A screenshot of our email communication with our supervisor is presented below in Figure 9.2. After each meeting, she gave us an online link to the audio recording of our group discussion, and we communicated regularly in this fashion.

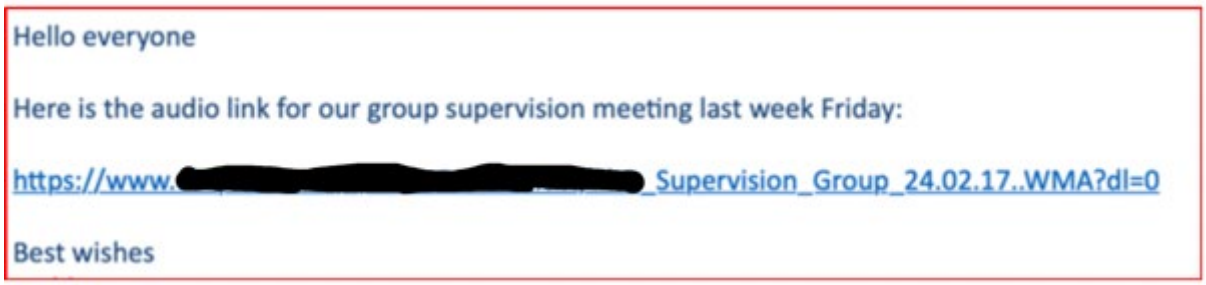


Figure 9.3: A screenshot of online communication from our supervisor

9.3 Individual Supervisory Conversations

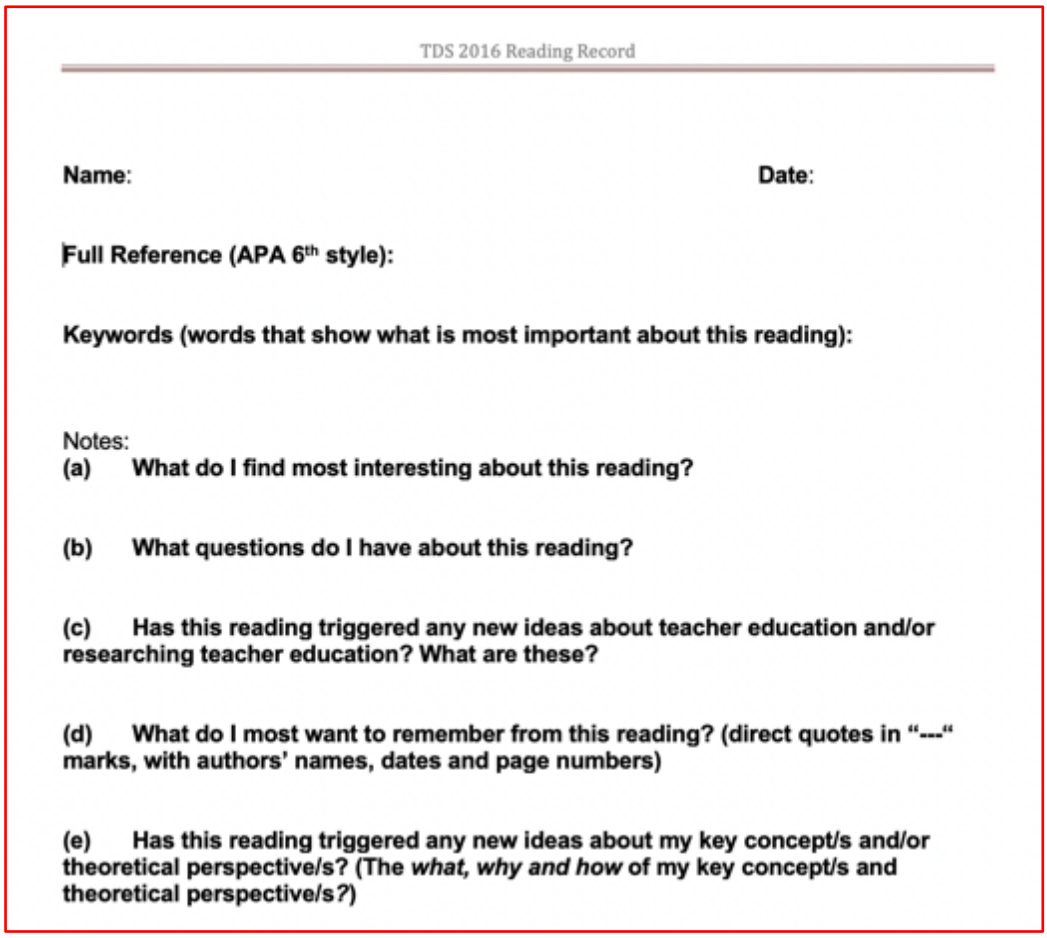
I engaged continuously with my supervisor, Kathleen, and had intensive conversations with her during these meetings. When I was still developing my proposal in the initial stage of my research, I would meet my supervisor once a month. At the end of each meeting, we would set a date for the following supervision meeting. We did this consistently throughout the year. After defending my proposal and receiving ethical clearance in the first year of the project, we met every second week in the following three years of study. My supervisor audio-recorded all our conversations and sent me the audio link via Dropbox. I would then transcribe the audios for my notes and references. The discussions were avid and comprehensive during these meetings. I shall highlight only the critical aspects of these conversations in the following section under the themes: *Beginning my doctoral journey as a self-study researcher; Article writing;* and *Analysis in self-study research*.

9.3.1 Beginning my doctoral journey as a self-study researcher

I was excited to embark on this doctoral journey. I wanted to do everything that my supervisor advised me to do. I learnt very early that I needed to be organised from the start. I understood that when you embark on a doctoral journey, as noted by Trafford and Leshem (2008), you spend many years in this study as it involves a long, high-quality research process. My supervisor guided me to have a file with lists and summaries of my readings. She noted that I would not only use them for my proposal, but I would keep on referring to them for my publications and presentations. She stated:

> *You read something for your proposal, but then throughout your doctoral research, as you go on, you always go back to that reading. It doesn't stop when you finish your PhD—looking at articles. That is how you push yourself; that is how you are learning. It is essential at such an early stage.*

My supervisor showed me how to make notes as I read articles and book chapters. She gave me a reading record template (Figure 9.3) that she had developed for the postgraduate students registered in the teacher development studies (TDS) discipline. I used the reading record when I read the articles.



TDS 2016 Reading Record

Name: **Date:**

Full Reference (APA 6th style):

Keywords (words that show what is most important about this reading):

Notes:

(a) What do I find most interesting about this reading?

(b) What questions do I have about this reading?

(c) Has this reading triggered any new ideas about teacher education and/or researching teacher education? What are these?

(d) What do I most want to remember from this reading? (direct quotes in "---" marks, with authors' names, dates and page numbers)

(e) Has this reading triggered any new ideas about my key concept/s and/or theoretical perspective/s? (The *what, why and how* of my key concept/s and theoretical perspective/s?)

Figure 9.4: A reading record template

After making notes in the reading record, I would send it to my supervisor, and we discussed it at our next meeting. To illustrate, I would summarise the relevant elements of an article or book chapter that I had read and indicate how this information was useful for my study. This is exemplified in the following excerpt:

> *The authors argue that this chapter will challenge us as mathematics educators to think about mathematics education; in other words, reflecting on what we do when we teach mathematics, which is good. Then they refer to The National Council of Teachers of Mathematics (NCTM) standards. It is similar to the NCS here in South Africa, with the Mathematics (CAPS) comprising five content areas. With them as well, it covers grades*

K-12, which is similar to our curriculum grades R-12. They list what the standards entail.

My supervisor voiced her validation and added:

Interestingly, they talk about the teachers' and learners' beliefs, attitudes, and emotions as important to maths. Because often we think of maths as purely 'can you do it?' It's not about how you feel about it or your prior knowledge or your previous experience or cultural resources or whatever. I think an essential contribution of your study will be if you also bring that out.

I provide an example of the reading record in Figure 9.4, showing the comments by my supervisor. This tool was useful throughout my research project. I tried to be consistent in using it. It also facilitated my writing process. For instance, I did not have to go back to reading a resource but just referred to my notes documented in the reading record. I also took note of the remarks and hints that my supervisor highlighted in the reading record.

TDS 2016 Reading Record

03 05 16.

Name: Makie Kortjass **Date**: 29 February 2016

Full Reference (APA 6th style):

Lee, Y. C. (2014). Teaching and sociocultural perspectives. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 1038-1041). Dordrecht: Springer.

Keywords (words that show what is most important about this reading):

Sociocultural perspectives, science education, diversity,

Notes:

(a) What do I find most interesting about this reading?

Sociocultural dimension is an important part of teaching and learning. Education systems, classroom teaching and learning are neither culture- nor context free.
We cannot avoid the fact that the learning of difficult subjects such as, Science and Maths are affected at varying levels by the sociocultural backgrounds of learners and teachers, the political and sociocultural and the broader global education environments.

(well explained)

(why is Maths a difficult subject?)

(b) What questions do I have about this reading?

How can we solve the language issue so that learners/students are able to access the content and it doesn't become a barrier to learning?
How can science teachers minimise the equity gap due to cultural diversity and help students to cross the cultural boundary? Mathematics has been viewed as a difficult subject, so this question will also apply to Mathematics.

(Can we solve it or engage with it?)

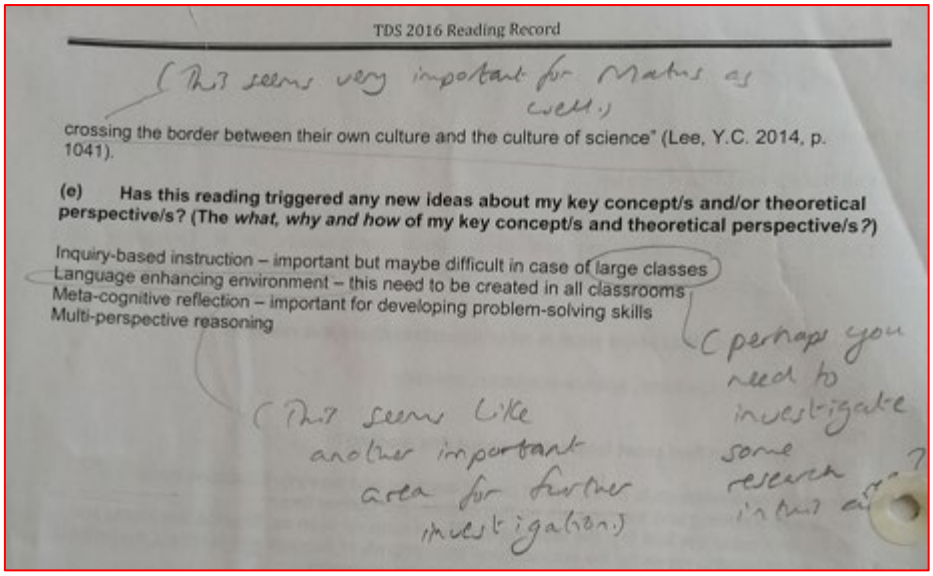
(c) Has this reading triggered any new ideas about teacher education and/or researching teacher education? What are these?

As the authors indicated, switching the Medium of Instruction (MOI) cannot solve the problem, I suggest that teachers make use of code-switching.
It will also be important for lecturers (teachers) to be competent in both the Home language of students and the language of teaching.

(It is important to consider a range of approaches and perspectives here. There are some criticisms of code switching.)

(d) What do I most want to remember from this reading? (direct quotes in "---" marks, with authors' names, dates and page numbers)

"Socioeconomic status and school factors influence students' changes of accessing the resources that are essential for achieving the goals of science education" (Lee, Y.C. 2014, p. 1039).
"Teachers are also under the influence of the mainstream values of the school, community, or society at large that may be at odds with their own beliefs or the goals of science education, thereby curtailing open discussion of some potentially controversial socio-scientific theories such as evolution" (Lee, Y.C. 2014, p. 1040).
"... making use of students' everyday knowledge relevant to science practices and considering how science practices could extend their personal knowledge base may facilitate students in


TDS 2016 Reading Record

(This seems very important for Maths as well.)

crossing the border between their own culture and the culture of science" (Lee, Y.C. 2014, p. 1041).

(e) Has this reading triggered any new ideas about my key concept/s and/or theoretical perspective/s? (The *what, why and how* of my key concept/s and theoretical perspective/s?)

Inquiry-based instruction – important but maybe difficult in case of large classes
Language enhancing environment – this need to be created in all classrooms
Meta-cognitive reflection – important for developing problem-solving skills
Multi-perspective reasoning

(perhaps you need to investigate some research in this area?

(This seems like another important area for further investigation.)

Figure 9.5: Example of a reading record

As I progressed with my study, my supervisor suggested how I could make connections with other readings about my practice and experience in teacher education. I had to read extensively to take part in scholarly conversations. Regarding this issue, my supervisor commented:

> *The importance of reading widely and understanding the concepts must be emphasised. This is important because you can link that to self-study literature in a sense that when they talk about interaction with others, they don't only mean live bodies in the room. They also mean interaction with ideas of others who have published.*

The conversations with my supervisor were productive. I was gaining confidence in what I was doing, and I felt free to ask questions or clarifications. For example, I asked:

> *So, what you are saying is that I should still focus on this part, but now bring in the literature?*

This issue of linking my work to related literature was raised again at another of these meetings, and I realised its importance. Kathleen emphasised that I could not offer a fresh perspective if I had not established what information already existed. She articulated this point as follows:

> *When you link your work with the scholarly context, you show how and what you say relates to what other people already stated. You need to show how different people*

inform your thinking, and you can maybe add something to what other people are thinking because, based on your experience and context, they might not have thought of it. But you can't do that unless you are familiar with the readings. They have to be like your friends that you can have a conversation with.

Studying for a doctorate can become a daunting task. You are told that you need to demonstrate 'doctorateness' and be able to contribute to knowledge. I remember that sometimes after I had read an article, I felt enthused, so that I read more and included related topics. But, I asked, "Will I ever finish this thing if I have to read so much?" To alleviate my apprehensiveness, my supervisor recommended:

Do one reading at a time. It's good to make a note to yourself, like 'Ok, I need to read more about play in ECE and mathematics'. But at the same time, don't let it paralyse you. Just keep putting one foot in front of the other at a time.

Knowing this made my doctoral journey less hard. It was helpful to know that I could attain my goals through persistence.

Ethical issues should be prioritised in any research. Mitchell et al. (2017, p. 181) propose that researchers must be cautious that they "do least harm and most good" when interacting with people during their studies. We have to be sensitive and thoughtful. With regards to the topic of ethics in self-study, my supervisor recommended the following:

In self-study, you should not ask your participants to do anything that you don't do yourself. Only when you do things can you ask them to do so too. You can then see what learning is happening for you and what learning is happening for them.

I was motivated to present my work to my critical friends. I also realised that feedback was essential to develop my research practices. It meant that I had to show my work to critical friends continuously. The following were words of encouragement from my supervisor:

The more you do it [presenting], the more you get used to it. This enables you to learn from the feedback. But the less you do it [presenting], the more frightened you are.

I took this advice with optimism and understood its importance. I knew I would overcome the challenges. I pointed out the following:

> *It is fundamental to do things right from the beginning. Even though I was too scared to present and receive feedback from critical friends initially, I'm getting used to it now.*

I realised that being a doctoral student and an Early Childhood scholar, I had to be open to feedback. In the beginning, I was petrified to present my work to critical friends. However, as time went by, they became a source of comfort and learning. I am now comfortable when people give me their opinions about how I can still improve my work.

9.3.2 Article writing

At the start of my doctoral research, I had one publication based on my Master's study. With my supervisor's help and guidance throughout my doctoral journey, I published three journal articles and two book chapters. Two of these publications were co-authored, and I was the sole author of the other three. Below are some transcriptions of our conversations when my supervisor guided me in writing these publications. At one of the meetings, she advised me on how I could go about telling my story. She said:

> *Bring in transcriptions and comments that prompted your reflections and [information] from the journals you read. You don't want to only tell but also show what happened. Discuss the collages and concept maps and what you learnt from them.*

I also attended a writing retreat, where we were encouraged to write and submit a paper to a journal. I showed my supervisor a request for contributions to a special issue of one of the Early Childhood journals. My supervisor encouraged me to send the article for that particular issue. She stated:

> *Special issues are very good because editors want your article, and what you then need to do is look at what they have put in the call. Make sure that you use some of the words in the title. So, immediately they can say, 'Aha, this one fits'. They obviously want something about the Southern African context.*

I was encouraged to learn about the benefits of special issues. It felt really good to have someone believe in me and think that I could do it. My supervisor advised me as follows:

> *I think you got a lot of material here already for the article, and then we can bring in some of your readings like the work of Paulus Gerdes. There is also somebody else who has written in South Africa about using traditional games in teaching mathematics.*

She was very patient in her guidance. For example, she would say:

> *Because here, you are giving us an outline of this article. You don't begin by tracing your personal development. You begin by telling us what an integrated learning approach is.*

I recall how I often made the mistake of inserting a quote without introducing it. I think I did this a couple of times. But she never got angry if I repeated the same error. For example, to bring this to my attention, she would just say:

> *Remember to introduce your quotes.*

I also struggled with the use of tense. Sometimes I would use the present tense when I was supposed to use the past tense. I said:

> *I am struggling with the tense in writing this chapter [Chapter one]. I understand that I am introducing my key concepts and informing the reader what to expect in the thesis. Do I write in the present or past tense?*

To guide me with this predicament, she would say humorously:

> *The tense is always confusing. I had a philosophy lecturer who used to say, "Tell the reader what you are going to tell them, tell them, and then tell them what you did tell them".*

This advice will stay with me forever. Supervision became a safe space for me as I felt at ease with my supervisor. I thought she respected me in a way that I had not anticipated. She practised

what she preached. Our scholarly conversations helped me to grow. As time went on, I looked forward to our discussions and her unstinting advice.

9.3.3 Analysis in self-study research

Analysing data proved to be an area that I struggled with on my journey. At first, I did not understand what my supervisor said when she stated that I needed to "zoom in and zoom out". The process of zooming in and zooming out is suggested by Chang (2008). My supervisor guided me as follows:

> *Imagine looking through the binoculars to zoom in, but then you step back and look from a different perspective when you turn them around. When you are zooming in, you are looking closely at the details of the data. When zooming out, you ask, 'How does this connect to my theoretical perspective, or to the work of other people?' It is a constant process of zooming in, looking closely at it, to say, 'What is here?' and 'How can I break it up into bits and what can I see what's there?'*

In one of the collages that I presented, there was a picture of a man looking through binoculars. She pointed at the image (Figure 9.5), stating that it was an example of the process I was following.

Figure 9.6: A man looking through binoculars

She explained that data analysis and interpretation do not happen linearly because researchers must revisit and re-examine data and information to understand what they are learning. Likewise, Samaras (2011) states that data analysis takes time, but the time and sweat help the teacher-researcher understand what transpires in the classroom. My supervisor said:

> *Analysis and interpretation don't happen at one time when you sit down and say, 'Now I'm analysing and interpreting'. It's actually happening all the way through. It will be useful to make memos to yourself when you find yourself doing these things.*

I responded by saying:

> *I must have all of these in my mind as I write. This is so overwhelming.*

A word of encouragement was always there when I felt despondent. My supervisor always said:

> *Keep putting one foot in front of the other. The idea of fracturing and then putting together is useful, and one tool [you can use] is poetry. Try to bring in poetry as a way of analysing your reflections. You could work with your reflective notes and create a Pantoum or Tanka poem using these notes to condense your learning.*

My supervisor guided me to use poetry, collages and other arts-based media that could be useful. When I saw the bigger picture, it was a turning point as I now understood different ways of analysing my work. I found that this was the beauty of engaging in self-study methods as I was not limited to using one method only.

I reminisced about the humorous moments during our meetings. Once I made a mistake about the first part of the title of an article I was discussing. It so happened that my supervisor had co-authored this article. I used the term 'thinking space' instead of 'thinking in space'. My supervisor said jokingly:

> '*Thinking space' is also interesting, but this one is 'thinking in space'.*

We laughed together. These humorous moments showed that although the journey was daunting, there were lighter moments that I enjoyed. These were the moments that kept me going. I was fortunate in that these meetings helped me to develop both personally and professionally. I shall cherish the life skills that I learnt from these experiences forever.

9.4 My Learning

My experiences of being involved in both group and individual supervisory conversations provided contexts for exploring learning in a way I had never imagined possible. Therefore, I created a collage to demonstrate what I had learnt from my critical friends and my supervisor (Figure 9.6). The collage was created using carefully selected words and phrases that I cut out of magazines and other texts that I had read, and that had stimulated my reflections.

Figure 9.7: Collage representing my learnings from critical friends and my supervisor

9.4.1 Development in self-study research

The phrase "dignity and development" in the collage embodies my learning in a safe space with intellectual people whom I respected and who also respected me. The suggestions and questions they posed were meant to help me grow and to reassure me that my journey was on the right track. Samaras and Freese (2006) acknowledge that learning happens as a result of sharing and creating knowledge in a "self-study community" (p. 51). My critical friends were also self-study researchers, and this made it possible to support one another. We were like-minded people who shared insights about our respective journeys as self-study researchers. The word "exploring" denotes that we were together on a journey of exploration. There was no feeling that one was superior to the other. For example, we could critique each other's data and interpretations when we presented our work in group meetings. Ritter and Hayler (2019) note that self-study aids teacher educators to understand the supporting role of scholarship. With my critical friends' support, I developed as a self-study scholar. Learning to write in an academic style was part of that development.

9.4.2 Putting one foot in front of the other

Metaphorically, I took "small steps for big gains". I attribute this phrase to how the writing exercises and my supervisor's guidance served as stepping stones to writing my thesis, peer-reviewed articles, and book chapters. Sometimes, as novice writers and scholars, we want to skip the small steps and go straight to "big gains". However, it is essential to remember that the writing process is a long one that involves re-working, re-reading, and listening to feedback from colleagues until that piece of writing is complete. It is certainly not a waste of time, as some novice writers might think. Sword (2009) believes that academic writing is hard work and can be nerve-wracking, but support helps students understand the process better. My supervisor always encouraged me to "*...put one foot in front of the other*". I followed her advice during our conversations and adopted a positive attitude towards academic writing. It felt like a 'breath of fresh air' when I became optimistic about my writing, and I believed that I could do it. However, this did not happen overnight. It took a considerable amount of time, and this increased my chances of making progress. I understood that my writing should be broad and deep at doctoral level because I needed to know and understand the essence of the critical concepts that I explored. This development was possible as I was not alone and learnt with and from others.

9.4.3 Flexibility for improved learning

Through my engagements with my critical friends over the years, I developed competencies and became more flexible – or be able 'to bend'. In other words, I was able to process my critical friends' advice and learn from it. The phrase "raise your chances" signifies that working with critical friends propelled me to be courageous when I presented my work to colleagues, and I believe that this enhanced my growth. For example, I unfailingly attended group meetings and participated diligently in group activities that included presenting my work. According to Samaras and Freese (2006), self-study scholars must have a profound responsibility to check their data and understandings with colleagues to extend their potential to learn. Likewise, Nash (2004) maintains that self-study scholars and writers continuously improve, reshape, and intensify. The words 'the lightness of being' resonate with my growth in the sense that I tried to be "light" so that I could be easily uplifted. For instance, I welcomed advice, which increased my development as a self-study scholar. My critical friends also shed 'light' on my learning as I began to see things in a "new light" when I received feedback from them. I acknowledge that it did not always feel comfortable, but I was taught to always have an open mind.

9.5 Conclusion

My self-study research journey was wealthy in both challenges and rewards. I strongly agree with Ritter and Hayler's (2019) view that self-study is not easy. However, I feel that the self-study approach was a "perfect fit" for me because it allowed me to grow by collaborating with critical friends. Although it did not seem that way initially, I gradually began to see myself as evolving as a teacher educator, self-study researcher, and writer. I hope to continue this progress after this doctoral study by writing and publishing scholarly articles.

I gained confidence through working with my critical friends, who gave me honest and constructive feedback. They became my friends as we came to know one another and established mutual trust. We took great care of one another's development and bonded as a self-study community. Our supervisor afforded us this comfortable intellectual space, which allowed me to gain a deeper understanding of what it means to be a self-study scholar. In this supportive environment, I could freely express what I was comprehending about my self-study research. This experience is corroborated by Samaras (2011), who notes that critical friends provide the best possible feedback that assists one to articulate one's thinking. Moreover, it reduces anxiety as these friends are always accessible. I acknowledge that it may not always have been rosy to learn from critical friends, but in the end, it was beneficial and enlightening.

In the concluding chapter titled '*Watching the rainbow after the rain',* I give a brief review of my thesis. I reflect on what I learnt personally and professionally through my self-study research. Finally, I examine my methodological and conceptual learning and present some concluding considerations.

CHAPTER TEN: WATCHING THE RAINBOW AFTER THE RAIN

It's the teacher at all levels who matters to students, even more
than what is taught. It's the students who matter to their
teachers, even more than the honours they earn.

Robert Nash

10.1 Introduction

My research focused on improving my practice of teaching early childhood mathematics in teacher education. I anticipated that I could enhance my practice by cultivating an integrated learning approach. This study was given impetus by some disheartening experiences of learning mathematics as a child in primary and secondary schools. In undertaking this study, I was also driven by my prior experiences of teaching mathematics as a teacher and a teacher educator. As I looked back at these experiences, I felt that mathematics was taught in an abstract way, which did not make sense as it did not connect with everyday lives. I was concerned that I had not made sufficient attempts to make mathematics accessible by considering the social, cultural and emotional influences on learning. Upon reflection, I realised that I had used teacher-centred teaching methods, which might not have inspired my learners. As with so many other mathematics teachers, I felt that I had used practices that exacerbated the notion that mathematics is a complicated subject that can only be mastered by "those who are brilliant".

In this concluding chapter, titled '*Watching the rainbow after the rain'*, I provide an *overall review* of the thesis and explain why this metaphor illustrates my *understanding* of this journey. I recap how my thinking was diversified by using various self-study methods (personal history, arts-based self-study, and a developmental portfolio) to gain new and different perspectives of my teaching practices. Some thought-provoking ideas were developed with valued critical friends, which helped me advance as a self-study scholar.

My experiences resonate with those of Nash (2004, p. 44) who declares, "It's the teacher at all levels who matters to students, even more than what is taught. It's the students who matter to their teachers, even more than the honours they earn". These words appeal to me as an indication of my attempts to re-envision early childhood mathematics teacher education. For instance, this journey enlightened my understanding of the importance of taking pre-service teachers' emotional experiences into consideration. Using an integrated learning approach, I

learnt that I could demystify the notion that mathematics is for "bright" people only and that I could inspire students with the knowledge that mathematics is all around us and can be learnt and understood practically and tangibly. In this process, I reviewed my own teaching practices of early childhood mathematics and started using innovative strategies to inspire my pre-service teachers. As a self-study researcher, I collaborated with my colleagues as critical friends and engaged with them in numerous conversations and presentations.

Furthermore, I briefly explain the gist of my discourse in the previous chapters. I also summarise my reflections on the lessons that I learnt during this doctoral journey. First and foremost, I understood the significance of an integrated learning approach in early childhood mathematics teacher education. Using this approach is vital as it allows pre-service teachers, and ultimately their future learners, to make real-life connections during their learning and thus learn meaningfully. Moreover, utilising the self-study methodology was fundamental in enhancing my growth. The sociocultural theoretical perspective underpinning the study illuminated that social phenomena are essential in stimulating mathematical knowledge. To conclude, I shall explain what undertakings I plan for the future due to this self-study research.

10.2 Review of the Thesis

In Chapter One, I commenced by explaining what motivated me to conduct this study, and I provided the background for this self-study research project. I expounded on the context of pedagogical practices with a particular focus on the integrated learning approach. Collaboration with my colleagues in early childhood education illustrated and validated this approach in the Foundation Phase. I also presented the three research questions that guided the study. Furthermore, I presented a collage to illustrate and clarify the key concepts. I discussed the theoretical perspective that guided the research. I elucidated the methodological approaches that I adhered to. I also shed light on the use of metaphors for the chapter headings of this thesis. To conclude, I explained my purpose of learning about and developing creative ideas to address the study's aim.

In Chapter Two, I provided a detailed description of the self-study methodological approach that I utilised in this study and emphasised the reasons why I found it appropriate. I then explained the research setting and the research participants and describing how I worked with my pre-service teachers. I clarified the steps that I took to cultivate an understanding of an integrated learning approach towards early childhood mathematics teacher education. I also

described what research processes I used to generate data, namely artefact retrieval, collage making, journal writing, taking and analysing photographs, memory drawings, audio recorded lesson presentations, and audio recorded conversations with my colleagues (i.e., my critical friends). Additionally, I explained the role that critical friends (my colleagues in various research spaces) played and their contribution to my growth as a teacher educator throughout the research process. I explained how my interactions and engagements helped me respond appropriately to the research questions and make meaning of the data that emerged. I stressed my dual position in this project as a researcher and a participant. I explained the processes of data analysis and interpretation. To conclude, I explained how I addressed ethical issues and safeguarded the study's trustworthiness. I also highlighted some challenges that I encountered during the study process.

In Chapter Three, I responded to the first research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with my memories?* I recounted my personal history in terms of my learning and teaching experiences of mathematics. I narrated my personal history of my early childhood, primary school, secondary school, and tertiary mathematics learning experiences. I also recounted my mathematics teaching experiences in primary school and at higher education institutions, with specific reference to my involvement in an undergraduate Foundation Phase programme. By using photographs of objects and drawings, I illuminated my memories and understandings. These photographs and drawings also allowed me to divulge my emotions and sentiments as I learnt and engaged with mathematics. I concluded by reminiscing about significant discoveries as I remembered the childhood games we used to play. These memories helped me understand that I could integrate mathematics and games, that mathematics should be taught 'across the curriculum' in an integrated way, and that I could best prepare my pre-service teachers by making mathematics accessible and enjoyable. I described why and how I could improve my practice to provide invaluable mathematics learning and teaching experiences to enlighten and capacitate pre-service teachers.

In Chapter Four, I described the pilot project that I introduced to explore an integrated learning approach (ILA) to teach mathematics in the early childhood years. This project involved a group of first year pre-service Foundation Phase teachers. I addressed the second research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* This investigation focused on arts-based study methods,

and I explained how this approach assisted me in using an integrated learning approach in the Foundation Phase. By framing this investigation within the sociocultural theoretical perspective, I was guided to reflect deeply on new approaches to teacher education, particularly about the teaching and learning of mathematics in the Foundation Phase. The pre-service teachers' evaluations of the module guided my perspectives on what I needed to do to bolster the implementation of an integrated learning approach in this phase. I gained valuable insights into pre-service teachers' thinking about mathematical pedagogy and concepts, which encouraged me to plan zealously for the following year.

In Chapter Five, I focused on improving my teaching of the early childhood mathematics module, focusing on utilising an integrated learning approach. I responded to the second question again: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* My learnings from the pilot study influenced my planning for this group of student teachers. I described how I modelled the teaching of some concepts and presented illustrations of the resources I had used in the classroom and the work that the pre-service teachers had done. I described my contemplations and feelings to demonstrate how my learning developed as a teacher educator. I showed how I created a collage using cut-out words to make sense of my learning. I identified patterns and generated codes that were categorised and developed into themes. I noted the dilemmas I had encountered due to a large number of pre-service teachers in this class. Finally, I articulated what I had learnt from engaging with these pre-service teachers and described the importance of engaging in hands-on experiences to enhance their teaching mathematics efficacy. I explained how I had learnt to embrace culturally responsive mathematics education by considering my pre-service teachers' backgrounds and circumstances (Gunn, Evans, Peterson, & Welsh, 2013). I learnt that I needed to reflect critically on my practice and to embrace change.

In Chapter Six, I explained how I understood the effects of exploring an integrated approach with a third group of pre-service teachers. I once again addressed my second research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* Based on my observations of my pre-service teachers' progress, I extended my discourse on cultivating an integrated learning approach towards teaching the early childhood mathematics module. I optimised my exploration of an integrated learning approach through the use of cultural artefacts. It was possible to embark on this activity with a different group of pre-service teachers in the year following my first endeavours, and I thus

had sufficient data for comparison and evaluation. I learnt that I needed to continually plan activities that enhanced my pre-service teachers' creativity and engage them in conversations about different cultural heritages.

In Chapter Seven, I described the extramural activities that a smaller group of pre-service teachers and I engaged in. I again addressed the question: *What can I learn about cultivating an integrated learning approach (ILA) from working with pre-service teachers?* I felt a need to broaden my exploration of the integrated learning approach in the second semester of the third year of my research project. During extramural activities, my pre-service teachers and I did memory drawings and played different board games. We reflected on our learning of mathematics in primary school through memory drawings and realised that most of our experiences had been discouraging. Playing board games heightened our positive attitude to mathematics and created a playful atmosphere and enthusiasm for our respective tasks. I learnt that it was beneficial to work with pre-service teachers informally outside the classroom. Therefore, I shall pursue similar activities as I move forward even after my doctoral study and hopefully engage more pre-service teachers.

In Chapter Eight, I narrated my engagements with my critical friends. I responded to my third research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with critical friends?* I commenced by clarifying my critical friends' role throughout my study, and I demonstrated how I presented my data and findings to them at different times during the project. I evaluated the discussions that I had had with my critical friends and revealed what I had learnt. I concluded this chapter by reflecting on what I had learnt using a collage and journal entries. Dialogue and collaboration with critical friends enhanced my growth and allowed me to continue to share my work as I developed as a teacher educator.

In Chapter Nine, I narrated the nature of my engagements with my fellow doctoral candidates and my supervisor. I responded again to my third research question: *What can I learn about cultivating an integrated learning approach (ILA) from working with critical friends?* I interacted informally with this small group throughout my research project. In addressing this question, I learnt the value of presenting one's work to colleagues to develop an authentic self-study project. Their contributions enhanced the reflective nature of my study. My doctoral journey with my fellow candidates and my supervisor taught me the power of personal and

professional relationships in enriching understanding. The experience of working with this group both informed and enriched my doctoral research. I improved my writing skills and developed as a self-study researcher. Learning from my colleagues and my supervisor and gaining new insights far surpassed the uncomfortable feelings that I sometimes experienced when presenting my work.

10.3 Personal-Professional Learning

10.3.1 Personal learning

I was learning about myself through my interactions with pre-service teachers in a variety of ways. I learnt about the creative ideas of assisting them in understanding the concept of an integrated learning approach. I learnt that I could actually be creative. I also learnt more about the classroom environment and that this space should be learner-centred. I thus got to know my pre-service teachers better and to understand the problems they experience with mathematics. Schuck and Russell (2005) admit that it is a struggle to get to know pre-service teachers on a more personal level. I concur with this view, especially when dealing with large classes.

A key lesson I learnt from this study is that positive learning experiences can be generated by employing an integrated learning approach using actual objects that pre-service teachers can relate to. This approach has significant implications for the teaching and learning of mathematics in the Foundation Phase, given that it can be fun and challenging at the same time. Thus, it was vital that I modelled innovative practice, capacitating pre-service teachers to implement the integrated learning approach for teaching mathematics in the Foundation Phase one day.

Through my interactions with critical friends, I learnt to be open-minded and gained confidence as a self-study scholar. Ritter and Hayler (2019) argue that critical friendship allows for openness to critique, which is essential for developing and bettering teacher education practice. This required enormous effort because it was not as simple as it may sound. In the beginning, I felt the need to defend myself when a critical friend raised an uncomfortable question. However, responding to and reflecting on these questions yielded good results.

Below, I highlight four of my key learnings engendered by the self-study project. As noted by Korthagen (2017), valuable professional development begins when practitioners value their

own work. For instance, on this journey, I evolved and learnt not to be complacent. I grouped my learnings as follows: *Become an agent of your own professional growth; take responsibility for your personal development; resist complacency; strive for academic honesty and integrity.*

10.3.1.1 Become an agent of your own professional growth

Figure 10.1: An image of a woman doing push-ups

I chose the above image to represent the metaphor "shape your life". This image was used in the collage that my fellow early career academics and I made during a workshop (Masinga et al., 2016). It represents how overwhelmed I sometimes felt as an early career academic in a research-led university. I was expected to do it all – teach, conduct research, do community engagement, and many other responsibilities when I was still trying to find my feet. The image elicited the feeling that I was doing push-ups while someone was screaming at me to keep going. However, the words "shape your life" illustrate that once I had done the push-ups and worked hard, I became fit and felt empowered. This enhanced my personal development. As a mathematics teacher educator in the early childhood phase, I know now that I hold the key to educational change and improvement. I shall attempt to channel my pre-service teachers' negative experiences into positive ones (Schuck & Perreira, 2011).

10.3.1.2 Take responsibility for your personal development

"Taking responsibility for your personal development" means I should be proactive and initiate activities to develop further. For example, I initiated extramural activities during which my pre-service teachers and I played board games. By taking responsibility for my development, I should not wait for someone and then react. To illustrate, during this research project, I did not always wait for my supervisor to call me, but I took the initiative to send her emails when I got

stuck. I thus avoided being co-dependent. Fortunately, my supervisor had a system that we adhered to, and I then developed a system that suited me. For example, I understood that I was most productive when working in the morning. Hence, I allocated my time accordingly. I made notes as I read articles and book chapters and completed the reading records diligently. I then shared these notes with my supervisor and discussed what I was learning from the readings. As a result, I understood what I was passionate about as a scholar. As suggested by Trafford and Leshem (2009, p. 40), I strove to demonstrate "doctorateness". By continuing on this path, I shall contribute to knowledge and take responsibility for my continued development. It is a lifelong process – I shall continue to read extensively and present my work on available platforms.

10.3.1.3 Resist complacency

I made every effort to avoid being complacent as a scholar and teacher educator. According to Schuck (2011, p. 61), "self-study of teacher education practices is [sic] useful for resisting such complacency". Thus, I sought to employ innovative ways of transforming my practice, and, to do so, I explored using an integrated learning approach in teaching mathematics in the Foundation Phase. I engaged my pre-service teachers in extramural activities during which we played different board games to enhance their mathematics skills. I think stepping out of my comfort zone and the formal teaching environment afforded me valuable opportunities to learn about and know the pre-service teachers. As teacher educators, we need to think about creative ways of disrupting our teaching practices (Schuck, 2011). I presented my work to critical friends and received feedback that helped me to grow.

10.3.1.4 Strive for academic honesty and integrity

At times, doctoral students may be under pressure due to the many roles that they are expected to fulfil. Correspondingly, Nash (2004, p. 80) states that sometimes you find yourself caught up in various functions on your journey; for instance, "you are a scholar, practitioner, and teacher all rolled up in one". Although this may have been the case, I needed to strive for academic honesty and integrity. I might have felt overwhelmed and tempted to cut corners, but I had to do things correctly. Likewise, Ellis (2007) highlights the significance of continually reflecting on ethical practices every step of the way. In my future endeavours to improve my practice and become a reputable scholar, I should therefore not be tempted to get involved in unethical activities such as being dishonest or harming my participants and the people I interact with. Also, as I told my story in this thesis, I attempted to be as "nuanced and truthful as

possible" (Ellis, 2007, p. 214). I acknowledge that I am still learning, and I need to continue to develop my strengths in the hope of reaping the rewards one day.

10.3.2 Professional Learning

Reflection is a significant action for self-study researchers because it provides perspectives about improving practice. Dinkelman (2003) argues that teacher educators acquire insights about their work as they reflect on their practice using self-study. I was able to obtain and engender knowledge, which became more widely useful. Employing the self-study method enabled me to use unconventional teaching and research methods that enhanced my thinking.

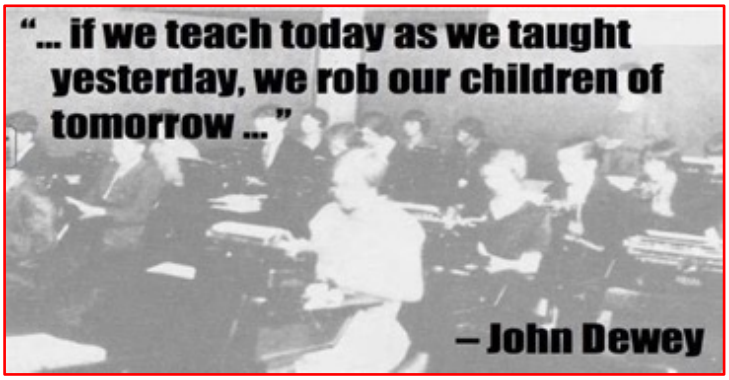


Figure 10:2: An image of adults using old typewriters

The adage by John Dewey (Figure 10.2), "if we teach today as we were taught yesterday, we rob our children of tomorrow", resonates with my experiences as I sought to develop professionally. The inventive methods that I used allowed me to learn from my pre-service teachers, as well. I plan to teach differently, and engaging in this study validated that it is possible. Moving forward, I shall make it my mission to reform my teacher education practice. This study has undeniably created knowledge about self-study methodologies. It has also contributed to knowledge about integration in the teaching and learning mathematics in teacher education, particularly in the Foundation Phase.

I learnt much from my colleagues through various collaborations at my institution and national platforms. I am thus more open to feedback than before. I shall make changes to my pedagogy; therefore, I shall continue to collaborate with colleagues to gain new insights and remain abreast of developments in my field of study. Critical friends prompt one to pause, reflect and consider the reasons for the actions taken in teaching pre-service teachers (Schuck &

Brandenburg, 2020). Therefore, this should be an ongoing process and should not stop after I have completed my thesis.

This self-study project taught me to focus on the following three fundamental learnings: *self-concept and efficacy; the affective domain*; and *signature pedagogy*.

10.3.2.1 Self-concept and self-efficacy

Confidence plays a significant role in any person's development. According to Henderson (2012, p. 376), a positive self-concept is the "over-arching construct that subsumes efficacy, also referred to as confidence". As an early childhood mathematics teacher educator, I learned to develop and display high self-efficacy in my classroom. Mahatma Gandhi once said, "If I have the belief that I can do it, I shall surely acquire the capacity to do it even if I may not have it at the beginning". In this self-study, I was working on my self-concept. Henderson (2012) argues that highly efficient teachers can employ more effective learner-centred teaching approaches and investigative practices than those with low self-efficacy who are prone to use teacher-centred methods. I learnt that I had to build a positive self-concept to teach mathematics and to accomplish my purpose of assisting my pre-service teachers to do the same. Likewise, pre-service teachers may one day help young learners in the Foundation Phase.

10.3.2.2 Affective domain

Throughout my research journey, I read about the importance of the affective domain. Korthagen (2017) maintains that students' experiences matter and states that "we feel, therefore we learn" (p. 390). I agree with this expression as my pre-service teachers felt loved, which was a beneficial experience. I thus learnt that I had to find ways to make them feel valued in the mathematics classroom as mathematics is notoriously regarded as a challenging, "elite" subject.

One of to support my pre-service teachers was to show them that I cared for them. According to Korthagen (2017), students become more confident when teacher educators show them that their experiences and feelings matter. I thus needed to take my pre-service teachers seriously and consider their responses carefully. I needed to engage personally with them so that they knew I heard what they were saying. The affective domain should receive as much attention as the cognitive domain. Samaras (2002) asserts that providing pre-service teachers with emotional and cognitive support structures allows them to get to know one another and to think

about the social and cultural effects that influence their development. Acknowledging this domain is critical if learners and students are to succeed.

10.3.2.3 Signature pedagogy

When I reflected on my study as a whole, I saw it as a process of developing 'a signature pedagogy'. I did not recognise this at the beginning of my research. Still, understanding the unique work done to teach mathematics in the early childhood phase made me realise the importance of embodying this discipline's essence. Shulman coined this concept and described signature pedagogies as "the types of teaching that organise the fundamental ways in which future practitioners are educated for their new professions" (Shulman, 2005, p. 57). I thus consider the integrated learning approach as my signature pedagogy. Shulman (2005) argues that awareness of our signature pedagogies make a difference because they play a role in influencing our future teahing practices.

During this doctoral study, I understood my signature pedagogy better and am now able to animate it in practice. Drawing on my background and past experiences, I embarked on employing an integrated learning approach as a pedagogical strategy to help pre-service teachers understand what is required to teach mathematics in the Foundation Phase. My pre-service teachers and I got an opportunity to reflect on our feelings towards mathematics during a memory work activity. I drew on Fletcher's (2019) model of "teaching games for understanding (TGfU)" and may now positively proclaim "playing games for understanding mathematics" (PGfUM) as my axiom. Involving pre-service teachers in playing board games as an extramural activity was invaluable and something I shall continue to do throughout my career as a teacher educator.

10.4 Methodological Learning

Choosing a self-study approach suited my purpose perfectly. Even though it was difficult for me to initially put myself at the centre, I concluded this study with a sense that this perspective was perfect because I learnt to focus on myself, which enhanced my growth and development to the advantage of my pre-service teachers. While putting myself at the heart of my research proved to be a challenge, the values of self-study that I learnt from many teacher education researchers helped me focus on myself, my growth, and *my* development.

The self-study methodology was difficult to understand initially, but I read extensively and concentrated on my learning. I found that the various self-study methods that I employed were appealing because they offered varying unconventional ways of generating and analysing data. These approaches assisted me in understanding the fundamental methodological concept for learning.

10.4.1 My writing journey

Feeling slightly uncomfortable at first, I asked myself the same question that has been raised by Kamler and Thompson (2006, p. 67): "Is the use of 'I' acceptable practice in doctoral writing?" It was a huge struggle to use the first-person perspective because, for a long time, I had been told that one has to be impersonal in academic writing. Then all of a sudden, I had to be personal and use the first-person perspective. I soon realised that, in this self-study project, how I felt mattered. Initially, I tended to downplay how I felt and thought it was not significant. But I soon began to feel like a researcher, a doctoral student, and teacher educator responsible for the early childhood mathematics module.

As the study progressed, I shifted from thinking mainly about my pre-service teachers' learning to focusing on *my* learning. This process was supported by my understanding of the sociocultural perspective. I learnt that it is desirable to emphasise the researcher's personal and subjective voice in a study of this nature. Nash (2004, p. 130) is of the view that "we need to unravel the system that perpetuates these genre dichotomies to teach and write the full range of possible genres". I concur with this view because it allowed me to write from a first-person perspective. It was an effort, as Nash (2004, pp. 130-131) rightly states: "The waters of traditional academia can be unusually rough and dangerous for scholarly transgressors to test". It was a challenge that I tackled head-on.

10.4.2 Using arts-based self-study methods

The study utilised a qualitative self-study research methodology because this approach provided me with opportunities to examine my own lived practices in context. The self-study arts-based methods, especially the collages, were instrumental in conceptualising my study and underscoring my findings. One of the expectations of being a doctoral student is writing a thesis. My chapters are clear, and all contain collages to illustrate my learning.

Figure 10.3 below portrays a selection of the collages that my pre-service teachers and I created during the project.

Figure 10.3: Collages

Samaras and Roberts (2011) maintain that teachers who engage in self-study research are inspired to improve their practice to help students improve their learning. The self is the focus of self-study research that aims to elicit an understanding of one's role in influencing students' learning (Samaras, 2011). I embarked on this self-study project because I anticipated that I could gain insight into enhancing my practice and add value to the teacher education community. Narrating my personal history offered me some prospects to consider my experiences and think about novel teaching methods. Schuck and Pereira (2011, p. 5) maintain that self-study inspires us to "continually endeavour to improve our practice to support our students' learning and, consequently, their teaching of maths". The self-study research approach was appropriate because my goal was to improve my practice in preparing pre-service teachers to teach mathematics in the Foundation Phase, using an integrated learning approach.

10.5 Conceptual and Theoretical Learning

In my attempts to improve my practice, I intended to know my pre-service teachers better. This was accomplished by taking heed of the sociocultural theoretical perspective. It was in this context that I strove to make mathematics accessible to them. Before embarking on this project, I used to explain mathematical concepts such as subitising, place value, additive relations, and so on out of context using the lecture (or the "chalk-and-talk") method. On this doctoral journey, however, I came to understand that knowledge is contextual. I also came to appreciate the active learning process that pre-service teachers need to be exposed to. Now I am genuinely a teacher educator who is more sensitive to my pre-service teachers' needs and interests.

Sociocultural theories of learning are based on the assumption that education is not solely an individual activity but also a social phenomenon. Alderton (2008, p. 101) points out that "communication and culture are more than just important aspects of learning; they are central tools through which learning develops". In exploring an integrated learning approach towards teaching mathematics in the Foundation Phase, I considered cultural tools that are believed to shape cognitive processes. For example, I demonstrated how learning could be mediated with the use of appropriate tools. By involving my pre-service teachers in the presentation and discussion of various cultural artefacts, they were able to illustrate the integration of mathematics with the everyday, real-life world. Making connections within mathematics, linking different learning areas, and integrating my pre-service teachers' existing knowledge with new knowledge, were pivotal steps in the process. I also allowed them to use their home language when they were presenting the artefacts. Upon reflection, I realised that I needed to

provide more opportunities for my pre-service teachers to acquire problem solving skills across various contexts and cultures so that they could better teach their learners one day.

By building on my pre-service teachers' cultural backgrounds, I learnt more about myself and my teaching practices, which equipped me to better support my pre-service teachers in the future. I was reminded to be continuously responsive to my pre-service teachers, to find out who they actually were and what they needed, rather than what I thought I needed. Thus, by taking a sociocultural stance in mathematics teacher education, I allowed myself to consider and utilise my pre-service teachers' cultural wealth. Moreover, by utilising and operationalising this perspective, I enriched my students' knowledge of mathematics and inspired them with new ways to teach it.

10.6 Original Contribution

This study explored an integrated learning approach in teacher education for teaching mathematics in the Early Childhood phase in South Africa. By examining international studies on integrating mathematics with real-life experiences and other learning areas, I drew on various scholars (Goos, 2014; Ladson-Billings, 2006; Nicol, 2010; Nicol, Archibald, & Baker, 2013). These studies promote the importance of culturally responsive knowledge and advocate for teacher educators to teach mathematics in culturally sensitive ways. I thus embarked on exploring my early childhood mathematics teacher education context through the sociocultural theoretical lens. Having completed this project, I may now add my voice to other South African scholars in conversations on mathematics integration, especially in early childhood mathematics modules in teacher education.

The experience I gained about learning mathematics through memory work has also been described in the literature. I discovered that the problems my students and I had experienced when we learnt mathematics had been similar for many learners over the years. The memory drawings that my students and I did helped us to tap into those memories. Conventionally, mathematics was taught as an "unrelated collection of skills, techniques and verbalisations" (Pereira, 2011, p. 149). Once I had identified the problems and challenges, I had to design and enact pedagogies that would be responsive to multiple histories that should be taken into consideration when teaching mathematics (see Chapters Five, Six and Seven). I thus devised teaching and research strategies for mathematics teaching using various art mediums that allowed me to understand innovative ways of teaching mathematics.

This study will undoubtedly contribute to the hitherto limited body of research conducted by mathematics teacher educators in the early childhood discipline. Schuck and Brandenburg (2020) draw attention to the absence of self-studies related to the preparation of early childhood educators. They pose the question, "Who is charged with supporting such teachers and are they getting support in mathematics education?" (Schuck & Brandenburg, 2020, p. 24). To the best of my knowledge, no study has been conducted in South Africa on mathematics teaching in Early Childhood teacher education employing the self-study methodology.

Schuck and Perreira (2011) claim that self-study urges researchers to continuously strive to enrich educational practices to support pre-service teachers' learning and, ultimately, their mathematics teaching. Therefore, as a teacher educator in the Foundation Phase, my focus was on teaching mathematics in this phase so that my pre-service teachers would be competent in both content and pedagogical content knowledge. According to Schuck and Perreira (2011, p. 6), "in self-study we examine the objective [mathematical content] and the subjective [ourselves as teachers], the subject matter and the pedagogy, the content and the processes". I wanted my pre-service teachers to develop confidence and mathematical self-efficacy to effectively employ an integrated learning approach in their classrooms one day. As a teacher educator, I have learnt to practice what I preach and model improving my practice through research and teaching. My endeavours will be underpinned by the sociocultural approach so that my pre-service teachers are exposed to a model they can explore in their teaching.

In my attempt to explore an integrated learning approach, I used unconventional research and teaching methods. As proposed by Samaras (2010), I was drawn to the arts to improve my pedagogy. This also helped me assist my pre-service teachers in understanding an integrated learning approach to teaching early childhood mathematics. I thus used arts-based methods for data generation, representation and analysis. While this is not new in self-study research, my research contributions will resonate in early childhood mathematics teacher education in the institution where I teach and, hopefully, in colleagues' work in broader contexts. I believe that I have now been capacitated to 'walk the talk' and to bring mathematics and the arts together through hands-on arts-based activities such as creating collages and concepts maps, artefact retrieval, and memory drawing.

Part of my contribution is how I created and presented my thesis. I presented this manuscript in a bright, colourful, engaging and unique way using collages and metaphors that embody

early childhood mathematics practices in teacher education. The thesis itself is an artefact of the integrated approach to mathematics teaching in early childhood and in teacher education. I would like my thesis to be accessible and exciting for a broad audience and for my undergraduate students. Badley (2017, p. 2) observes that academics "usually write for one another and do not even try to make their writing attractive". As a teacher educator, I believe that it was essential to demonstrate what I alluded to and show instead of just telling my students and the academic world about the value of the integrated learning approach.

10.7 Moving Forward

This study has been an incredible, impactful and directional journey. I received validation from pre-service teachers who increasingly found mathematics exciting and accessible through using an integrated learning approach. By engaging in a self-study project, I built a firm foundation for future research and practice. I value Schuck and Brandenburg's (2020) advice to give attention to both the pedagogical content knowledge and mathematical knowledge for teaching. Critical friends validated and affirmed the uniqueness of utilising an integrated learning approach in self-study and teacher education. I also shared my work with colleagues outside the self-study research community by presenting aspects of my work at national conferences in my field of study. By involving critical friends throughout this journey, my research was strengthened.

Based on this study, I aim to create an exciting and accessible classroom for my diverse groups of pre-service teachers. Moving forward, I envisage that my classes will be vibrant and resourceful, as depicted in Figure 10.4 below.

Figure 10.4: A collage depicting my future teacher education classroom

I shall strive to enhance the integrated learning approach in my teaching and cultivate innovative and arts-based self-study methods. As noted by Samaras (2002, p. 151), "innovation and learning are lifelong processes that can be modelled through one's teaching and self-study practices". These improved teacher education practices will be beneficial for my students. I envisage that their teaching of mathematics in the Foundation Phase will profoundly improve on the teacher-centred and punitive methods that I and many others experienced as schoolchildren. I hope to build on this self-study project by offering my pre-service teachers exciting opportunities to reconsider their early learning of mathematics and envision themselvves as change agents.

My goal is to continue to enrich my practice and abilities and to improve my pedagogy through self-study, arts-based methods, memory drawing, and integration, which I think go well together. I shall also share my efforts and attainments in that my work will enlighten and orientate others to develop positive mathematical learning experiences for pre-service teachers. In particular, memory drawings are invaluable in teacher education as they allow pre-service teachers to unravel their past experiences and gain intellectual joy from learning and teaching mathematics.

10.8 Conclusion

I conducted this study to explore an integrated learning approach in the early childhood mathematics module during the first semesters of three consecutive years in an undergraduate teacher education programme. In the first year, I commenced with a pilot study, and in the second semester of the last year, I engage a small group of pre-service teachers in extramural activities. My research demonstrated that interacting with pre-service teachers and connecting with them in a sociocultural way to learn about an integrated learning approach to mathematics teaching in the Foundation Phase were invaluable. I believe that this approach has significant implications for the teaching and learning of mathematics in this phase, given that it can be fun and challenging at the same time. Evidently, self-study methods (such as recalling personal history, using arts-based techniques, memory drawing, and constructing a critical friends' portfolio) were pivotal in this study. Without these methodologies, our understanding of the integrated learning approach would not have been enriched. Therefore, I intend to expand the methodological landscape of self-study by encouraging a robust arts-based approach to mathematics teaching in teacher education for the Foundation Phase.

This innovative approach was liberating because it engendered a different outlook on and provoked exciting prospects for teaching and learning mathematics in my pre-service teachers' classrooms one day. Moreover, teacher educators may feel at ease about involving their students in various innovative methods to guide them to understand and like mathematics teaching and learning. The findings of this self-study research project, which utilised an arts-based approach, are thought-provoking and will hopefully inspire other teacher educators to employ similar methods. I hope this study will provide insights into understanding the cultural influences that may impact the teaching approaches that teacher educators use in the future (Schuck, 2009). Using artefacts in mathematics learning is essential, especially in early childhood teacher education programmes.

The study will also contribute to research about collaborative teaching and learning. The presence of colleagues who acted as critical friends is vital in developing an authentic self-study project because their contributions enhance the reflective nature of such studies. Unfavourable comments may not be pleasant, but they must be viewed as a learning opportunity. I shall continue to share my work as it evolves because this will help me grow even more as a teacher educator.

I also used poetry as another arts-based medium as it concisely captured what I was learning in my self-study project. A Kyrielle is a French form of rhyming poetry written in quatrains (a stanza consisting of 4 lines). Each quatrain contains a repeating line or phrase as a refrain (usually appearing as the last line of each stanza). Each line within the poem consists of only eight syllables. There is no limit to the number of stanzas a Kyrielle may have, but three is considered the accepted minimum. I composed the poem presented below by using the chapter headings of this thesis, which are metaphors for my experiences, hopes, and achievements. I believe that poetry best captures the essence of my research. Below is my Kyrielle poem:

The echoing sea

First steps into unknown waters
I took my first tentative steps
I embarked on a journey of self-discovery
Into the broad luminous seas

Time to start paddling
I explored an integrated learning approach
I welcomed feedback from critical friends
Into the broad luminous seas

Keeping my head above water
I encountered some dilemmas
But now, I am floating, sailing through
Into the broad luminous seas

Watching the ebbing tide
I promoted the emotional aspect
I acknowledge that thinking and feeling matter
Into the broad luminous seas

In essence, as a teacher educator, I need to show my pre-service teachers that I care about them and their learning. I have been inspired by my development as an early childhood mathematics teacher educator. I hope to make a difference in my pre-service teachers' educational endeavours and that they, in turn, will inspire their learners to enjoy discovering mathematics.

REFERENCES

Adamu, A. U. (2003). *The Concept of Curriculum Integration: Its Meaning, Scope and Modalities*. Paper presented at the Workship on Integrating Qur'anic Education, Arewa House, Nigeria, March 14, 2003.

Adler, J., Pournara, C., & Graven, M. (2000). Integration with and across mathematics. *Pythagoras, 9*(53), 2-13.

Adler, J., Slonimsky, L., & Reed, Y. (2002). 'Subject-focused INSET and teachers' conceptual knowledge in practice'. In J. Adler & Y. Reed (Eds.), *Challenges of teacher development. An investigation of take-up in South Africa* (pp. 135-152). Pretoria: Van Schaik.

Alderton, J. (2008). Exploring self-study to improve my practice as a mathematics teacher educator. *Studying Teacher Education, 4*(2), 95-104.

Alfaki, I. M. (2015). University students' English writng problems: Diagnosis and remedy. *International Journal of English Language Teaching, 3*(3), 40-52.

Allender, D., & Allender J. (2006). How did our early education determine who we are as teachers? In L. M. Fitzgerald, M. L. Heston, & D. L. Tidwell (Eds.). *Collaboration and community: Pushing boundaries through self-study. Proceedings of the sixth international conference on self-study of teacher education practices.* Herstmonceux Castle, East Sussex, England, July 30 - August 3: Cedar Falls, IA: University of Northern Iowa.

Allender, J., & Manke, M. P. (2008). Evoking self in self-study: The analysis of artifacts. *Journeys of hope: Risking self-study in a diverse world, 14*(6), 20-23.

Atmore, E. (2013). Early childhood development in South Africa - progress since the end of aparthed. *International Journal of Early Years Education, 21*(2-3), 152-162.

Badley, G. F. (2018). Why and how academics write. *Qualitative Inquiry*, 1-10. doi:1077800418810722

Bailey, M. (Producer). (2017, 28 September). Corporal punishment: A teacher's point of view *Daily Maverick.*

Baker, C. K., Bitto, L. E., Wills, T., Galanti, T., & Eatmon, C. (2018). Developing teacher leaders through selfstudy: A mathematics education field experience. In T. Hodges & A. Baum (Eds.), *The handbook of research on teacher education* (pp. 635-658). Hershey, PA: IGI Global.

Barends, Z., & Nel, C. (2017). Work-integrated learning within the reading literacy component of foundation phase teacher preparation programmes. *South African Journal of Childhood Education, 7*(1), 1-13.

Bates, A. B., Latham, N., & Kim, J. (2011). Linking preservice teachers' mathematics self-efficacy and mathematics teaching efficacy to their mathematical performance. *School Science and Mathematics, 111*(7), 325-333.

Bertram, C., & Christiansen, I. (2015). *Understanding research: An introduction to reading research*. Pretoria: Van Schaik Publishers.

Bishop, A. J. (1988). *Mathematical enculturation: A cultural perspective on mathematics education*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Björklund, C., & Ahlskog-Björkman, E. (2017). Approaches to teaching in thematic work: early childhood teachers' integration of mathematics and art. *International Journal of Early Years Education, 25*(2), 98-111.

Boaler, J. (1998). Open and closed mathematics. *Journal for Research in Mathematics Education, 29*, 41-62.

Boaler, J., Chen, L., Williams, C., & Cordero, M. (2016). Seeing as understanding: The importance of visual mathematics for our brain and learning. *Journal of Applied & Computational Mathematics, 5*(5), 1-6.

Brady, P., & Bowd, A. (2005). Mathematics anxiety, prior experience and confidence to teach mathematics among pre-service education students. *Teachers and Teaching, 11*(1), 37-46.

Bragg, L. A. (2012). Testing the effectiveness of mathematical games as a pedagogical tool for children's learning. *International Journal of Science and Mathematics Education, 10*, 1444-1467.

Brandenburg, R. (2011). How students teach you to learn: Using roundtable reflective inquiry to enhance a mathematics teacher educator's teaching and learning. In S. Schuck & P. Pereira (Eds.), *What counts in teaching mathematics: Adding value to self and content* (pp. 77–91). Dordrecht: Springer.

Brüssow, S.M., & Wilkinson, A.C. (2010). Engaged learning: A pathway to better teaching. *South African Journal of Higher Education, 24*(3), 374-391.

Bullough, R. V., & Pinnegar, S. (2001). Guidelines for quality in autobiographical forms of self-study research. *Educational Researcher, 30*(3), 13-21.

Butler-Kisber, L. (2008). Collage as inquiry. In A. L. Knowles & L. Cole (Eds.), *Handbook of the arts in qualitative research* (pp. 265-276). Thousand Oaks: Sage Publications.

Butler-Kisber, L., & Poldma, T. (2010). The power of visual approaches in qualitative inquiry: The use of collage making and concept mapping in experiential research. *Journal of Research Practice, 6*(2), 1-16.

Carrim, N. (1998). Antiracism in the "new" South African educational order. *Cambridge Journal of Education, 28*(3), 301-320.

Case, J. M., Marshall, D., McKenna, S., & Mogashana, D. (2018). *Going to university: The influence of higher education on the lives of young South Africans* (Vol. 3). Cape Town: African Minds.

Chang, H. (2008). *Analyzing and interpreting data: Autoethnography as method*. California: Left Coast Press.

Charlesworth, R. (2012). *Experiences in math for young children*. Wadsworth, Boston: Cengage Learning.

Chisanga, T., & Meyiwa, T. (2020). Reflexive ubuntu, co-learning, and transforming higher education at a rural university in South Africa. In J. Kitchen (Ed.), *2nd International Handbook of Self-Study of Teaching and Teacher*

Education (pp. 1-16). Springer Nature Singapore: Springer International Handbooks of Education.

Christie, P. (1986). *The right to learn: The struggle for educaton in South Africa*. Johannesburg: Ravan Press.

Cimen, O. A. (2014). Discussing ethnomathematics: Is mathematics culturally dependent? *Procedia – Social and Behavioral Sciences,, 152*, 523-528.

Clarke, A., & Erickson, G. (2003). Teacher Inquiry: A defining feature of professional practice. In A. Clarke & G. Erickson (Eds.), *Teacher inquiry: Living the research in everyday practice* (pp. 1-6). London: Routledge Falmer.

Clements, D. H., Wilson, D. C., & Sarama, J. (2004). Young children's composition of geometric figures: A learning trajectory. *Mathematical Thinking and Learning, 6*(2), 163-184.

Cloutier, C. (2016). How I write: An inquiry into the writing practices of academics. *Journal of Management Inquiry, 25*(1), 69-84.

Coffman, T. (2006). Using simulations to enhance teaching and learning: Encouraging the creative process. *Virginia Society for Technology in Education Journal, 21*(2), 1-7.

Cohen, L., Manion, L., & Morrison, K. (2009). *Research methods in education*. New York: Routledge.

Conkbayir, M., & Pascal, C. (2016). *Early childhood theories and contemporary issues: An introduction*. Bloomsbury: London.

Cross, C. T., Woods, T. A., & Schweingruber, H. (2009). *Mathematics learning in early childhood*. Washington, DC: The National Academies Press.

Cross , M., Mungadi, R., & Rouhani, S. (2002). From policy to practice: Curriculum reform in South African education. *Comparative Education, 38*(2), 171-187.

Davis, J. S., & Maistry, S. M. (2017). 'Involvement' and 'Fun' as Potential for Deep Learning: Unusual Suspects in a Higher Education Economics Programme. *Alternation, 24*(2), 34-55.

Delaney, K. (2010). Making connections: Teachers and children using resources effectively. In I. Thompson (Ed.), *Issues in Teaching Numeracy in Primary Schools* (pp. 72-83). Berkshire: Open University Press.

Department of Basic Education. (2009). *National Early Learning and Development Standards for Children Birth to Four Years (NELDS)*. Pretoria: Government Press.

Department of Basic Education. (2011a). *Curriculum and Assessment Policy Statement Grades R-3: Life Skills*. Pretoria: Government Press.

Department of Basic Education. (2011b). *Curriculum and Assessment Policy Statement Grades R-3: Mathematics*. Pretoria: Government Press.

Department of Education. (2003). *Revised National Curriculum Statement Grades R-9: Teacher's Guide for the Development of Learning Programmes*. Pretoria: Department of Education.

Department of Higher Education and Training. (2015). *Revised Policy on Minimum Requirements for Teacher Education Qualifications*. Pretoria: Government Press.

Dewah, C., & Van Wyk, M. M. (2014). The place of indigenous cultural games by educators in the teaching and learning of mathematics. *Journal of Human Ecology, 48*(1), 189-197.

Dhlula-Moruri, M. N., Kortjass, M., Ndaleni, T., & Pithouse-Morgan, K. (2017). A stove, a flask, and a photograph: Learning together through object inquiry in self-study research. In D. Pillay, K. Pithouse-Morgan, & I. Naicker (Eds.), *Object medleys: Interpretive possibilities for educational research* (pp. 81-98). Rotterdam, Netherlands: Sense Publishers.

Dimitriadis, G., & Kamberelis, G. (2006). Lev Semenovich Vygotsky *Theory for Education* (Vol. 4, pp. 191-199). New York: Routledge.

Dinkelman, T. (2003). Self-study in teacher education: A means and ends tool for promoting reflective teaching. *Journal of Teacher Education, 54*(1), 6-18.

Dinkelman, T., Margolis, J., & Sikkenga, K. (2006). From teacher to teacher educator: Experiences, expectations, and expatriation. *Studying Teacher Education, 2*(1), 5-23.

Dockett, S., & Perry, R. (2010). What makes mathematics play? In M. S. t. f. o. M. Education (Ed.), (pp. 715-718). Fremantle: Mathematics Education Research Group of Australasia.

du Plessis, J. (2018). Early algebra: Repeating pattern and structural thinking at foundation phase. *South African Journal of Childhood Education, 8*(2), 1-11.

Eunsook, H. (2000). *Ecological human brain and young children's "naturalist intelligence" from the perspective of developmentally and culturally appropriate practice (DCAP).* Paper presented at the Ppaper presented to the AERA Annual Conference, April 24-28, 2000, New Orleans, Louisiana.

Feldman, A. (2003). Validity and quality in self-study. *Educational Researcher, 32*(3), 26-28.

Fiske, G. B., & Ladd, H. F. (2004). Balancing public and private resources for basic education: school fees in post-apartheid South Africa. In L. Chisholm (Ed.), *Changing class: Education and social change in post-apartheid South Africal*. Cape Town: HSRC Press.

Fleisch, B. (2007). *Primary education in crisis. Why South African schoolchildren underachieve in reading and mathematics*. Cape Town: Juta and Co.

Fletcher, T. (2012). Using self-study to develop a pedagogy of elementary teacher education: Addressing the specialist-generalist issue. In S. M. Bullock & T. Russell (Eds.), *Self-studies of science teacher education practices* (Vol. 12, pp. 85-102). Dordrecht: Springer.

Freire, P. (1998). *Pedagogy of freedom*. New York: Rowman & Littlefield Publishers.

Furman, R., Lietz, C., & Langer, C. L. (2006). The research poem in international social work: Innovations in qualitative methodology. *International Journal of Qualitative Methods, 5*(3), 24-34.

Gerdes, P. (1988a). On culture, geometric thinking and mathematics education. *Educational Studies in Mathematics, 19*(2), 137-162.

Gerdes, P. (1988b). On possible uses of traditional Angolan sand drawings in the mathematics classroom. *Educational Studies in Mathematics, 19*(1), 3-22.

Gerdes, P. (1998). On culture and mathematics teacher education. *Journal of Mathematics Teacher Education*(1), 33-53.

Gerhard, G., & Mayor-Smith, J. (2008). Casting a wider net: Deepening scholarship by changing theories. *International Journal for the Scholarship of Teaching and Learning, 2*(1), 1-11.

Gerstenblatt, P. (2013). Collage portraits as a method of analysis in qualitative research. *International Journal of Qualitative Research, 12*, 294–309.

Ginsburg, H. P., Lee, J. S., & Boyd, J. S. (2008). Mathematics education for young children: What it is and how to promote it. *Social Policy Report, XX22*(1), 3-22.

Goodell, J. (2006). Using critical incident reflections:A self-study as a mathematics teacher educator. *Journal of Mathematics Teacher Educational Psychologist, 9*(3), 221-248.

Goos, M. (2014). Creating opportunities to learn in mathematics education: A sociocultural perspective. *Mathematics Education Research Journal, 26*(3), 439-457.

Gordon, A. M., & Browne, K. W. (2014). *Beginnings and Beyond: Foundations in Early Childhood Education* (2nd ed.). Pretoria: Perskor.

Govender, D. S., & Sookrajh, R. (2014). 'Being hit was normal': Teachers'(un) changing perceptions of discipline and corporal punishment. *South African Journal of Education, 34*(2), 1-17.

Graham, A., Powell, M. A., & Taylor, N. (2015). Ethical research involving children: Encouraging reflexive engagement in research with children and young people. *Children & Society, 29*(5), 331-343.

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.

Guillemin, M., & Gillam, L. (2004). Ethics, reflexivity, and "ethically important moments" in research. *Qualitative Inquiry, 10*(2), 261-280.

Gunn, A., Bennett, S., Evans, L. S., Peterson, B. J., & Welsh, J. L. (2013). Autobiographies in preservice teacher education: A snapshot tool for building a culturally responsive pedagogy. *International Journal of Multicultural Education, 15*(1), 1-20.

Hagger, M. S., & Chatzisarantis, N. L. D. (2012). Transferring motivation from educational to extramural contexts: a review of the trans-contextual model. *European Journal of Psychology Education, 27*, 195-212.

Halinen, I. (2015). *General Aspects of Basic Education Curriculum Reform 2016 Finland*. Retrieved from www.noodle.com/articles/phenomenon-based-learning-what-is-pbl

Hamilton, M. L., Smith, L., & Worthington, K. (2008). Fitting the methodology with the research: An exploration of narrative, self-study and auto-ethnography. *Studying Teacher Education, 4*(1), 17-28.

Harley, K., & Wedekind, V. (2004). Political change, curriculum change and social formation, 1990 to 2002. In L. Chisholm (Ed.), *Changing class: Education and social change in post-apartheid South Africa*. Cape Town: HSRC Press.

Harris, P. (2007). Developing an integrated play-based pedagogy in preservice teacher education: A self-study. *Studying Teacher Education, 3*(2), 135-154.

Haylock, D., & Manning, R. (2014). *Mathematics explained for primary teachers* (4th ed.). London: Sage Publishers.

Hellison, D. R. (2003). *Teaching responsibility through physical activity* (2nd ed.). Champaign, IL: Human Kinetics.

Hiralaal, A. (2017). *A self-study of my role modelling as a teacher educator of accounting pedagogy* (Unpublished Phd thesis). University of KwaZulu-Natal, South Africa.

Houston, J. I., A., Singh, R. I., Ntenza, S. P., Hough, S. M., Grussendorff, D., & VBooyse, C. (2014). *What's in the CAPS package?: A comparative study of the National Curriculum Statement (NCS) and the Curriculum and Assessment Policy Statement (CAPS)*. Pretoria: Council for Quality Assurance in General and Further Education and Training.

Hughes, M. (1986). *Children and number: Difficulties in Learning Mathematics*. Oxford: Basil Blackwell.

Human, A., van der Walt, M., & Posthuma, B. (2015). International comparisons of Foundation Phase number domain mathematics knowledge and practice standard. *South African Journal of Education, 35*(1), 1-13.

Humphreys, A., Post, T., & Ellis, A. (1981). *Interdisciplinary Methods: A thematic Approach*. Santa Monica, CA: Goodyear Publishing Company.

Hunting, R. P. (2010). Little people, big play, and big mathematical ideas. In I. M. S. t. f. o. M. Education (Ed.), (pp. 715-718). Fremantle: Mathematics Education Research Group of Australasia.

John-Steiner, V., & Mahn, H. (1996). Sociocultural Approaches to Learning and Development: A Vygotskian Framework. *Educational Psychologist, 31*(3/4), 191-206.

Kamler, B., & Thompson, P. (2006). *Helping doctoral students write: Pedagogies for supervision*. London: Routledge.

Kampmann, J. (2018). The complexity of preparing new teachers. *Young children, 13*(3), 1-7.

Kitchen, J. (2016). Looking back on 15 years of relational teacher education: A narrative self-study. In J. Williams & M. Hayler (Eds.), *Professional learning through transitions and transformations* (pp. 167-182): Springer.

Korthagen, F. (2017). Inconvenient truths about teacher learning: Towards professional development 3.0. . *Teachers and Teaching, 23*(4), 387-405.

Kortjass, M. (2019a). Enriching Teaching Through Artefacts: An Early Childhood Mathematics Teacher Educator's Self-Study Project. *Educational Research for Social Change (ERSC), 8*(1), 70-85.

Kortjass, M. (2019b). Reflective self-study for an integrated learning approach to early childhood mathematics teacher education. *South African Journal of Childhood Education, 9*(1), 1-11.

Kortjass, M. (2020). Re-Envisioning early childhood mathematics education: Learning through memory drawing. In C. Edge, A. Cameron-Standerford, & B. Bergh (Eds.), *Textiles and Tapestries* (pp. 1-14): EdTech.

Krog, S. (2015). Movement activities: A critical link in developing motor skills and learning in early childhood. *African Journal for Physical, Health Education, Recreation and Dance, 21*(1:2), 426-443.

Kühne, C., Lombard, A., & Moodley, T. (2013). A learning pathway for whole numbers that informs mathematics teaching in the early years. *South African Journal of Childhood Education, 3*(2), 77-95.

Kunene, A. (2009). Learner-centeredness in practice: Reflections from a curriculum education specialist. In K. Pithouse, C. Mitchell, & R. Moletsane (Eds.), *Making connections: Self-study & social action* (pp. 139–152). New York: Peter Lang.

LaBoskey, V. K. (2004). The methodology of self-study and its theoretical underpinnings. In J. J. Loughran, M. L. Hamilton, V. K. LaBoskey, & T. Russell (Eds.), *International handbook of self-study of teaching and teacher education practices* (Vol. 2, pp. 817-869). Dordrecht: Kluwer Academic Publishers.

Ladson-Billings, G. (1995). That's Just Good Teaching! The Case for Culturally Relevant Pedagogy. *Theory into Practice, 34*(3), 159-165.

Ladson-Billings, G. (2006). It's not the culture of poverty, it's the poverty of culture: The problem with teacher education. *Anthropology & Education Quarterly, 37*(2), 104-109.

Lahman, M. K. E., Taylor, C. M., Beddes, L. A., Blount, I. D., Bontempo, K. A., Coon, J. D., . . . Motter, B. (2020). Research falling out of colorful pages onto paper: Collage inquiry. Qualitative Inquiry *Qualitative Inquiry, 26*(3-4), 262-270.

Lake, K. (1994). *Integrated Curriculum*. Oregon: Northwest Regional Education Laboratory (NWREL).

Laridon, P., Mosimege, M., & Mogari, D. (2005). Ethnomathematics research in South Africa. In R. Vithal, J. Adler, & C. Keitel (Eds.), *Researching Mathematics Education in South Africa: Perspectives, Practices and Possibilities* (pp. 133-160). Cape Town: HSRC Press.

Lee, Y. C. (2014). Teaching and sociocultural perspectives *In R. Gunstone (Ed.), Encyclopedia of Science Education* (pp. 1038-1041). Dordrecht: Springer.

Linder, S. M., Powers-Costello, B., & Stegelin, D. A. (2011). Mathematics in early childhood: Research-based rationale and practical strategies. *Early Childhood Education Journal, 39*, 29-37.

Loughran, J. J. (2004). *A history and context of self-study of teaching and teacher education practices* (Vol. 1). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Lovin, L. H., Sanchez, W. B., Leathan, K. R., Chauvot, J. B., Kastberg, S. E., & Norton, A. H. (2012). Examining Beliefs and Practices of Self and Others: Pivotal points for change and growth for mathematics teacher educators. *Studying Teacher Education, 8*(1), 51-68.

Luneta, K. (2014). Foundation phase teachers' (limited) knowledge of geometry. *South African Journal of Childhood Education, 4*(3), 71-86.

Maasepp, B., & Bobis, J. (2015). Prospective Primary Teachers' Beliefs about Mathematics. *Mathematics Teacher Education and Development, 16*(2), 89-107.

Madondo, S., Mkhize, N., & Pithouse-Morgan, K. (2019). "I recognised that I needed to look searchingly at my own teaching": Storywork as a self-study method for educational research for social change. *Educational Research for Social Change, 8*(2), 14-28.

Mampane, R., & Bouwer, C. (2011). The influence of township schools on the resillience of their learners. *South African Journal of Education, 31*, 114-126.

Marais, P. (2011). The significance of student teachers' involvement in co-curricular activities. *International Journal for e-Learning Security, 1*(2), 81-88.

Masinga, L. (2012). Journeys to self-knowledge: Methodological reflections on using memory-work in a participatory study of teachers as sexuality educators. *Journal of Education and Research, 54*, 121-137.

Masinga, L., Myende, P., Marais, A., Singh-Pillay, A., Kortjass, M., Chirikure, T., & Mweli, P. (2016). "Hear our voices": A collective arts-based self-study of early-career academics on our learning and growth in a research-intensive university. *Educational Research for Social Change, 5*(2), 117-135.

Mathison, S., & Freeman, M. (1997). *The logic of interdisciplinary studies.* Paper presented at the Paper presented at the 1997 Annual Meeting of the American Educational Research Association Retrieved on 12 September 2013 from http://cela. albany.edu/reports/mathisonlogic12004.pdf.
Maxwell, J. A., & Miller, B. (2008). Categorizing and connecting as components in qualitatve data analysis. In P. Leavey & S. Hesse-Biber (Eds.), *Handbook of emerging methods* (pp. 461-475). New York: Guilford.
McGlynn-Stewart, M. (2010). Listening to students, listening to myself: Addressing pre-service teachers' fears of mathematics and teaching mathematics. *Studying Teacher Education, 6*(2), 175-186.
Mercer, N., & Sams, C. (2006). Teaching Children How to Use Language to Solve Maths Problems. *Language and Education, 20*(6), 507-528.
Mitchell, C. (2008). Getting the picture and changing the picture: visual methodologies and educational research in South Africa. *South African Journal of Education, 28*, 365-383.
Mitchell, C. (2011). *Doing visual research*. London: Sage.
Mitchell, C., MacEntee, K., Cullinan, M., & Allison, P. (2019). Working with photographs: Seeing, looking, and visual representation as professional learning. In K. Pithouse-Morgan, D. Pillay, & C. Mitchell (Eds.), *Memory Mosaics: Researching teacher professional learning through artful memory-work* (pp. 35-54). Cham, Switzerland: Springer.
Mitchell, C., Magubane, S., Burkholder, C., & Saloojee, S. (2019). Ethically significant moments in stirring up memories. In K. Pithouse-Morgan, D. Pillay, & C. Mitchell (Eds.), *Memory Mosaics: Researching teacher professional learning through artful memory-work* (pp. 175-192). Cham, Switzerland: Springer.
Mntunjani, L. M., Adendorff, S. A., & Siyepu, S. W. (2018). Foundation phase teachers' use of manipulatives to teach number concepts: A critical analysis. *South African Journal of Childhood Education, 8*(1), 1-9.
Moll, I., Welch, T., & Naidoo, J. (2004). Curriculum responsiveness in programme and materials development for distance Teacher Education. In H. Griesel (Ed.), *Curriculum responsiveness: Case studies in Higher Education*. Pretoria: SAUVCA.
Moosa, & Bhana, D. (2019). Masculinity as care: men can teach young children in the early years. *Early Years: An International Journal*, 1-15.
Morrell, R. (2001). Corporal punishment in South African schools: A neglected explanation for its persistence. *South African Journal of Education, 21*(4), 292-299.
Morrow, W. (2007). *Learning to teach in South Africa*. Pretoria: HSRC Press.
Motswai, N. (2018, April). Mishael Matohndze is the best in her class. *Public Sector Manager, 20-21*.
Moyo, G., Khewu, N. P., & Bayaga, A. (2014). Disciplinary practices in schools and principles of alternatives to corporal punishment strategies. *South African Journal of Education, 34*(1), 1-14.
Mpungose, C. B. (2020). Is Moodle or WhatsApp the preferred e-learning platform at a South African university? First-year students' experiences. *Education and Information Technologies*, *25*, 927–941.
Murray, C., Grant, M. J., Howarth, M. L., & Leigh, J. (2008). The use of simulation as a teaching and learning approach to support practice learning. *Nurse education in practice, 8*(1), 5-8.
Nash, R. J. (2004). *Liberating scholarly writing: The power of personal narrative*. New York: Teachers College Press.
National Association for the Education of Young Children, N. (2002). *Early Childhood Mathematics: Promoting Good Beginnings*. A joint position statement of the National

Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM). Adopted in 2002. Updated in 2010.
National Department Commission: Department of Presidency. (2012). *National Development Plan 2030: Our Future-make it work*. Pretoria: Government Press.
Naudé, M., & Meier, C. (2016). *Teaching Foundation Phase Mathematics: A guide for South African students and teachers.* Pretoria: Van Schaik Publishers.
Ndimande, B. S. (2016). School choice and inequalities in post-apartheid South Africa. *Global Education Review, 3*(2), 33-49.
Nealson, K. H., & Hastings, W. (2006). Quorum sensing on a global scale: Massive numbers of biolumnescent bacteria make milky seas. *Applied and Environmental Microbiology, 72*(4), 2295-2297.
Nicol, C. (2011). Growing possibilities: Designing mathematical and pedagogical problems using variation. In S. Schuck & P. Pereira (Eds.), *What counts in teaching mathematics: Adding value to self and content* (Vol. 11, pp. 45-60). New York: Springer.
Nicol, C., Archibald, J., & Baker, J. (2013). Designing a model of culturally responsive mathematics education: Place, relationship and storywork. *Mathematics Education Research Journal, 25*, 73-89.
Nicol, C., Archibald, J., & Baker, J. (2013). Designing a Model of Culturally Responsive Mathematics Education: Place, Relationship and Storywork *Mathematics Education Research Journal, 25*, 73-89. doi:10.1007/s13394-012-0062-3
Nieuwenhuis, J. (2010). Introducing qualitative research. In K. Maree (Ed.), *First Steps in Research* (pp. 98-122). Pretoria: Van Shaik Publishers.
Nkopodi, N., & Mosimege, M. (2009). Incorporating the indigenous game of morabaraba in the learning of mathematics *South African Journal of Childhood Education, 29*, 377-392.
O'Reilly-Scanlon, K. (2002). Muted echoes and lavender shadows: Memory work and self-study. In C. Kosnik, A. R. Freese, & A. P. Samaras (Eds.), *Making a difference in teacher education through self-study*. Proceedings of the Fourth International Conference on Self-Study of Teacher Education Practices, Herstmonceux Castle, East Sussex, England (Vol. 2. pp. 74-78). Toronto, ON, Canada: OISE University of Toronto.
Padayachie, R., Atmore, E., Biersteker, L., King, R., Matube, J., Muthayan, S., . . . Evans, J. L. (1994). *Report of the South African Study on Early Childhood Development*. Johannesburg/Washington, DC: Centre for Education Policy Development/World Bank.
Parker, D. (2006). Grade 10-12 mathematics curriculum reform in South Africa: A textual analysis of new national curriculum statements. *African Journal of Research in Science, Mathematics and Technology Education, 10*, 59-73.
Parker, M., Patton, K., & O'Sullivan, M. (2016). Signature pedagogies in support of teachers' professional learning. *Irish Education Studies, 35*(2), 137-153.
Payet, J.-P., & Franchi, V. (2008). 'The rights of the child and 'the good of the learners': A comparative survey on the abolition of corporal punishment in South African schools. *Childhood, 15*(2), 157-176.
Pereira, P. (2005). Becoming a teacher of mathematics. *Studying Teacher Education, 1*(1), 69-83.
Pinnegar, S., & Hamilton, M. L. (2009). *Self-study of practice as a genre of qualitative research:Theory, methodology, and practice*. Dordrecth, The Netherlands: Springer.
Pithouse, K., Mitchell, C., & Weber, S. (2009). Self-study in teaching and teacher development: A call to action. *Educational Action Research, 17*(1), 43-62.

Pithouse-Morgan, K., Makhanya, H., Downing, G., & Phewa, N. (2019). Picturing a more hopeful future: Teacher-researchers drawing early memories of school. In K. Pithouse-Morgan, D. Pillay, & C. Mitchell (Eds.), *Memory mosaics: Researching teacher professional learning through artful memory-work* (pp. 55-75). Cham, Switzerland: Springer.

Pithouse-Morgan, K., & Samaras, A. P. (2017). Thinking in space: Virtual bricolage self-study for future-oriented teacher professional learning. In D. Garbett & A. Ovens (Eds.), *Being self-study researchers in a digital world: Future oriented research and pedagogy in teacher education* (Vol. 16, pp. 133-150). New York: Springer.

Pithouse-Morgan, K., & van Laren, L. (2012). Towards academic generativity: working collaboratively with visual artefacts for self-study and social change. *South African Journal of Education, 32*(4), 416-427.

Pournara, C., Hodgen, J., Adler, J., & Pillay, V. (2015). Can improving teachers' knowledge of mathematics lead to gains in learners' attainment in Mathematics? *South African Journal of Education, 32*(5), 1-10.

Pradhan, J. B. (2018). Cultural Games as a Pedagogical Tool: A Nepales Experience of Teaching and Learning of School Mathematics. *International Journal of Mathematics Trends and Technology (IJMTT), 60*(4), 198-204.

Ramani, G. B., & Eason, S. H. (2015). It all adds up: Learning early math through play and games. *Phi Delta Kappan, 96*(8), 27-32.

Ramani, G. B., Siegler, R. S., & Hitti, A. (2012). Taking it to the classroom: Number board games as a small group learning activity. *Journal of Educational Psychology, 104*(3), 661-672.

Reddy, V., Meyer, S., Shefer, T., & Meyiwa, T. (2014). Towards a critical theory of care. In V. Reddy, S. Meyer, T. Shefer, & T. Meyiwa (Eds.), *Care in context: Transnational gender perspectives* (pp. 1-27). Cape Town: HSRC Press.

Richards, J. C. (2013). Exploring education students' reflexivity through the arts and sharing my "bricolage" dilemmas. *The Qualitative Report, 18*(44), 1-23.

Richardson, L. (2000). New writing practices in qualitative research. *Sociology of Sport Journal, 17*(1), 5-20.

Ritter, J. K., & Hayler, M. (2019). Challenges in engaging in self-study within teacher education contexts. In J. Kitchen, A. Berry, H. Guðjónsdóttir, S. M. Bullock, M. Taylor, & A. R. Crowe (Eds.), *2nd International Handbook of Self-Study of Teaching and Teacher Education* (pp. 1-27). Singapore: Singapore.

Samaras, A. P. (2002). *Self-study for teacher educators.* New York: Peter Lang.

Samaras, A. P. (2010). Explorations in using arts-based self-study methods. *International Journal of Qualitative Studies in Education, 23*(6), 719-736.

Samaras, A. P. (2011). *Self-Study Teacher Research: Improving your Practice Through Collaborative Inquiry*. London: Sage Publications, Inc.

Samaras, A. P., & Freese, A. R. (2006). *Self-study of teaching practices primer*. New York: Peter Lang.

Samaras, A. P., Hicks, M. A., & Garvey, B., J. (2004). Self-study through personal history. In J. Loughran, M. L. Hamilton, V. K. LaBosky, & T. Russell (Eds.), *The international handbook of self-study of teaching and teacher education practices* (pp. 905-942). Dordrecht, The Netherlands: Kluwer Academic Press.

Samaras, A., & Roberts, L. (2011). Flying solo: Teachers take charge of their learning through self-study research. *JSD, 32*(5), 42-45.

Santori, D., Ven, K., & Hennessey, K. (2019). Collaborative exploration of classroom discourse (voices). *Young children, 74*(3), 1-16.

SANTS. (2013). *Numeracy in the Foundation Phase (NFO116) Student Training Manual*. Lynnwood Ridge: South African National Tutor Services.
Schratz, M. (1992). Researching while Teaching: An Action Research Approach in Higher Education. *Studies in Higher Education, 17*(1), 81-95.
Schuck, S. (2002). Using self-study to challenge my teaching practice in mathematics education. *Reflective Practice, 3*(3), 327-337.
Schuck, S. (2009). How did we do? Beginning teachers teaching mathematics in primary schools. *Studying Teacher Education, 5*(2), 113-123.
Schuck, S. (2011). Resisting complacency: My teaching through an outsider's eyes. In S. Schuck & P. Pereira (Eds.), *What counts in teaching mathematics: Adding value to self and content* (Vol. 11, pp. 61-73). New York: Springer.
Schuck, S., & Brandenburg, R. (2020). Self-study in mathematics teacher education. In J. Kitchen, A. Berry, H. Guðjónsdóttir, S. M. Bullock, M. Taylor, & A. R. Crowe (Eds.), *2nd International Handbook of Self-Study of Teaching and Teacher Education* (pp. 1-29). Singapore: Springer Singapore.
Schuck, S., & Grootenboer, P. (2004). Affective issues in mathematics education. In B. Perry, G. Anthony, & C. Diezmann (Eds.), *Research in mathematics education in Australasia 2000-2003* (pp. 53-74). Flaxton, QLD: PsostPressed.
Schuck, S., & Pereira, P. (2011). What counts in mathematics education? In S. Schuck & P. Pereira (Eds.), *What counts in teaching mathematics: Adding value to self and content* (pp. 1-9). New York: Springer.
Schuck, S., & Russell, T. (2005). Self-study, critical friendship and the complexities of teacher education. *Studying Teacher Education: A Journal of Self-Study of Teacher Education Practices, 1*(2), 107-121.
Shinga, S. (February, 2018). Accounting academic encourages students in maths day initiative. *UKZNdaba Online, 6*(4), 1-2. Retrieved from ndabaonline.ukzn.ac.za/StoryPrinter.aspx?id=5297
Shoemaker, B. (1989). Integrative Education: A Curriculum for the Twenty-First Cectury. *Oregon School Study Council* (Vol. 33/2).
Shulman, L. S. (1986). Those who understand: knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.
Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*, 1-22.
Shulman, L. S. (2005). Signature Pedagogies in the Professions. *Daedalus, 134*(3), 52-59.
Siemon, D., Adendhorf, S., Austin, P., Fransman, J., Hobden, S., Kaino, L., . . . Warren, E. (2017). *Teaching Mathematics: Foundation and Intermediate Phase*. Cape Town: Oxford University Press.
Sigelman, E., & Rider, C. (2006). *Life-Span Human Development*. Belmont, CA: Wadsworth Cengage Learning.
Strauss, V. (2015). "No, Finland isn't ditching tradtional school subjects. Here's what's really happening.". *The Washington Post*.
Sword, H. (2009). Writing higher education differently: A manifesto on style. *Studies in Higher Education, 34*(3), 319-336.
Tahir, S. (2010). Building big number times tables. *Procedia Social and Behavioral Sciences, 8*, 164-172.
Taylor, P. C. (2014). Socio-cultural perspectives and characteristics *In R. Gunstone (Ed.), Encyclopedia of Science Education* (pp. 981-983). Dordrecht: Springer.
Thames, M. H., & Ball, D. L. (2010). What math knowledge does teaching require? . *Teaching children mathematics, 17*(4), 220-229.

Thames, M. H., & Ball, D. L. (2010). What math knowledge does teaching require? *Teaching children mathematics, 17*(4), 220-229.

Thorpe, K. (2004). Reflective learning journals: From concept to practice. *Reflective Practice, 5*(3), 327-343. doi:10.1080/1462394042000270655

Tidwell, D. L., & Jónsdóttir, S. R. (2020) . Methods and tools of self-study. In J. Kitchen, A. Berry, S. M. Bullock, A. R. Crowe, M. Taylor, H. Guðjónsdóttir, & L. Thomas (Eds.), *2nd International handbook of self-study of teaching and teacher education* (1-50). Singapore: Springer.

Trafford, V., & Leshem, S. (2008). *Stepping stones to achieving your doctorate*. Maidenhead, UK: Open University Press.

Trafford, V., & Leshem, S. (2009). Doctorateness as a threshold concept. *Innovations in Education and Teaching International, 46*(3), 305-316.

Trauth-Nare, A., Buck, G. A., & Beeman-Cadwallader, N. (2016). Promoting student agency in science inquiry: A self-study of relational pedagogical practices in science teacher education *Enhancing professional knowledge of pre-service science teacher education by self-study research* (pp. 43-67). Cham, Switzerland: Springer International Publishing.

Tsamir, P., Tirosh, D., & Levenson, E. (2011). Windows to early childhood mathematics teacher education. *Journal of Mathematics Teacher Education, 14*, 89-92.

Turner-Bisset, R. (1999). The knowledge bases of the expert teacher. *British Educational Research Journal, 25*(1), 39-55.

van den Heuvel-Panhuizen, M., Kühne, C., & Lombard, A. (2012). *Learning pathway for number in the early primary grades*. Northlands, South Africa: Macmillan.

van Laren, L. (2014). Beyond metaphor drawings to envisage integration of HIV & AIDS education: A self-study in primary Mathematics teacher education. *Perspectives in Education, 32*(2), 21-36.

Van Schalkwyk, G. J. (2010). Collage Life Story Elicitation Technique: A Representational Technique for Scaffolding Autobiographical Memories. *The Qualitative Report, 15*(3), 675-695.

Venkat, H., & Askew, M. (2018). Mediating primary mathematics: theory, concepts, and a framework for studying practice. *Education Studies in Mathematics, 97*, 71-92.

Venville, G., Wallace, J., Rennie, L. J., & Malone, J. (1998). The integration of science, mathematics, and technology in a discipline-based culture. *School Science and Mathematics, 98*(6), 294-302.

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental processes*. Cambridge MA: Havard University Press.

Warin, J. (2019). Conceptualising the value of male practitioners in early childhood education and care: gender balance or gender flexibility. *Gender and Education, 31*(3), 293-308.

Weber, S. (2014). Arts-based self-study: Documenting the ripple effect. *Perspectives in Education, 32*(2), 8-20.

Wilmot, D., & Shäfer, J. (2015). Visual arts and the teaching of the mathematical concepts of shape and space in Grade R classrooms. *South African Journal of Childhood Education, 5*(1), 62-84.

Yin, R. K. (2011). *Qualitative research from start to finish*. New York: The Guilford Press.

Zayyadi, M., Hasanah, S. I., & Surahmi, E. (2018). Ethnomatematics exploration in traditional games as a form of students' social interaction. *Jurnal Ilmiah Pendidikan Matematika, 6*(2), 125-132.

ANNEXURE A: LESSON PLAN OVERVIEW

Grade	Content Areas	Lesson Topics	ILA - Maths (Integration of concepts within the mathematics learning area)	ILA – Lang (Integration with the Languages learning area)	ILA – Life Skills (Holistic Development) (Integration with the Life Skills learning area)	Sociocultural Theoretical Perspective (Vygotsky)
Grade R	Numbers, Operations and Relationships	**Lesson 1**: Counting	Number patterns	Say and use number names in familiar contexts (listening & speaking)	Fine motor skills Performing arts – action rhyme rational counting, value of numbers *Cognitive development* *Physical development*	Human activities take place in cultural contexts, are mediated by language and other symbols, systems, and can be best understood when investigated in their historical development.
		Lesson 2: Number recognition	Number of 2-shapes and 3-D objects	Recognise and read number names Rhymes Story	Familiar contexts – learners' personal details: age, house no. *Social development* *Cognitive development*	Modes of tools like artefacts – social resources Sociocultural researchers emphasise methods that document cognitive and social change.
Grade 1	Patterns, Functions and Algebra	**Lesson 3**: Patterns - Copy, extend, describe and create patterns	Numbers (counting)	Listen to and repeat rhythmic patterns and copy them correctly	Creating, interpreting & presenting Movement – Gross motor skills *Physical development* *Emotional development*	Kinetic concepts linked to culturally shared systems and to developmental activities.
		Lesson 4: Patterns around us	Space and shape Symmetry	Patterns in sounds & songs.	Plant and animals Pattern movement Laterality *Social development*	The socio-cultural environment, the world of things, created by human labour.

Grade	Content Areas	Lesson Topics	ILA - Maths (Integration of concepts within the mathematics learning area)	ILA – Lang (Integration with the Languages learning area)	ILA – Life Skills (Holistic Development) (Integration with the Life Skills learning area)	Sociocultural Theoretical Perspective (Vygotsky)
Grade 2	Space and Shape (Geometry)	**Lesson 5**: Two-Dimensional (2-D shapes)	Patterns, functions and algebra	Communication among learners, negotiating how to create shapes with bodies	Participating & working collaboratively Body movements: Jumping, playing hopscotch *Physical development* *Social development*	In psychological framework, the unification of nature & culture is powerfully embodied in early development .
	Space and Shape (Geometry)	**Lesson 6**: Three-Dimensional (3-D objects)	Patterns, functions and algebra: 3-D objects in patterns Arranging objects from smallest to biggest	Community & negotiating creation of shapes with bodies Language vocabulary: taller, wider, round, flat, corners	Objects from the community: relate their own world to mathematical 3-D objects *Social development* *Emotional development*	Synthesising several influences into learner's novel modes of understanding and participation.
Grade 3	Measurement	**Lesson 7**: Measuring length	Space and shape Measuring 2-D shapes Operations – adding measures of the sides	Solve word problems and participate in discussions & conversations. Vocabulary: long, short, wide, narrow Enjoy rhymes	Body movements - physical education Perceptual skills *Cognitive development* *Social development*	Extended opportunities for discussion & problem solving in the context of shared activities in which meaning & action are collaboratively constructed & negotiated.
		Lesson 8: Measuring perimeter and area	3-D objects Operations – adding measures of the sides	Solve word problems Language skills - Vocabulary: long, short, wide, longest, narrow, thick, thin, as long as, low, deep, shallow, shorter, longer, shortest, tallest	Objects from the community. Cooperative learning Perceptual skills *Cognitive development*	Education thought in terms not of the transmission of knowledge but of transaction & transformation of knowledge & creation of the new.

ANNEXURE B: LESSON PLANS

LESSON PLAN 1

Date: March 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Grade R learners Counting

CAPS Topics: Counting objects, count forwards and backwards

Lesson Vocabulary: Numbers one to ten

Objectives:

By the end of the session, students should be able to:

- Understand what learners need to learn in order to develop their number sense.
- Understand how to teach numbers informally during other activities throughout the day.
- Explain what counting is, the different ways of counting and describe how to teach counting on a concrete and semi-concrete levels.
- Explain how to teach counting forwards and backwards on a concrete level using concrete objects, rhymes and songs and body movements.
- Discuss how to teach counting forwards and backwards on a semi-concrete level.
- Describe activities that a teacher can use to teach Grade R learners counting.

Learning Areas	Integration
Life-Skills	Creative arts: Manipulate and work with materials, move and make music Everyday objects – blocks, sticks, leaves, windows in the classroom, stones, bread tags, bottle tops Songs and rhymes (performing arts) Rhythm - action songs
Language	Story with repetitive structure – Three little pigs Memorise and perform action rhymes, simple poems and songs

Knowledge	Skills	Values
Rote counting - knowing the counting words in the correct sequence **Rational counting** - counting of real objects with understanding **Value of numbers** **One-to-one correspondence**	**Estimation** can assist learners to understand the value of numbers **Counting skills**	Respecting one another Work as a member of the group Handling of resources

Resources: Number Frieze, counting blocks, counting sticks, dot cards, picture cards, magazines, scissors, glue, beads and straws.

Mental Mathematics

Count aloud from 1 - 5

Introduction

Ask questions on a story of 'Three little pigs'. (Learnt in the language lesson)

- How many pigs were there?
- Which pig built its house with bricks?

LESSON PRESENTATION

Developmental Stage 1.

What is counting? Counting in Grade R is when the learners learn to count up to 10 everyday objects accurately. Counting can be divided into **rote counting** (knowing the counting words in the correct sequence) and **rational counting** (counting of objects with understanding). In learning to count it also important that learners understand the **value of numbers** and what **one-to-one correspondence** means. **Estimation** can assist learners to understand the value of numbers.

Developmental Stage 2

Some Grade R learners may already know some counting words, but maybe not in the correct sequence. Teach them step by step – gradually increasing the counting sequence until they know the sequence from one to ten by heart.

Learners must be able to recite the counting words in the correct order before they can count with understanding. Rote counting in Grade R means to be able to say the counting words in the correct order: One, two, three … up to ten.

When you teach rote counting in Grade R you want your learners to feel the rhythm of counting – using number rhymes and songs.

It is important that you must teach your learners songs in their home language.

Example of a number rhyme: ***One little finger, one little finger, one little finger, tap, tap, tap.***

Example of a song/rhyme: ***Ten green bottles***

The main objective here is to teach learners the order of the counting words in an informal way: one must be followed by two; two must be followed by three, etc.

Once learners can do rote counting, they can use the counting words in one-to-one correspondence to do rational counting (counting with understanding).

Developmental Stage 3

One-to-one correspondence

Matching one-to-one – when you hand out papers for an activity show learners that you are matching one-to-one, one paper for one learner. Say 'one for you' and 'one for you' as you hand out the papers.

Model one-to-one correspondence – at the start of the day when you need to complete the register, walk around the class, touching each learner gently as you count aloud. Tell the learners that the last number you say is the number of learners at school today.

Matching objects – Give learners counters such as stones or bottle tops that will fit on top of the dots.

Counting objects – Remind your learners that each object they count must be given only one number name and that they must count using the correct number order; 1, 2, 3, 4 … Explain to your learners that the last number they say is the number of counters they have.

Discuss applicable questions

Assessment / Application

Students discuss activities that a teacher can use to teach Grade R learners counting.
For example: counting body parts, counting body movements, counting and clapping hands, counting and stamping feet, climbing steps.
Students reflect by answering the following questions:
Tweet your friend about: (140 characters)

- What you understand about Integrated Learning Approach (ILA)?
- How was integration implemented in this lesson?

Conclusion / Homework

Students make their own dot cards and picture cards.

Design art activities to use pictures for counting. For example, ask learners to cut out a magazine picture of one thing (object). Or you can ask your learners to draw one thing. The class can all combine their pictures to make a joint display of all the one thing.

Three little pigs

Once upon a time there were three little pigs. One pig built a house of straw while the second pig built his house with sticks. They built their houses very quickly and then sang and danced all day because they were lazy. The third little pig worked hard all day and built his house with bricks.
A big bad wolf saw the two little pigs while they danced and played and thought, "What juicy tender meals they will make!" He chased the two pigs and they ran and hid in their houses. The big bad wolf went to the first house and huffed and puffed and blew the house down in minutes. The frightened little pig ran to the second pig's house that was made of sticks. The big bad wolf now came to this house and huffed and puffed and blew the house down in hardly any time. Now, the two little pigs were terrified and ran to the third pig's house that was made of bricks.
The big bad wolf tried to huff and puff and blow the house down, but he could not. He kept trying for hours but the house was very strong and the little pigs were safe inside. He tried to enter through the chimney but the third little pig boiled a big pot of water and kept it below the chimney. The wolf fell into it and died.
The two little pigs now felt sorry for having been so lazy. They too built their houses with bricks and lived happily ever after.

Rhymes and songs

One little finger, one little finger, one little finger, tap, tap, tap.

One little finger, one little finger, one little finger, tap, tap, tap. *[Hold up your index finger and bend it up and down.]*
Tap tap tap. *[Tap your one index finger against your other index finger 3 times.]*
Point it to the ceiling. *[Point up!]*
Point it to the floor. *[Point down!]*

And lay it in your lap, lap, lap! *[Put your finger in your lap]*

Two little finger, two little finger, two little finger, tap, tap, tap.
Tap tap tap. *[Tap your two fingers from each hand against each other 3 times.]*
Point them to the ceiling. *[Point up!]*
Point them to the floor. *[Point down!]*
And lay them in your lap, lap, lap! *[Put your fingers in your lap]*

[Continue singing using 3, 4, and finally all 5 fingers.]

Ten green bottles
[At the start of Grade R use only 5 green bottles and as you introduce the numbers keep singing this song but start with more bottles each time. Collect empty green sprite bottles or make pictures of green bottles to put up. As the class sing the song take or knock down the bottles. By the end of the year you will start with 10 green bottles.]

FIVE green bottles hanging on the wall,
FIVE green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

FOUR green bottles hanging on the wall,
FOUR green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

THREE green bottles hanging on the wall,
THREE green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

TWO green bottles hanging on the wall,
TWO green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

ONE green bottles hanging on the wall,
ONE green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

LESSON PLAN 2

Date: March 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Grade R learners Number recognition

CAPS Topics: Number symbols, number names

Vocabulary: Numbers one to ten

Objectives:

By the end of the session, students should be able to:

- Define the term "Number Recognition".
- Explain how a Grade R teacher must teach his/her learners number recognition.
- Describe activities that a teacher can use to teach Grade R learners number recognition.
- Develop activities to create learners' awareness of numbers in the world around them.
- Demonstrate how to teach number recognition on a concrete level using learners' bodies, concrete objects and counting activities.

Learning Areas	Integration
Life-Skills	Familiar contexts – Learners' personal details: age, house number and address, home or cell numbers, their birthdays. Songs and rhymes (performing arts)
Language	Rhythm - action songs Number names (incidental learning)

Knowledge	Skills	Values
Number recognition – recognize the numerals or number symbols and name them. Awareness of numbers in their lives and in the world around them. counting of real objects with understanding **Value of numbers** **One-to-one correspondence**	**Counting skills** **Sequencing**	Playing well together during free play time. Tidying up – putting away the objects they have been using.

Resources: Number frieze, number display table, sandy patch, flard cards, play dough, counting trays sticks, dot cards, picture cards and magazines.

Mental Mathematics

Count aloud from 1 - 10

Introduction

Recite a rhyme, 'one, two, once I caught a fish alive; three four …'

LESSON PRESENTATION

Developmental Stage 1.

What is number recognition? Number recognition is the learner's ability to recognize the numerals or number symbols and name them. In Grade R we focus on the numerals 0 – 10, introducing one number at a time. By the end of the Grade R year the learners should be able to 'read' any number from 0 – 10. The first number to be introduced in Grade R is the number 1. You will show the learners the number 1, one dot and one picture of one thing. The learners will find 1 something in the classroom, 1 thing on their body, they will draw 1 thing. All to show the learners what 1 is and for them to recognize and identify 1 thing, 1 picture, 1 dot and the number 1 all as one.

The numbers will be introduced over the 4 terms as follows:

Term 1 – 1
Term 2 – 2, 3, 4
Term 3 – 5, 6, 7
Term 4 – 8, 9, 10 and 0

Your aim is to focus on each number individually and continually revise the numbers you have already introduced.

Developmental Stage 2

Here is an example on how you can teach number recognition.

Number frieze

The numbers, zero – ten, should be displayed on the walls of your classroom for the learners to see every day and become familiar with. You can display all the numbers from 0 – 10 from the start of the year.

You can point to each number on your number frieze as the class count from 0 – 10 – counting forwards. Use your number frieze in the same way to guide your learners through the numbers as you teach them to count backwards from 10 – 0.

When introducing a new number, for example the number 7. Ask learners to help you to find the number seven on your number frieze. Count the pictures with the learners to make sure you have found the right number.

Number recognition of each number is taught separately in Grade R. To teach number recognition you will need to find a space in your classroom where you can display number cards and objects for counting. You change the cards and objects for each number.

Developmental Stage 3

Using numbers in familiar contexts

While having a classroom that is filled with numbers so the learners can see numbers all the time is important, it is also important to use numbers in a way that is familiar to the learners. Learners need to see where numbers are used in their lives and in the world around them. This will give meaning to the numbers you are teaching them.

Example

Learners' personal details: Grade R need to know certain information about themselves. Through the year you will emphasise different details the learners should practice and know. You will focus on their details in this order:

	Learners Details
Term 1	Age
Term 2	House number and address
Term 3	Home or cell phone number
Term 4	All above details

Term 1

Learners love their birthdays. They cannot wait for their birthday. Talk to your learners about their age

during free play. Ask each learner: How old are you? What age will your turn at your net birthday? When it is one of your learner's birthdays you can focus on the age of the learner with the whole class. Tell the class that Ayanda is turning 6. Ask them what age she was before she turned 6. Ask them to put their hands if they are 5 too. Then ask the learners who are 6 to put up their hands. You may have learners of different ages in your class; make sure you ask about the age groups in your class.
Discuss applicable questions

Assessment / Application

- Students work in groups and create mind maps to how integration was implemented in this lesson.
- Make own play dough.

Conclusion / Homework (Assignment)

- Make/ design Number Frieze 1-10. Use 10 A4 charts.
- Briefly discuss how you will use the number-frieze to teach mathematics in Grade-R.
- Explain how a Grade R teacher should teach **counting forwards and backwards** on a concrete level using rhymes and songs.

1, 2, 3, 4, 5 Once I Caught a Fish Alive
One, two, three, four, five,
Once I caught a fish a alive,
Six, seven, eight, nine ten,
Then I let it go again.

Why did you let it go?
Because it bit my finger so.
Which finger did it bite?
This little one on the right.

Making play dough.

Ingredients

- 2 cups plain flour
- 2 table spoons vegetable oil
- $\frac{1}{2}$ cup salt
- 2 tablespoons cream of tartar
- Up to 1,5 cups boiling water (add slowly until it feels just right)
- Food colouring (optional)

How to make your play dough:

- Mix the flour, salt cream of tartar and oil in a large mixing bowl.
- Add the boiling water.
- Stir continuously until it becomes a sticky, combined dough.
- Add the food colouring.
- Allow it to cool down then take it out of the bowl and knead it vigorously for a couple of minutes until all of the stickiness has gone. *This is the most important part of the process, so keep at it until it is the perfect consistency!*

- (If it remains a little sticky then add a touch more flour until just right).
- You can store this play dough in an air tight container for at least 6 months.

LESSON PLAN 3

Date: March 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Grade 1 learners Patterns and functions

CAPS Topics: Geometric patterns, number patterns

Vocabulary: Shapes: square, triangle, rectangle, circle

Objectives:

By the end of the session, students should be able to:

- Understand the development of algebraic thinking in the Foundation Phase curriculum.
- Help FP learners discover patterns.
- Teach Grade 1 learners to investigate, copy, extend, describe and create geometric patterns.
- Teach Grade 1 learners to investigate, copy, extend, describe and create number patterns.
- Develop learner activities focused on geometric and number patterns.
  - investigate, design, make, evaluate, communicate

Learning Areas	Integration
Life-Skills	Technological process skills: investigate, design make, evaluate, communicate Create own geometric patterns with physical objects Draw lines, shapes or objects Use cut-outs (e.g. triangles, and squares) to pack out growing patterns.
Language	Builds some conceptual vocabulary (e.g. shapes, size, direction) Responds physically to two simple instructions Describe the pattern in their own words.

Knowledge	Skills	Values
Conceptual knowledge relating to patterning Representing and discovering patterns	Touching, feeling and manipulating mathematical objects that develop algebraic concepts Copy, extend and describe and create own geometric patterns	Learning the rules of patterns

LTSM: buttons, rulers, pencils, erasers,

Mental Mathematics

Count in 2's up to 50.

Place the numbers on a number line.

Introduction

Song: If you're happy and you know it clap your hands

LESSON PRESENTATION

Developmental Stage 1.

A pattern is something that happens in a regular and repeated way. When a collection or array of objects or numbers such as △□○ or 5 4 6 2 are repeated in a specific sequence, this forms a repeating pattern which can be identified and described as generalised rules or functions. For example, what will the function or rule of the following pattern be?

△□○; △□○; …

The rule of this pattern: The repetition of three geometric shapes in the same order where the first shape is always a triangle, the second always a square and the last is always a circle.

Before they enter the reception year, young learners have already acquired a variety of concepts relating to patterns, functions and algebra. This develops when they learn repetitive songs, rhythmic chants and predictive poems and stories that are based on repeating and growing patterns. They engage in pattern-related activities and recognize patterns in their everyday environment – and the recognition, comparison and analysis of patterns are considered an important component of their intellectual development, because they provide a foundation for the development of algebraic thinking.

In patterns, functions and algebra, learners get opportunities to complete an extend patterns represented in different forms; and identify and describe patterns. Describing patterns lays the basis for the learners in the Intermediate Phase to describe rules for patterns. This in turn becomes more formalized in algebraic work I the Senior Phase

Developmental Stage 2

Discovering patterns in the Foundation Phase

The best way to learn more about patterns is to investigate patterns practically. When teaching patterns, you have to design activities which will enable learners to investigate patterns.

The following hints will guide you during a pattern investigation:

- The relationship between the elements (or terms) of the pattern.
- Similarities and differences in patterns.
- How patterns repeat, grow or change.

The activities you design must help learners to:

- Find the pattern and identify the rule.
- Predict what comes next. Extend the pattern.
- Explain the rule.
- Explain where a pattern core (a part that is repeated a number of times) begins and ends.
- Create their own pattern.
- Describe their pattern (indicate the number of repetitions and the rule).
- Describe differences and similarities between patterns.
- Create a pattern using objects. Use the same objects to make a different pattern.
- Find the missing part in a pattern.

- Present a pattern in different modes e.g. objects – sound – movements.
- Hear and repeat the pattern in a rhythm, e.g. clap-tap-tap-clap-tap-tap.
  Make their own rhythm. Tell how many times it was repeated.

Developmental Stage 3

How to teach geometric patterns

Repeating patterns must be introduced to learners following the sequence: from concrete to semi-concrete to abstract/symbolic.

Concrete	Semi-concrete	Abstract (symbolic)
Learners copy, find, extend or make a pattern using real objects (buttons, beads, bottle tops, etc.) in a visual, auditory or kinaesthetic mode.	Learners copy, find, extend or make a pattern in pictorial or 2-D- format.	Learners copy, find, extend or make patterns using number symbols or letters.
A pattern with buttons:	A drawing of the same pattern:	The same pattern described in number symbols or letters: **ABAB**… or 1212…

You will start by showing the learners an easy pattern to follow and slowly build up to more challenging patterns. Here are some pattern examples in order of difficulty.

Pattern name	Example
AB	Sock, shoe, sock, shoe, sock, shoe…
AABB	Sock, sock, shoe, shoe, sock, sock, shoe, shoe…
ABC	Sock, shoe, tie, sock, shoe, tie, sock, shoe, tie,…
ABB	Sock, shoe, shoe, sock, shoe, shoe…
AAB	Sock, sock, shoe, sock, sock, shoe,…

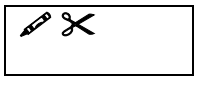
In these examples the same objects have been used to show the different patterns. These patterns can be made using any items.

Discuss applicable questions

Assessment / Application

- Students work in groups and create collages to show how integration was implemented in this lesson.
- Students discuss activities that a teacher can use to teach Grade 1 geometric patterns on concrete and semi-concrete level.

Example 1: Place two real objects on the teachers' desk in a basic pattern. For example:



- Learners clap the pattern. E.g.:
  - One clap for the crayon.
  - Two claps for the scissors.
- Put the same objects on each group's desk.
- Learners copy the teacher's pattern on their desks.

- They clap the pattern together.

Example 2

- Make a set of 9 geometric pattern cards before the activity.
- The set of cards are made up of only 3 shapes. For example

- Learners make their own pattern using the nine cards.
- Learners draw these patterns in their exercise books.

ASSESSMENT GRID		
SKILL: MAKE AND DRAW OWN PATTERN		
LEVEL	**DESCRIPTION**	**CRITERION**
7	Outstanding achievement	Learner was able to: • make a pattern with all 9 cards • correctly draw the pattern in the exercise book
6	Meritorious achievement	Learner was able to: • make a pattern but only used 6 cards • correctly draw the pattern in the exercise book
5	Substantial achievement	Learner was able to: • make a pattern but only used 6 cards • draw the pattern in the exercise book with some mistakes
4	Adequate achievement	Learner was able to: • make a pattern but only used 3 cards • correctly draw the pattern in the exercise book
3	Moderate achievement	Learner was able to: • make a pattern but only used 3 cards • draw the pattern in the exercise book with some mistakes
2	Elementary achievement	Learner was able to: • make a pattern but only used 3 cards • draw the pattern in the exercise book with many mistakes
1	Not achieved	Learner was unable to make a pattern at all

Conclusion / Homework

Students develop three activities where learners:

- Copy a pattern.
- Make and draw own pattern.
- Extend a pattern.

Reflection activities

How has ILA changed your thinking about Mathematics/Mathematics?

Are there any challenges you might foresee in implementing ILA?

Song

If you're happy and you know it clap your hands

If you're happy and you know it clap your hands x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it clap your hands

If you're happy and you know it stamp your feet x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it stamp your feet

If you're happy and you know it nod your head x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it nod your head

If you're happy and you know it say ha ha! x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it say ha ha!

If you're happy and you know it do them all x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it do them all

LESSON PLAN 4

Date: April 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Grade 1 learners Patterns around us / number patterns

CAPS Topics: Geometric patterns, patterns around us

Vocabulary: Shapes: square, triangle, rectangle, circle

Objectives:

By the end of the session, students should be able to:

- Help Foundation Phase learners discover patterns in nature, modern everyday life and cultural patterns.
- Teach Grade 1 learners to investigate, copy, extend and describe patterns.
- Teach Grade 1 learners to explain the regularity in patterns.
- Develop learner activities focused on patterns in nature, modern everyday life and cultural patterns.
- Develop learner activities focused on number patterns.

Learning Areas	Integration
Life-Skills	Performing arts: dramatise, sing, dance and explore movement Patterns in nature: patterns on animals and plants
Language	Memorise and perform simple poems, action songs Patterns in song

Knowledge	Skills	Values
Describe the regularities found in patterns in nature	Touching, feeling and manipulating objects that develop algebraic concepts Copy, extend and describe patterns Create own patterns	The rules of patterns

LTSM: leaves, plants, seeds, pictures of bricks and buildings, artefacts, etc.

Mental Mathematics

Count in 3's up to 60.

Place the numbers on a number line.

Introduction

Song: If you're happy and you know it clap your hands

LESSON PRESENTATION

Developmental Stage 1.

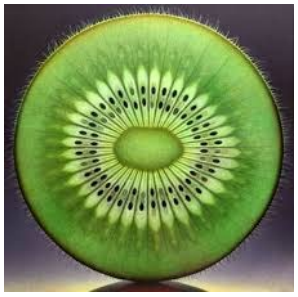
Most learners are very interested in nature and love investigating nature. Use learners' natural curiosity as opportunity to make them aware of patterns in their natural surroundings.

Patterns on animals: Let learners investigate the regularities (and try to find the rules) in the patterns found on animals, insects and plants in their environment. Focus learners' attention on the important concepts relating to these patterns.

To focus learners' attention on natural patterns, ask learners the following questions:

- Tell me what you see. What does it feel like?
- Can you see the pattern? Is it a pattern? How do you know?
- How can you describe the pattern?
- Can you explain the rule of the pattern? (How does the pattern repeat or grow?)

Patterns in plants: Patterns on plants are easily available and accessible. Let learners investigate different leaves, seeds, cones or any other plant parts. Let them notice the regularity. In some cases, symmetrical patterns can be investigated.

To focus learners' attention on natural patterns, ask learners the following questions:

- Tell me what you see. What does it feel like?
- Can you see the pattern? Is it a pattern? How do you know?
- How can you describe the pattern?
- Can you explain the rule of the pattern? (How does the pattern repeat or grow?)

To extend the pattern investigation, integrate Art into your Mathematics lesson. (Making leaf rubbings)

Developmental Stage 2

Patterns in modern everyday life

Introduce patterns in modern everyday life to learners by talking about the man-made patterns we find in the classroom and immediate surroundings. Point out that windows, burglar bars, floor tiles and the bricks of the buildings, etc. all consist of different patterns. Also take learners outside to identify patterns in nature and connect the patterns found in nature to the patterns made by people. Often patterns created by people were inspired by patterns found in nature. Can you see the link between natural and man-made patterns below?


Patterns on buildings and architecture: Patterns are often found in buildings and architecture. Let learners identify such patterns within the school grounds.

Ask learners questions such as:

- Is there a pattern? Why do you say so? Describe the pattern.

- Draw the pattern.
- What is the rule of the pattern? Describe the regularity in the pattern.
- Can you find a similar pattern somewhere else in your environment?

Patterns on fabric/material: Many patterns can be found on clothing. Let learners bring some of their clothing with a pattern on it (sweater, dress, shirt, skirt) to school to identify, describe, discuss and draw the patterns.

Remember to constantly ask learners relevant questions, to let them focus on the pattern(s):

- Do you see the pattern? Describe the pattern in your own words.
- What is the rule of the pattern? Describe the regularity in the pattern.
- Can you create your own pattern from the investigated pattern?

We also find patterns in sounds and movement.

Cultural patterns: Exploring cultural patterns is an excellent opportunity for learners to learn more about patterns as well as other cultures.

Developmental Stage 3

How to teach number patterns

To help learners understand our number system, learners need to learn about the **order** of numbers as well as their **value**. A good way to help learners learn and understand number relationships is to let them investigate the patterns in the structure of numbers.

A number pattern can be defined as a sequence of numbers that follows a rule for determining how the sequence continues. For example, 2; 6; 10; 14; … the next number in the sequence is determined by the rule e.g. $2 + 4 = \boxed{6} + 4 = \boxed{10}$.

Teaching number patterns and sequences

Number sequences can be linked with counting. Sequences should show counting forwards and backwards in the specified intervals. Number sequences consolidate and develop learners' counting skills. As learners' counting skills change and develop, so will the number sequences. As your learners become more and more numerate, the number sequences they work with can be increased in range in complexity. Eventually they must explore number patterns with an extended number range of 0 – 1 000 by the end of Grade 3.

Give learners sufficient opportunities to practice their skills in implementing number patterns, grids/tracks, lines, sequences, strings or chains in the Mathematics workbooks.

Learners should continually develop, reinforce and extend their algebraic thinking through explaining the rules for simple number patterns or sequences. Because learners use symbols to extend number patterns and number sequences, they are required to work on the **abstract** level.

Discuss applicable questions

Assessment / Application

Students bring cultural artefacts for example, clay pots, beadwork, jewellery, clothing, etc.

- How ILA happen in this lesson
- Study the patterns on cultural artefacts and discuss them in groups.

Conclusion / Homework

Plan exercises for learners to:

- Find the rule and extend number patterns and sequences.
- Complete number chains.
- Write a pattern sequences in a given range.
- Find the missing numbers in a sequence.
- Describe number patterns.
- Create own number patterns.

Song

If you're happy and you know it clap your hands

If you're happy and you know it clap your hands x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it clap your hands

If you're happy and you know it stamp your feet x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it stamp your feet

If you're happy and you know it nod your head x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it nod your head

If you're happy and you know it say ha ha! x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it say ha ha!

If you're happy and you know it do them all x2
If you're happy and you know it, then you'd surely want to show it
If you're happy and you know it do them all

LESSON PLAN 5

Date: April 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Two-Dimensional Shapes (2-D Shapes) to Grade 2 learners

CAPS Topics: 2-D Shapes, features of shapes

Lesson Vocabulary: Describe, sort, compare, 2-D shapes, circles, rectangles, triangles, squares, size round sides, straight sides, less, more

Objectives:

By the end of the session, students should be able to:

- Describe the concepts space and shape.

- Discuss the strategies for teaching shapes to FP learners.
- Plan activities for learners to recognize and name 2-D shapes (circles, triangles, squares, rectangles).
- Plan activities for learners to sort, classify and compare 2-D shapes in terms of size, shape, straight sides and round sides.

Learning Areas	Integration
Life-Skills	Movement (kinaesthetic) skills: creating a straight line with body, working together in creating a circle, jump on or off objects Playing hopscotch
Language	Name and describing the shapes Communication: creating shapes with bodies

Knowledge	Skills	Values
Recognize and name 2-D shapes (circles, triangles, squares, rectangles). Use correct vocabulary	Sort, classify and compare 2-D shapes in terms of size, shape, straight sides and round sides	Solve problems involving 2-D shapes

Learner Teacher Support Material (LTSM): cut-out cardboard shapes, chart with different shapes, objects

Mental Mathematics

Count in 5's up to 100.

Learners respond rapidly to oral questions. For example: Sam ate 17 biscuits and Jane ate 9 biscuits.

How many more biscuits did Sam eat than Jane?

Introduction

Song: The wheels of the bus go round and round

LESSON PRESENTATION

Developmental Stage 1.

In space and shape (geometry), learners get the opportunities to learn about the properties, relationships, orientations, positions and transformations of two-dimensional (2-D) shapes and three-dimensional (3-D) objects. This helps learners to understand and appreciate the pattern, precision, achievement and beauty in natural and cultural forms.

Life exists because of only two things: **space** occupied by **shapes.** This makes one very keen to learn how to make use of this space which is occupied by shapes, which are well coordinated in order to make the world a beautiful unconfused space to occupy. Shapes are all around us, mainly in the form of 2-D shapes and 3-D objects. However, learners are not familiar with all the kind of shapes in their environments. It is therefore important that Foundation Phase teachers develop learners' powers of observation of their environment as well as their mental imagery of shapes.

A 2-D shape has the elements of length and breadth (width). They are all flat. Examples of 2-D shapes are triangles, squares, rectangles and circles.

Developmental Stage 2

Teaching 2-D shapes on a concrete level

To help learners become aware of 2-D shapes, you should involve them actively by including the following skills:

- **Visual skills**: Include the activities involved in the act of looking. Learners must observe, compare and sort shapes by seeing that one is the same or different from another.
- **Tactile skills**: Include handling shapes to feel if they are the same or different. It also involves, constructing with shapes and working with their hands to draw, cut-out or to paste shapes.
- **Verbal skills**: Include activities enabling learners to describe the shapes i.e. the activities involved in the act of talking.
- **Movement (kinesthetic)**: Include activities enabling learners to describe to, amongst other ways of moving, climb over and onto, crawl through, walk and run to or from and jump on or off objects while being aware of their bodies in space.
- **Mental skills**: Include activities that involve learners in the thinking process; being able to recognize a shape and label it.

Keep in mind that teaching we focus on the concrete and move to the abstract once learners have gained from the concrete experience.

Geometric shapes in the environment

One of the best ways in which shapes could be recognized, is in the immediate environment – the school. Take the learners outside to investigate and explore. Note that some of the shapes or objects in learners' surroundings will be three-dimensional. Let them examine the shape of leaves and flowers (even flowers on weeds). Ask them to look at man-made objects and see if they can identify shapes on the objects.

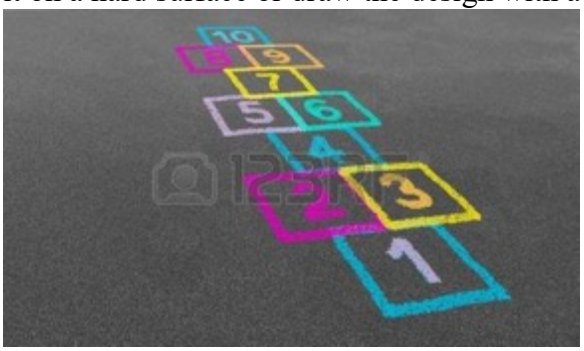
Play

Play is an important method to use to teach 2-d shapes. When learners are provided with adequate time to play, their play grows in complexity and becomes cognitively and socially more demanding. Thus, the learning of shapes can also be achieved through play.

Make a hopscotch court four your school so that learners can learn about shapes while playing a game.

Hopscotch

- A game for two to six players.
- Construct the court according to the design below. Draw it with chalk on a cement slab, paint it on a hard surface or draw the design with a stick on the ground.



Developmental Stage 3

Teaching sorting, classifying and describing shapes

The main focus of space and shape in the Foundation Phase is to provide lots of sorting and classifying activities to let learners see how shapes are similar or different. Learners need to be able to compare (i.e. look for points of similarity and differences between shapes), sort and classify them together according to specific categories or points of similarity. When sorting and classifying shapes and objects, their properties must be taken into consideration so that they can be described according to their properties.

Sorting Shapes						
According to sides		According to any additional category, such as colour, size or thickness	According to number of corners			According to making another shape by putting together shapes
straight	**curved**		**4**	**3**	**0**	Two squares can make a rectangle. Two triangles (one upside down) can make a rectangle or square depending on the shape of the triangles.
Square Triangle Rectangle	circle		Square	triangle	Circle	

Assessment / Application

- Students discuss activities that a teacher can use to teach Grade 2 learners 2-D shapes.
- Students work in groups to create a game showing integration using 2-D shapes.

Conclusion / Homework

Learners need to be exposed to lots of problem-solving activities based on 2-D shapes.

Plan activities for learners to:

- Copy a picture made up of geometric shapes
- Compare the size of similar 2-D shapes
- Order 2-D shapes from biggest to smallest and from smallest to biggest.
- Sort shapes into colours.
- Sort shapes according to whether or not they have straight or round sides.
- Sort and group shapes according to whether they are triangles, rectangles, squares or circles.

Rhyme

The wheels on the bus go round and round

The wheels on the bus go round and round.
round and round.
round and round.
The wheels on the bus go round and round,
all through the town!

The people on the bus go up and down.
up and down.
up and down.
The people on the bus go up and down,
all through the town!

The horn on the bus goes beep, beep, beep.
beep, beep beep.
beep, beep, beep.
The horn on the bus goes beep, beep, beep.
all through the town!

The wipers on the bus go swish, swish, swish.
swish, swish, swish.
swish, swish, swish.

The wipers on the bus go swish, swish, swish,
all through the town!

The signals on the bus go blink, blink, blink.
blink, blink, blink.
blink, blink, blink.
The signals on the bus go blink, blink, blink,
all through the town!

The motor on the bus goes zoom, zoom, zoom.
zoom, zoom, zoom.
zoom, zoom, zoom.
The motor on the bus goes zoom, zoom, zoom,
all through the town!

The babies on the bus go waa, waa, waa.
waa, waa, waa.
waa, waa, waa.
The babies on the bus go waa, waa, waa,
all through the town!

The parents on the bus go shh, shh, shh.
shh, shh, shh.
shh, shh, shh.
The parents on the bus go shh, shh, shh,
all through the town!

LESSON PLAN 6

Date: May 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Three-Dimensional Objects (3-D Shapes) to Grade 2 learners

CAPS Topics: 3-D objects, features of objects

Lesson Vocabulary: taller, wider round, flat corners, points, curved, straight, solid, hollow, roll, cannot roll, slide

Objectives:

By the end of the session, students should be able to:

- Describe the concepts space and shape.
- Discuss the strategies for teaching shapes to Foundation Phase learners.
- Plan activities for learners to recognize and name 3-D objects in the classroom and in pictures (ball shapes: spheres, box shapes: prisms, cylinders).
- Plan activities for learners to describe, sort and compare 3-D objects in terms of size, objects that roll and objects that slide.
- Plan activities for learners to observe and build 3-D objects using concrete materials.

Learning Areas	Integration
Life-Skills	Visual arts: sensory-motor skills and fine and gross motor coordination through the manipulation of materials

	Objects from the community: boxes, bins, box of chocolates, cereal boxes
Language	Vocabulary: taller, wider round, flat corners, points, curved, straight, solid, hollow, roll, cannot roll, slide

Knowledge	Skills	Values
Be able to recognize and name 3-D objects Describe, sort and compare 3-D objects in terms of size, objects that roll and objects that slide Use correct vocabulary	Arrange objects in terms of size, those that roll and those that slide	Work in pairs in building 3-D objects using concrete materials

Learner Teacher Support Material (LTSM): Ball shaped objects: globe, apple, beads, soccer ball, tennis ball. Box shaped objects: shoe box, dice, match box, square box, box of chocolates, cereal boxes. recycling material, construction kits, and other 3-D objects

Mental Mathematics

Learners work with numbers 0 to 20.

Learners respond rapidly to oral questions. For example:

- You have 3 sweets. Your brother gives you 4 more sweets. How many do have now?
- There are 12 children in a group. 5 children leave. How many children are left?

Introduction

Song: The wheels of the bus go round and round

LESSON PRESENTATION

Developmental Stage 1.

In space and shape (geometry), learners get the opportunities to learn about the properties, relationships, orientations, positions and transformations of two-dimensional (2-D) shapes and three-dimensional (3-D) objects. This helps learners to understand and appreciate the pattern, precision, achievement and beauty in natural and cultural forms.

Learners should not only learn the names of **two-dimensional** (2-D) shapes, but also get the opportunity to explore, discover, describe, sort and construct with **three-dimensional** (3-D) **objects.**

A three-dimensional object has **three** dimensions, namely length, width and height or depth. Examples of three-dimensional objects are prisms, pyramids, cylinders, spheres and cones.

Developmental Stage 2

Teaching 3-D objects on a concrete level

To help learners acquire an understanding of the difference between geometrical (2-D) shapes and geometrical (3-D) objects, you can explain it in the following way: 3-D objects take up space while 2-D

shapes are flat. Learners can physically climb into some 3-D objects, like boxes, if they are big enough. They can put a marble into a smaller box (if it has an opening), or they can imagine that there is an open space inside the 3-D object. A 2-D shape is always flat. Nothing can fit into it because there is no space inside the shape, not even an imaginable one.

Explore 3-D objects in the environment

Take learners on a "shape/object-walk" to explore and investigate the shapes of different objects around them. Ask questions to guide learners to describe the different features or properties of the 3-D objects they observe. In your questions, include vocabulary like the following: taller, wider round, flat corners, points, curved, straight, solid, hollow, roll, cannot roll, and slide.

The following types of questions could be asked to guide learners to recognize, identify and name 3-D objects:

- Which objects look like tubes?
- What box-like objects do you see?
- What shape does the steps of the ladder form?
- What ball-like object do you see.
- What do we call a ball-like object?
- What do we call a box-like object?

Use empty containers

Another way in which learners can be guided to recognize, identify and name geometrical objects, is to ask them to bring different empty containers to school. These objects are also part of their own world and can be used effectively to help them relate their own world to mathematical 3-D objects. The value of an activity like this is to make learners aware of the different shapes we find in our environment. You will see how their knowledge of 2-D shapes helps them to describe the 3-D objects.

Ask the learners to tell the class the names of the 3-D objects. At this stage some learners might be able to identify shapes on the faces of objects, such as: "All the faces of the cereal box are rectangles".

Learners can sort objects as either balls or boxes, and then organize the objects in each group according to size. First, from smallest to biggest and then from biggest to smallest.

Hold up two objects and a short object. Ask learners to tell which is different. Also ask them HOW they are different. If learners struggle to explain how they are different, ask: "Which is longer?" Use the vocabulary of shorter, taller and longer.

Repeat the exercise with objects that are NOT the same, (e.g. objects with different colours, shapes, functions, etc.), but focus on the **length**. For example, let learners compare the difference in length of a pencil and a crayon, or a pencil and a ruler, etc.

Developmental Stage 3

Teaching 3-D objects on an abstract level

Learners are often taught the names of geometric (3-D) objects only, but they need to be able to describe properties of three-dimensional objects in order to tell how two or more objects are alike or different

geometrically. On an abstract level, learners have to recognize and name 3-D objects. The following hands-on activities will assist learners to familiarize themselves with 3-D objects and its properties. In order for learners to sort objects into a category they must compare them to see which objects fit the category and which not. When sorting and classifying objects, their properties must be taken into consideration. The categories for sorting are provided in the tables below.

Sorting objects			
According to movement		**According to size**	
slide	**roll**	**small**	**large**
all examples of boxes/prisms	all examples of balls/spheres and cylinders	marble toothpaste box match box empty jam tin	ball cereal box empty paint tin

Remember, at Foundation Phase level, the names of properties are less important than the ability to observe and discover what objects have in common or how they differ. Learners must practically sort real 3-D objects by placing them on piles or putting them together in other ways. They can complete a table as written exercise to consolidate the practical work.

Assessment / Application

Students discuss activities that a teacher can use to teach Grade 2 learners
3-D objects. Focussed activities:

Students build 3-D objects using concrete materials such as cut-out 2-D shapes, building blocks, recycling material, construction kits, and other 3-D objects.

Conclusion / Homework

Learners need to be exposed to lots of problem-solving activities based on 3-D objects.

Plan activities for learners to:

Rhyme

The wheels on the bus go round and round

LESSON PLAN 7

Date: May 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Measuring length to Grade 3 learners

CAPS topics: Length, informal measuring, introducing formal measuring

Lesson Vocabulary: Area, length, measure, measurement, compare, hand span, paces, non-standard measures.

Objectives:

By the end of the session, students should be able to:

- Know and use the correct mathematical vocabulary applicable to measurement.
- Understand the development of measurement knowledge and skills.
- Explain effective and efficient approaches for teaching measuring length.
- Describe various characteristics and the applications of non-standard and standard measurement instruments and units.
- Understand the importance of an estimation skill and how to help learners develop this skill.
- Develop learner activities focused on measuring length.
- Develop learner activities focused on solving problems involving length.

Learning Areas	Integration
Life-Skills	Scientific process: the process of enquiry which involves observing, comparing, measuring, experimenting, and communicating. Measuring length using body parts like hand spans and feet. Body movement
Language	Vocabulary: long, short, wide, narrow, thin, thick, high, low, shallow, deep, broad Enjoying rhymes

Knowledge	Skills	Values
Be alert to reasonableness of measurement and results Understand formal and informal units of measurement Use correct vocabulary	Make sensible estimates Measure length	Learning the rules of measurement Solve problems involving length

LTSM: Learners' bodies (hands, feet), papers (with cut-out handspans), pencils, counters, erasers, crayons

Mental Mathematics

Count in 5's from 100 - 200

Learners respond rapidly to oral questions. For example: There are 10 buses. There are 17 people on each bus. How many people are on the buses?

Introduction

Song: The wheels of the bus go round and round

LESSON PRESENTATION

Developmental Stage 1

Length is usually the first attribute learners learn to measure. Many learners in the Foundation Phase already have some understanding of length and some vocabulary associated with it, but that does not mean that they have a clear understanding of length measurement.

Length is the **measurement** of something from one end to the other. Through length we determine how tall, how long, how short how far and what the distance is around an object.

The ability to measure length is a useful skill in our daily lives. Learners should be involved in many practical activities where they measure informally, before being introduced to standard units of

measurement and correct use of measuring instruments. Keep the developmental stages in mind when deciding on learning experiences.

Developmental Stage 2

Measuring length through comparison

All activities must start with activities where NO measuring units are involved and where learners measure through comparison.

Learners must compare the length of objects by:

- Looking to see if they look the same or different.
- Comparing objects directly by placing the objects next to each other.
- Using a third objects to compare two objects to.

Compare lengths of real objects visually

At first, to help learners build the concept of length as an attribute of long, thin things, learners should compare **the same type** of objects (same type, same colour, etc.), except for length.

Hold up two objects and a short object. Ask learners to tell which is different. Also ask them HOW they are different. If learners struggle to explain how they are different, ask: "Which is longer?" Use the vocabulary of shorter, taller and longer.

Repeat the exercise with objects that are NOT the same, (e.g. objects with different colours, shapes, functions, etc.), but focus on the **length**. For example, let learners compare the difference in length of a pencil and a crayon, or a pencil and a ruler, etc.

Directly compare lengths of real objects

Provide activities for Grade 2 learners to compare the lengths of real objects directly. Hold up two pencils of more or less the same length. Ask the learners: "Which is longer?" if there is some disagreement, call one of the learners to your table. Let the learner put the two pencils upright on the table and then compare the length. (make sure that the pencils are placed on the same baseline. Through the direct comparison, learners will realise that the one pencil is **longer** than the other one. Let them then compare their own height with their peers, the length of their feet, etc. using a baseline (the line where measurement must start). By directly comparing different lengths, they get a feel for length as a measurable attribute.

Then place a few familiar items in a box and place it on each group's table. Ask learners to directly compare the items, and place them in three different heaps: shorter, the same as and longer.

Developmental Stage 3

Use non-standardised units to measure length

The concept of short, long, shorter, longer, taller, further, nearer, the distance around, etc. are concepts learners must grasp through manipulating a range of informal measuring instruments to determine length and distance.

The informal measuring of length should start with continuous measurement activities where learners compare their own heights to one another's in an activity where they have to place themselves in a row from the shortest to the tallest. Measure the length of table, books and other concrete objects with hands counters, string etc. are also examples of forming the concept of measuring length. Activities to measure distance could for instance be how many steps it is from the teacher's table to the door, or other similar activities to form the concept of distance.

These continuous measurement activities should also focus on the difference between length and distance. During these activities the teacher must make the learners aware of measuring accurately, no matter which unit is being used. Learners must start measuring at a specific point and stop measuring at another specific point.

On the concrete level, you can also divide your learners into groups. Let learners use parts of their bodies as measuring units to do length measures in the classroom.

Let the different groups, for example, each measure one of the following:
Group 1: Use feet to measure the length of the classroom.
Group 2: Use their hand palms to measure the length of their desks.
Group 3: Use finger widths to measure the width of a classroom desk (table).
Group 4: Use hand spans to measure the width of the door, etc.

Let the members in the groups assist each other to take their measurement as accurately as possible. When they measure, the measure must not overlap and they must leave no gaps. When they measure, for example with their feet, they must make sure that they place one heel in front of the other toe, then the other heel in front of that toe, etc. the same principle applies for any of other units of measurement.

Formal measuring of length/distance

Rulers and different kinds of tape measured are useful in teaching learners about units of length – metres and centimetres. In the Foundation Phase, the formal measuring of length and distance focuses on the use of the ruler as a standard unit instrument and the correct use of it. Activities for formally measuring length and distance are the same as with informal measurement, but with the use of standard units. Learners will observe that short lengths can be measured with a ruler, introducing the centimetre, and longer lengths with a tape measure that introduces the metre.

Teach your learners how to make accurate length measurements, how to use the measuring instruments effectively and how to correctly record their results.

When you measure:

Always start on the "0" line on the beginning of the ruler. You can use

Discuss applicable questions

Planning a length and distance measuring activity

Process for teaching and learning length/distance measurement with relevant activities

Step 1	Learners must understand the	Measuring how long objects are and

	specific feature that has to be measured.	comparing the lengths (length) Measuring the distance (space) between two objects (distance)
Step 2	Learners must understand the units that will be used.	Non-standard: hands, feet, steps, rope, paper-clips Standard: Ruler, measuring tapes, odometer.
Step 3	Learner must know which measurement strategy to use to determine the measurement.	Measuring length: Starting at one end of an object and measuring up to the other end. Measuring distance: Starting at the end of one object close to the end of another object
Step 4	Learners use measurement to develop and solve their own real-life problems	Measurement of length and distance problems. How long is my pencil? (Length) How far is my desk from the door? (Distance)

Assessment / Application

Students create concept maps to display:

- How ILA happen in this lesson.
- How ILA changed their thinking about Mathematics.

Conclusion / Homework

Learners need to be exposed to lots of problem-solving activities based on measurement.

Plan activities for Grade 3 learners to:

- Use direct comparison
  - using body parts
  - using wool or string
- Sort objects into long or short lengths

Rhyme

Ten green bottles
[At the start of Grade R use only 5 green bottles and as you introduce the numbers keep singing this song but start with more bottles each time. Collect empty green sprite bottles or make pictures of green bottles to put up. As the class sing the song take or knock down the bottles. By the end of the year you will start with 10 green bottles.]

TEN green bottles hanging on the wall,
TEN green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

NINE green bottles hanging on the wall,
NINE green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

EIGHT green bottles hanging on the wall,
EIGHT green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

SEVEN green bottles hanging on the wall,
SEVEN green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

SIX green bottles hanging on the wall,
SIX green bottles hanging on the wall,
And if one green bottle should accidentally fall,
There will be …

LESSON PLAN 8

Date: May 2017

Duration: 90 minutes

Learning Area: Mathematics

Topic: Teaching Measuring perimeter and area to Grade 3 learners

CAPS Topics: Informal measuring and formal measuring

Lesson Vocabulary: Area, length, perimeter, estimate, tiling, squares, distance, formal units, 2-D shapes, 3-D objects, investigate

Objectives:

By the end of the session, students should be able to:

- Know and understand what perimeter and area are.
- Be able to teach learners how to measure around body parts on a concrete level.
- Be able to teach learners to compare height and perimeter on a semi-concrete level.
- Be able to measure the perimeter of shapes
- Be able to teach area
- Develop learner activities focused on perimeter and area.
- Develop learner activities focused on solving problems involving area.

Learning Areas	Integration
Life-Skills	Scientific process: the process of enquiry which involves observing, comparing, measuring, experimenting, and communicating. Measuring distance around their: Heads or waists; and arms or ankles. Using cereal, toothpaste, match boxes – covering the surface
Language	Vocabulary: long, short, wide, longest, narrow, thick, thin, as long as, low, deep, shallow, shorter, longer, shortest, tallest Group discussion

Knowledge	Skills	Values
Be alert to reasonableness of measurement and results Understand formal and informal units of measurement	Make sensible estimates Make direct comparisons Measure length, perimeter and area	Learning the rules of measurement Solve problems involving length

Use correct vocabulary		

LTSM: measuring tapes, strings, rulers, metre stick, square and rectangular shaped objects, slates/whiteboards, cereal, toothpaste & match boxes, cut-out shapes

Mental Mathematics

Count forwards and backwards in 50s between 0 and 1000.

Learners respond rapidly to oral questions. For example:

- How many fingers do 9 hands have?
- Mondli sees four triangles. How many corners does she see altogether?

Introduction

Song: The wheels of the bus go round and round

LESSON PRESENTATION

Developmental Stage 1.

Perimeter is a special type of length. It describes the distance around a region. The perimeter of a shape, for instance, is the distance around the shape. It is the length of the boundary around the outside of the shape. If the shape is round (like the shape of a circle), we talk about the **circumference** of the shape. **Area** is the space we want to measure **within the perimeter** – **the size of the flat surface inside the boundary of the shape**.

Developmental Stage 2

How to teach perimeter

Teaching learners about perimeter must start on concrete level.

Measure around body parts on a concrete level

Let your learners use measuring tapes (or strings) to measure the distance around a number of body parts (heads, waists, arms or ankles). Guide learners HOW to measure around the body parts.

If measuring tapes are not available, let learners use string to 'measure'. Let them then take their string to the metre stick in front of the class and check how many centimetres the 'perimeter' of their head, arm waist, middle or leg is.

Let learners compare their measurement with those of other learners. Let them discuss the measurement and talk about bigger and smaller or longer and shorter **distance around,** for example their heads.

Ask learners questions like:

- What did you measure?
- Can you show me HOW you have measured?
- HOW does your measurement compare?
- Can you explain what is meant by perimeter?

Compare height and perimeter (circumference) on a semi-concrete level

On an advanced level for Grade 3's, you can let learners compare the **distance around** objects with its **height.** For this activity, you need to collect empty tins of various sizes. You need to have at least 4 tins for each small group of learners, and string. Label each tin (A, B, C, D).

First hold up a tin and ask learners which they think are longer: the **distance around** the tin or the **height** of the tin. Learners usually find this an exciting challenge and are very eager to find the answer. Let them confirm their guess by measuring it.

Let learners work in small groups. They should first decide **which is longer** (the **height** of the tin or the **distance around** the tin) by looking and making a guess. Then they must record their estimation (guess). After this, learners must measure each distance with a piece of string and record their findings on a recording sheet like the following:

Thin	**My guess**	**My measurement**
A	Height: Distance around:	Height: Distance around:
B	Height: Distance around:	Height: Distance around:
C	Height: Distance around:	Height: Distance around:
D	Height: Distance around:	Height: Distance around:

Afterwards, have a discussion with the learners about the height and distance around of the tins that were easier to guess, i.e. which is longer (height or distance around); and which ones fooled their eyes.

Measure the perimeter of shapes

Let your learners measure the perimeter (distance around) of some objects with straight sides in the classroom.

Let them measure, for example, the distance around:

- The teacher's desk
- A learner's desk
- The window pane

Emphasise that **perimeter means the distance around the shape**. If measuring tapes are not available, let them again use string and take their string to the metre stick in front of the class to check the actual measurements. Let them use their rulers to measure the shorter straight distances.

After sufficient practice with measuring real object with string, you can let Grade 3 learners use their rulers to measure the distance around cut-out or drawn shapes.

Thereafter, on an abstract level, learners must calculate the distance around by adding all the measures of the sides, for example:

4 cm + 3 cm + 3 cm = 10 cm. thus the perimeter of the triangle is 10 cm.

Developmental Stage 3

How to teach area

In the Foundation Phase, we focus on developing learners' concept of area (how 'big' the flat surface is). Areas must be introduced as "covering a surface". To guide learners to grasp this very elementary definition, let them explore it practically.

Teach area on a concrete level by covering the surface

Provide two boxes of the same size (e.g. cereal boxes) for each group. Also provide two small boxes that differ in size (e.g. toothpaste and match boxes) to measure with. Let learners use the toothpaste box, place it on the cereal box, cover the surface (the area) of the front of the cereal box. They must do the same with the match boxes.

Let learners then compare the two measurements. Which used less boxes to cover the surface of the cereal box – the toothpaste boxes or the match boxes? Area work must not be rushed. You must give your learners plenty of opportunities to cover areas of different sizes.

Teach area on a semi-concrete level through square grids

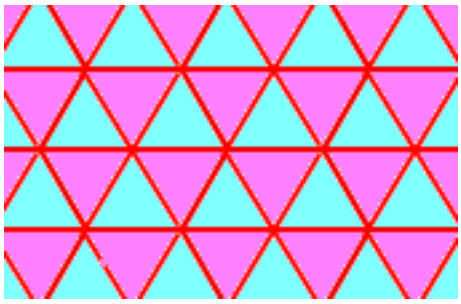
Let learners also explore ways in which to cover surfaces with square grids or use square grids to measure area. Learners can make footprints (pressing feet on a sponge soaked with water-based paint) and then step onto the grid made on a sheet of paper. Make sure that the grid contains square blocks to reinforce the fact that area must be measured in square units.

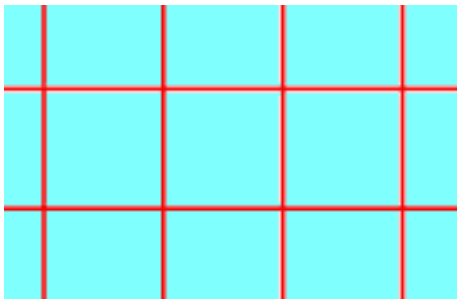
Ask learners to count the squares that their footprint covered. They may only count whole squares at first. If they ask what to do with the bits of squares, you can tell them to try and add up bits to make more or less a whole square. This is not so much about accuracy as it is about the concept of covering the surface area.

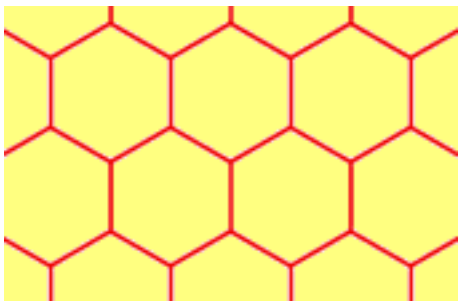
Tilling patterns can also be used to develop the notion of area as the covering of a surface.

Tiling areas (Tessellations)

When you tile a surface, the tiles (shapes) used must line up perfectly with the next ones, without leaving gaps and without overlapping.







In this tiling activity the learner covered a rectangular shape by dividing it into squares. She then divided each square into two triangles and coloured them in two different colours.

Explain to learners that in order to tile an area, all the tiles must be the same shape and must interlink without leaving a space between tiles. They must also not overlap. Learners can practically experience this fact by trying to pack circles or stars in a tiling pattern. They will discover that squares, triangles, rectangles and other shapes that interlink, such as the hexagon, can be used for tiling. In the mathematical language we call the tiling pattern a tessellation.

Assessment / Application

- Students create concepts maps to portray their primary school experience with respect to ILA or theme teaching.
- In groups they discuss why integration is important.

Conclusion / Homework

Learners need to be exposed to lots of problem-solving activities based on perimeter and area.
Plan activities for Grade 3 learners to:

- Measure area
  - using boxes
  - using cut-out shapes
- Tiling an area (tessellation)

Rhyme

Ten green bottles
(For Grade 3 big numbers can be used)

ANNEXURE C: LETTER OF CONSENT TO THE PRE-SERVICE TEACHERS

My name is Makie Kortjass and I am a PhD student studying at the University of KwaZulu-Natal, Edgewood campus, South Africa.

The tittle of the research project is "Cultivating an Integrated Learning Approach to Early Childhood Mathematics: A Teacher Educator's Self-study".

Aims of the Research:

1. To examine my lived experiences about cultivating an integrated learning approach (ILA) in Early Childhood Mathematics education.
2. To cultivate an Integrated Learning Approach (ILA) to Early Childhood Mathematics in teacher education.

You have been identified to participate in this research project as you are a first year preservice teacher enrolled for the B.Ed. Foundation Phase programme.

To gather data I will use the following data collection methods which will include you in providing contribution to my study.

Data generation activities are:

Collage and concept maps

I will ask you to create collages and concepts maps with me to show the integration of Mathematics and Languages and Life Skills learning areas.

Audio recording

I will record meetings that the 8 lesson presentation on the integration of Mathematics and Languages and Life Skills learning areas.

Reflections

You will be asked to develop learner activities and reflect on your understanding of ILA in Early Childhood Mathematics.

Please note that:

- You will *not* be disadvantaged if you choose not to participate or if you chose to withdraw from the study at any stage.
- Your involvement is purely for academic purposes only, there is no financial benefit.
- Data collected will be used for research purposes only.
- Research finding will be discussed with you using the collages, concept maps and reflections, which will briefly explain the integrated learning approach (ILA) in Early Childhood Mathematics.

The supervisor for my research study is Prof Kathleen Pithouse-Morgan. Her contact details are as follows: Prof Kathleen Pithouse-Morgan (Tel: 031 260 3460), email: Pithousemorgan@ukz.ac.za

Kind Regards

Ms. Makie Kortjass
0829342621
Kortjassm@ukzn.ac.za

Should you have no objection with the conditions mentioned above, please fill in the following form.

I …… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am free to withdraw from the project at any time, if I want to.

……

SIGNATURE OF PARTICIPANT DATE

ANNEXURE D: INFORMED CONSENT LETTER FOR EARLY CHILDHOOD EDUCATION LECTURERS

My name is Makie Kortjass and I am a PhD student studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am conducting a self-study about Integrated Learning Approach (ILA) in teaching Early Childhood Mathematics to first year Bachelor of Education (B.Ed.) students.

To collect information for my research study, I would like to work with you as my colleagues in the Early Childhood Education Discipline. I have selected you because the study requires me to explore strategies that I could use to cultivate an integrated learning approach (ILA) in arly Childhood Mathematics education. To gather data, I will use the following data collection methods which will include you in providing contribution to my study.

Data generation activities are:

Collage and concept maps

I will ask you to create collages and concepts maps with me to show the themes I will use in the integration of Mathematics and Languages and Life Skills learning areas.

Audio recording

I will record meetings that I will hold with you in our discussion of the themes that I will use in the integration of Mathematics and Languages and Life Skills learning areas.

I will have recorded meetings with you to examine the data that I collected.

I can be contacted at: Email: Kortjassm@ukzn.ac.za Tel: 031 2603669.

My supervisor is Professor Kathleen Pithouse-Morgan who is located in Education Studies at Edgewood campus of the University of KwaZulu-Natal. Email: Pithousemorgan@ukz.ac.za Tel: 031 2603460 .

Kind regards

Ms Makie Kortjass

DECLARATION

I _____ hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project: "Cultivating an Integrated Learning Approach to Early Childhood Mathematics: A Teacher Educator's Self-study".

I understand that I am free to withdraw from the project at any time, if I want to.

SIGNATURE ……

DATE ……

ANNEXURE E: ETHICAL CLEARANCE (PILOT PROJECT)

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

4 May 2016

Ms Makie Kortjass 26133
School of Education
Edgewood Campus

Dear Ms Kortjass

Protocol reference number: HSS/0178/016
Project Title: "Walking our talk": Putting into practice an Integrated Learning Approach (ILA) in teaching Early Childhood Numeracy

Full Approval – Expedited Application

In response to your application received 24 February 2016, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview 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 securely stored in the discipline/department for a period of 5 years.

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

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

.....

Dr Shenuka Singh (Chair)
Humanitities & Social Scinces Research Ethics Committee

/pm

Cc Supervisor: Jabulile Mzimela
Cc Academic Leader Research: Dr SB Khoza
Cc School Administrator: Ms Tyzer Khumalo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

ANNEXURE F: APPROVAL LETTER FROM THE REGISTAR

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

3 November 2016

Ms Dimakatso LP Kortjass (SN 204523782)
School of Education
College of Humanities
Edgewood Campus
UKZN
Email: kortjassm@ukzn.ac.za

Dear Ms Kortjass

RE: PERMISSION TO CONDUCT RESEARCH

Gatekeeper's permission is hereby granted for you to conduct research at the University of KwaZulu-Natal (UKZN), towards your postgraduate studies, provided Ethical clearance has been obtained. We note the title of your research project is:

"Cultivating an Integrated Learning Approach to Early Childhood Mathematics: A Teacher Educator's Self-study".

It is noted that you will be constituting your sample by using a self-study research methodology and/or conducting interviews with students and academic members of staff from the School of Education on the Edgewood Campus.

Please ensure that the following appears on your notice/questionnaire:

- Ethical clearance number;
- Research title and details of the research, the researcher and the supervisor;
- Consent form is attached to the notice/questionnaire and to be signed by user before he/she fills in questionnaire;
- gatekeepers approval by the Registrar.

You are not authorized to contact staff and students using 'Microsoft Outlook' address book.

Data collected must be treated with due confidentiality and anonymity.

Yours sincerely

[redacted]

MR SS MOKOENA
REGISTRAR

Office of the Registrar
Postal Address: Private Bag X54001, Durban, South Africa
Telephone: +27 (0) 31 260 8005/2206 **Facsimile:** +27 (0) 31 260 7824/2204 **Email:** registrar@ukzn.ac.za
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Edgewood · Howard College · Medical School · Pietermaritzburg · Westville

ANNEXURE G: ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

17 January 2017

Ms Dimakatso Kortjass 204523782
School of Education
Edgewood Campus

Dear Ms Kortjass

Protocol reference number: HSS/0060/017D
Project Title: Cultivating an Integrated Learning Approach (ILA) to Early Childhood Mathematics: A teacher educator's self-study

Full Approval – Expedited Application

In response to your application received 10 January 2017, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview 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 securely stored in the discipline/department for a period of 5 years.

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

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

.....

Dr Shenuka Singh (Chair)
Humanitities & Social Scinces Research Ethics Committee

/pm

cc Supervisor: Dr Kathleen Pithouse-Morgan
cc. Academic Leader Research: Dr SB Khoza
cc. School Administrator: Ms Tyzer Khumalo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

ANNEXURE H: TURNITIN REPORT

turnitin **Turnitin Originality Report**

Final thesis by Dimakatso Kortjass

From Chapter drafts (Phd)

Processed on 19-Oct-2020 11:02 AM CAT
ID: 1419633849
Word Count: 108291

Similarity Index	Similarity by Source	
2%	Internet Sources:	0%
	Publications:	3%
	Student Papers:	1%

sources:

1 1% match (publications)
"International Handbook of Self-Study of Teaching and Teacher Education Practices", Springer Science and Business Media LLC, 2020

2 1% match (publications)
Robyn Brandenburg, "Powerful Pedagogy", Springer Science and Business Media LLC, 2008

paper text:

CHAPTER ONE: THE FIRST STEPS INTO UNKNOWN WATERS Teachers can be the change agents in schools, countries, and states when they take their first steps in unknown waters Anastasia Samaras 1.1 Introduction To improve my practice as a teacher educator, I decided to embark on a self-study project focused on exploring

1**an integrated learning approach** (ILA) in **early childhood mathematics**

teacher education. As a recently appointed lecturer working with Foundation Phase (Grade R to Grade 3) pre-service teachers in the Bachelor of Education (B.Ed.) programme

1**at a university in** KwaZulu-Natal, **South Africa,**

the primary purpose for my research was to enhance my own pedagogical practices. I thus employed various self-study methods. The first chapter of this thesis is titled, The first steps into unknown waters, because I attempted an approach to early childhood mathematics teacher education that was new for me. This self-study project was a journey into the unknown. The opening quotation, "Teachers can be change agents in schools, countries, and states when they take their first steps in unknown waters" (Samaras, 2002, p. 149), resonates with my first tentative steps towards becoming a change agent. This chapter offers my motivation for embarking on this self-study research project. I also provide background information on the integration of subjects in the Foundation Phase. Next, I briefly elucidate the methodological approach that I followed and the self-study methods that I employed, and I explain why these were appropriate for my research. To follow, I present the research questions that guided the study. I then explain the key concepts and the theoretical perspective that helped me understand these concepts differently. I conclude the chapter with an overview of the thesis chapters as a whole. The chapter headings of this thesis are metaphors for the various self-study research activities that I undertook. They offer a creative image of my self-study research experiences and my engagement with other scholars' work. Also, as Badley (2018) advises academics to use titles that will engage and inform the envisioned readers, I intended to draw the readers'

APPENDIX I: LANGUAGE EDITING CERTIFICATE

lindac@skytec.co.za | 083 344 0706

Research Skills Development Services CC

SARS Income Tax No. 9249355208; CC Founding Statement No. CK94/16841/23 SARS; Tax Clearance Certificate No. 1994/016841/23

SACE REGISTRATION NUMBER: N.D. COERTZE – 1082433 (2003)

DECLARATION OF PROOF-READING

TO WHOM IT MAY CONCERN

I, Nicolina D. Coertze, declare that I meticulously perused the PhD manuscript referred to below for language editing purposes. I identified and corrected linguistic and stylistic inaccuracies to the best of my knowledge and ability. Using the *Word* Tracking system, I kept track of any changes that I made for consideration and review by the author. I also offered annotations as recommendations to the author and supervisor for review of areas that, in my view, needed additional attention in terms of logical flow of language and meaning. I declare that I adhered to the general principles that guide the work of a language editor and that I remained within my brief as had been agreed with the author of the thesis.

Details

TITLE	**CULTIVATING AN INTEGRATED LEARNING APPROACH TO EARLY CHILDHOOD MATHEMATICS: A TEACHER EDUCATOR'S SELF-STUDY**

SURNAME	**KORTJASS**
FULL NAMES	**Dimakatso**
STUDENT NUMBER	**204523782**
PROPOSED QUALIFICATION	**PhD**
DEPARTMENT	**Education: UKZN Edgewood Campus**
TERTIARY INSTITUTION	**University of KwaZulu-Natal**
NAME OF SUPERVISOR	**Professor Kathleen Pithouse-Morgan**
REFERENCING STYLE	**APA6th**

Respectfully submitted on: 18 September 2020

[redacted]

(MRS) N.D. COERTZE
LANGUAGE EDITOR