EXPLORING THE ROLE OF THE ADVANCED CERTIFICATE IN EDUCATION MATHEMATICAL LITERACY PROGRAMME IN DEVELOPING TEACHER KNOWLEDGE OF MATHEMATICAL LITERACY TEACHERS IN UMGUNGUNDLOVU DISTRICT

BY

THANDAZILE ANNAMARIA MKHIZE

A Dissertation submitted in partial fulfilment of the requirements for the degree of Master of Education in Teacher Development Studies

School of Education

College of Humanities

University of KwaZulu-Natal

Pietermaritzburg

2019

DECLARATION

I, Thandazile Annamaria Mkhize (Student Number: 984212090), declare that:

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

(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, graphs, pictures 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, then their writing has been placed in italics and inside quotation marks, and referenced.

(v) 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 sections.

---------------------- ------------------

Student Signature Date

----------------------- ------------------

Supervisor's Signature Date

Dr J. Naidoo

----------------------- ------------------

Co-supervisor's Signature Date

Professor S. Bansilal

DEDICATION

This work is dedicated to my mother Tryphinah Chamane (Maxaba) and my late father Macaleni Hurry Chamane. I am who I am today because of your good advice and strong personalities.

Mama no Baba, this is for you!

ACKNOWLEDGEMENTS

I would like to thank the following people for their contributions in motivating me to complete this dissertation. I honestly believe that without their continual support, I would never have completed this study

1. The Lord, my Provider who promised me that if He brought me to it, He would bring me through it. "The will of God will never take you where the grace of God cannot protect you".
2. My supervisors: Dr J Naidoo and Professor S Bansilal for all their guidance, advice and motivation even during the times when I doubted myself.
3. My sister, Dr J.C Ngwenya (Machamane), for all her motivation and strong belief in my abilities.
4. My family, especially my husband, Velaphi, my daughter Slondiwe, my sons Alwande and Anele for their understanding and patience during the course of this study.
5. My participants who allowed me to collect data from them.
6. My principal, Mr S.B Sishi, for his unlimited encouragement.

ACRONYMS

ANA - the Annual National Assessments

GET- General Education and Training phase

ML- Mathematical Literacy

DoE- Department of Education

LO- Learning Outcome

OBE- Outcome Based Education

ACE- Advanced Certificate in Education

ACEML- Advanced Certificate in Education in Mathematical Literacy

UKZN- University of KwaZulu-Natal

FET-Further Education and Training phase

DBE-Department of Basic Education DBE

TIMSS-Trends in International Mathematics and Science Study

NCS- National Curriculum Statement

CAPS-Curriculum and Assessment Policy Statement

PCK - Pedagogic Content Knowledge

KZN- Province of KwaZulu-Natal

MST- Mathematics Science and Technology

HEI-Higher Education Institutions

MSSI-Mpumalanga Secondary Science Initiative

USA-United State of America

TL-Teacher Leader

ACEMST- Advanced Certificate in Education in Mathematics Science and Technology

BS- Business Studies

EMS-Economic & Management Sciences

NS- Natural Science

AS- Agricultural Sciences

LS- Life Sciences

ABSTRACT

Learner performance in Mathematics has been a great challenge in South Africa. This has been due to inadequate teacher training and professional development of mathematics teachers during the apartheid era. The numbers of learners enrolling for mathematics decreases after grade 9 as many learners fail mathematics and as a result they cannot continue with the subject in grade 10. The Department of Education (DoE, 2003) decided to introduce the subject Mathematical Literacy (ML) in 2006. The challenge was that, the newly introduced subject ML was taught by teachers who specialised in other subjects, therefore there was a need to re-train them. The Advanced Certificate in Education Mathematical Literacy (ACEML) programme was introduced as a formal professional development initiative to re-train such teachers.

This study examined the ACEML programme as a new initiative in enhancing professional development with regard to teacher knowledge of ML teachers. This study aimed to explore the extent to which the ACEML programme contributed to the development of teacher knowledge of ML teachers with regard to their content knowledge, pedagogical content knowledge and confidence.

The study was located within the pragmatic paradigm and adopted a mixed method approach. The conceptual framework that underpinned this study was Shulman’s (1997) principles of teacher knowledge, and Ball, Hill and Schilling’s (2008) dimensions of teacher knowledge. Purposive sampling was used to select the participants to participate in this research study. The study was conducted in Umgungundlovu district, with teachers who teach ML and have completed the UKZN ACEML programme. Questionnaires and semi- structured interviews were used as data collection methods. Quantitative and qualitative data analysis was used in this study.

The findings of this study revealed teachers’ content knowledge, PCK and confidence were developed as a result completing the ACEML programme. However, these ML teachers still require teacher support and assistance to teach some of the content topics in ML. Furthermore, ML teachers also engaged in collaborative teaching which enabled them to support each other.

This study recommends that more professional development programmes which focus on the development of ML teachers’ content knowledge and pedagogical content knowledge need to be

conducted. Secondly, ML teachers should attend more professional development workshops to collaborate in various teaching activities such as designing lesson plans, assessment tasks and sharing teaching strategies. Thirdly, the Department of Basic Education (DBE) should offer and fund more teacher development programmes. Thus, ongoing teacher professional development is necessary to maintain professionalism and enhance teacher knowledge of ML teachers.

Table of Contents

CHAPTER 1

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This chapter provides an overview of the study, introducing the main focus of the study. The chapter begins by outlining the background of the study, the subject Mathematics and the outline of the Advanced Certificate in Mathematical Literacy. It then describes the rationale and the purpose of the study. Following these are the key research questions guiding this study. The chapter concludes by giving a brief overview of the thesis.

1.2 Background to the study

The new democratic dispensation in South Africa in 1994 resulted in many new policies which have been introduced in the country, including in the field of education (Robinson, 2002). These new policies were intended to eradicate the imbalances of the past due to racial inequalities and apartheid. Some policies which related to changes in the school curriculum had far- reaching the goal for developing relevant teachers to implement the new curriculum.

The majority of the teachers in South Africa belong to the previously disadvantaged community. The Colleges they attended were poorly resourced and equipped since funds were allocated according to race; therefore, the system was ineffective in the provision of quality teacher education. The apartheid policies were clearly evident in the training of Mathematics teachers. This had a negative impact, especially in Mathematics and Science education (Adler, 2000). For ten years later after the new democracy, the shortage of qualified Mathematics teachers was a problem in South Africa (Parker, 2004). This brought about extremely low dimensions of education in the grown-up population. This announcement is affirmed in the after effects of 2015 (TIMSS) Trends in International Mathematics and Science Study and (ANA) Annual National Assessments (Arends, Winnaar & Mosimege, 2017). Furthermore, the report showed how ineffectively arithmetic is comprehended and conceptualized in South African learners (Arends, Winnaar & Mosimege, 2017).

According to Department of Education:

> In the past learners who could not perform well in Mathematics in the General Education and Training (GET) band usually stopped studying Mathematics, thus contributing to a perpetuation of high rate of innumeracy in South Africa (DoE, 2007, p. 9).

Furthermore, Clark (2012) states that between 2000 and 2005, 40% of grade 12 learners who were evaluated in South Africa were not contemplating studying Mathematics, and half of the individuals who did this subject were at lower grade level.

1.3 Mathematical literacy as a school subject

Mathematical Literacy (ML) for Grades 10-12 was introduced in 2003 and implemented for the first time in 2006 in South Africa (Botha, 2010). South Africa was the first country in the world to have ML as a school subject (Christiansen, 2007). The purpose of the DoE introducing ML, was to introduce a fundamental subject in the Further Education and Training curriculum that would bring mathematics to all learners and to ensure that citizens of the future are highly numerate consumers of mathematics (DoE, 2003). The hope was also that ML would provide learners with an awareness and understanding of the role that Mathematics plays in the modern world. ML is a subject driven by life-related applications of Mathematics (DoE, 2003). ML was also meant to provide necessary skills to learners who otherwise would not have had an opportunity of becoming more mathematically literate according to the previous system of education in South African schools (North, 2017).

The intentions of the DoE (2003) for introducing ML as an alternative to Mathematics were highly acknowledged, but due to implementation problems, not all ML teachers share the DoE's vision. Sidiropolous' (2008, p. 255) study on the implementation of ML in South African schools found that "the threat experienced by qualified mathematics teachers regarding their 'status identity' undermines the proper implementation of the subject". She also found that "teachers did not understand and value the new curriculum which involves understanding not only the concept of mathematical literacy but also the nature of mathematics, its transformative purpose and possibilities" (Sidoropolous, 2008, p. 255). Another problem was the belief of some teachers that ML was the dumping ground for mathematics underperformers (Mbekwa, 2007). Moreover, some principals believed that any teacher can teach ML, not necessarily mathematics teachers (Mbekwa, 2007).

With the introduction of ML and its implementation, ML teachers have become crucial agents of change. Therefore, there was a need to train teachers to teach ML as a new subject. Teachers needed more training especially on content, contexts and methodology because new content such as data handling, probability and models were added. ML being a new subject required that the different learning outcomes (LO's) had to be taught within a given context. The method of teaching also had to change, with a move from teacher-cantered to learner-centered classrooms. Some of the Outcomes Based Education (OBE) methods of teaching and assessment were a challenge for teachers, from both advantaged as well as disadvantaged backgrounds, who felt insecure and less confident in their classrooms (Goba, James, Bansilal, Webb & Khuzwayo, 2011).

The Department of Education (DoE) recognized that existing teachers within the system should be properly trained in order to implement ML as a subject (Bansilal & Rosenberg, 2011). However, the national instruction office connected with universities to introduce a programme suitable for teachers to teach the subject ML (Bansilal & Rosenberg, 2011). Moreover, Vilakazi (2010) argues that this re-skilling and retraining would enable teachers to implement ML appropriately.

Teachers were drawn from a variety of subjects, even from the scarce subjects such as Afrikaans and History. Teachers had to be trained in content knowledge and teaching strategies to be able teach the new subject which was not similar to Mathematics. ML was a new subject with reasoning that was not the same as mathematics and it was context driven. The DoE arranged training workshops for the teachers in the different districts where the aims and objectives of the curriculum were cascaded to the teachers. However, insufficient time was spent on the content and the pedagogic content knowledge. Hence, this training proved to be inadequate in terms of professional development. This type of training which was termed the Cascade Model involved a 'top–down' approach which followed the hierarchical system:

> A representative from national department of education trains a provincial representative who in turn trains a district official who in turn trains the circuit representatives and the teachers who belong to that circuit. Teachers would then cascade that information to the rest of the teachers within the school. This type of training was strongly criticised by Chisholm, Volmink, Ndhlovu, Potenza, Mahomed, Lubisi, Vinjevold, Ngozi, Malan and Mphahlele, in their report. (Brijlal, 2013, p. 2)

1.4 The ACEML curriculum

Professional development programs and models have been developed in South Africa, but there are concerns about the extent to which these programs contribute to teacher knowledge (Vilakazi, 2010). Kriek and Grayson (2009, p. 9) argue that "professional development integrates the development of teachers along three dimensions, namely content knowledge, teaching approaches and identity." In contrast, Ball, Thames and Phelps (2008, p. 5) contend that "Mathematics teachers' subject matter knowledge interacts with their assumptions and explicit beliefs about teaching and learning, about students and about context to shape the ways in which they teach their subject to the students."

Ball et al. (2008) also assert that teacher knowledge is acquired when the teacher has mastered the art of knowing the subject content, and the manner in which the students can learn the subject content. Therefore, strengthening Mathematics teachers' content knowledge should be an essential component of any professional development programme.

Some universities such as the University of KwaZulu-Natal designed and offered the two-year ACEML programme to enable teachers to implement the subject ML. ACEML programme consisted of 8 modules which focused on:

> Knowledge dealing with the school and the profession, teaching, learning, context, resources, etc. There are six modules designed and coordinated by the UKZN School of Science, Mathematics and Technology Education related to the teaching and learning of mathematical literacy. Two of these are mathematical literacy education modules that are related specifically to issues around the teaching of mathematical literacy and are based on the philosophy and theories of mathematical literacy and reflective practice. Another four mathematical literacy education modules are related respectively to the four generic mathematical literacy outcomes with the aim of developing the content knowledge of the participants (Vilakazi, 2010, p. 16).

The majority of the teachers who were identified by the DoE to study the ACEML programme consisted of non-mathematics teachers and it was intended that the knowledge that they gained would transform them into professional ML teachers.

Brijlal (2013) noted that these teachers had previously belonged to a community of practice centred on the subjects that they had trained for and taught for a number of years with their own beliefs and structures. Teachers had entered the programme for various reasons such as re-skilling and upgrading their qualification which resulted in monetary gains, a desire to learn Mathematics, a sense of belonging, taking charge of a new subject and an opening to higher education (Goba et al., 2011).

1.5 Rationale of the study

With the introduction of ML as a subject in 2006, teachers had to enrol for the ACEML programme in order for them to improve their ML content knowledge and teaching strategies to teach ML. This was an opportunity for teachers to re-train and develop their subject knowledge in ML.

The subject ML demands an understanding of numerical concepts (Botha, 2011). Thus, it would be difficult for teachers who had not majored in Mathematics or had previously taught it for a long time to teach ML. There were a few teachers teaching Mathematics in grade 9 or grades 10 to 12 who enrolled for the ACEML programme. The DoE relied upon these teachers to go back to their schools and cascade the information to assist other teachers in the teaching of ML. However, not all of the teachers enrolled in the ACEML programme went back to their schools and shared the ML knowledge and skills gained. All things considered, a few teachers had the opportunity to upgrade their qualifications and skills to a higher level with no expectation of teaching ML. Bansilal (2015) reported that out of a total of 691 students captured in the database, who enrolled in 2007, only 55% graduated in 2009. This is a low completion rate within the minimum time. Although a further 20% completed over a longer period, it is a concern because the ACE is a professional qualification for practising teachers, and being a fully funded programme, one would expect completion rates closer to 100%.

Another interesting issue was that some teachers only taught ML during the time they were students in the ACEML, since it was the requirement of the university that they should teach at least one class of ML. Upon completion of the course, some teachers went back to teach in those subjects that they had been teaching in prior to enrolling in the ACEML programme. This raises questions about the role of the ACEML programme in these teachers' lives

Furthermore, because the decision of who should enrol was taken primarily by the school management, many teachers would have joined the programme on the instruction of their principal and not because they wanted to. Similarly, I was selected to enrol for the ACEML programme at UKZN, and acquired knowledge and skills about ML and how it should be taught. This motivated me to embark on this study to examine teachers' perspectives on how their knowledge was enhanced as a result of participating in the ACEML programme.

There is a need to identify important issues to be considered when teachers are to be trained to become ML teachers. The philosophy of ML should be clarified with those teachers who want to teach ML. An important issue is the knowledge of ML content as opposed to content learned in mathematics. Teachers who wanted to teach ML need to have a strong identity with the subject and hence be clear about the purpose of ML as opposed to mathematics. Also of importance was learning to design the assessment tasks in ML which should be based on context. Also, teaching strategies used in ML need to be explored as opposed to those used in Mathematics. The teachers' beliefs about the subject ML based on their knowledge of the purpose of the subject had to be explored. Therefore, teachers who had participated in the ACEML Programme are best placed to explain how the programme contributed to the development of their ML knowledge.

Many scholars have argued that teacher knowledge comprises subject content knowledge and pedagogical content knowledge. South Africa has a past in which poor quality or lack of education resulted in a very low levels of literacy in our adult population. International studies have shown that South African learners fare very poorly in Mathematical literacy tests when compared to other developed countries (DoE, 2003). South African learners performed poorly in mathematics because their teachers had poor mathematics content knowledge (Kriek & Grayson, 2009).

Therefore, there is a need to examine ML teachers' content knowledge and pedagogic content knowledge, which highlights the importance of this study.

1.6 Purpose of the study

This study aims to explore the ways in which the Advanced Certificate in Mathematical Literacy (ACEML) programme contributed to the professional development of teachers who participated in the programme. To this end, the purpose of the study is to explore how teachers' engagement in the ACE ML programme contributed to their acquisition of content knowledge and pedagogical content knowledge as well as enhancing their confidence to teach ML.

1.7 Key research questions

The following research questions will guide this study:

1. How has ML teachers' participation in the ACEML programme contributed to their professional development?

There are three sub-questions:

1.1 How has their participation in the ACEML programme contributed to their content knowledge in ML?

1.2 How has their participation in the ACEML programme contributed to their pedagogic content knowledge?

1.3 How has their participation in the ACEML programme contributed to their confidence?

2. What are some challenges experienced by ML teachers when teaching ML?

3. What further support do ML teachers need, after completing the ACEML programme?

1.8 Research design and methodology

This study aims to explore the extent to which the ACEML program contributed to the development of teacher knowledge of ML teachers. This study used the pragmatic paradigm. According to Maree (2007), a pragmatic paradigm believes that the truth is what works. Thus, I believe that through questionnaires and semi-structured interviews teachers who participated in the ACEML programme will provide rich details of their reality and experience of the programme towards the development of their knowledge and confidence.

The study used mixed method or triangulation method where two methods of data collection contrast with each other (Creswell, 2009). The first phase of this study adopted a quantitative approach and used a survey. Maree (2012, p. 157) defines a survey as "an assessment of the current status, opinions, beliefs and attitudes by questionnaires or interviews from a known population". Similarly, in my study, I administered fifty questionnaires to teachers who completed the ACEML programme at UKZN in 2009 and 2010 to explore the beliefs to their professional development needs. The second phase adopted a qualitative approach using semi-structured interviews with five participants to allow them to share their views about and experiences with the ACE ML programme (Maree, 2007). Moreover, Maree (2007) defines a qualitative approach as research that attempts to collect in-depth data in respect of the particular phenomenon in order to gain an understanding of what is researched. Qualitative research in this study was used to supplement quantitative data (Cohen, Manion, & Morrison, 2011).

Purposive sampling was used in this study as I purposively administered 50 questionnaires to ML teachers in uMgungundlovu district, of which of them 5 teachers were also interviewed. Rule and John (2011) argue that the selection of data is influenced by the purpose of the study and is done through sampling. "Purposive sampling means that participants are selected because of some defining characteristics that makes them holders of the data needed for the study" (Maree, 2012, p. 79). ML teachers were easily accessible to me in the uMgungundlovu district since I teach in this district. According to Cohen et al. (2011) this type of sampling is occasionally called opportunity sampling and "involves choosing the nearest individuals to serve as respondents to generate data that is needed" (Cohen et al., 2011, p. 113).

The data in this was generated through questionnaires "to allow the researcher to make a true assessment of what the respondent really believes, and also enabled the researcher to classify and quantify the findings of the study" (Cohen et al., 2011, p.357). In this study a questionnaire was used for the following reasons:

> "Allowed minimum expenses of both time and money, allowed more answers from the respondents, allowed the collection of responses which were classified and, allowed the gathering of information contained in the responses which were quantified" (Maree, 2012, p. 57).

The data of the second phase of the study was also generated through the semi structured interviews. However, the semi-structured interviews was used in this study with the aim of exploring authentic and rich responses from the participants, about some claims they made in the questionnaires." According to Cohen et al (2011, p. 357) "semi-structured interviews allow for open-ended responses, it also allows for flexibility and the interviewer can probe the interviewee in order to get an in depth understanding or a clear understanding".

The data was analysed manually, no software program was used, and it was reported in tables and graphs. Data was summarised in tables and graphs "to see at a glance where differences and similarities lie between individuals" (Cohen et al., 2011, p. 266). Thereafter thematic analysis was used. The interviews were tape-recorded and transcribed into narrative format and I was then able to examine more clearly the perceptions of the five participants of the ACEML programme. Codes were grouped in to categories which led to many themes that began to emerge from the data analysis (Rule & John, 2011). Shulman's (1996) Conceptual framework on teacher knowledge was used as an analytical framework.

1.9 Outline of the thesis

This study is organised into five chapters, followed by a list of references and the relevant appendices:

Chapter 1 discusses the introduction and background of the study. In this chapter, I present the background of the study, outline the purpose of the study, provide a rationale and briefly outline the research design and formulation of the research questions. Chapter 1 concludes with an outline of the chapters in the thesis.

Chapter 2 describes a detailed literature review on two aspects of teacher knowledge: content knowledge and pedagogical content knowledge in relation to mathematical literacy. It also describes professional development in developed and developing countries. The chapter concludes with a discussion of the conceptual framework.

Chapter 3 describes the research design and methodology chosen for this research. In the process, attention was also given to research ethics and how to ensure validity and trustworthiness of the results. This chapter includes a discussion on data collection, sampling strategies and data analysis.

Chapter 4 focuses on presenting the findings of the data that was collected from the questionnaires and interviews with the participants. Results are discussed according to patterns, trends and themes.

Chapter 5 discusses data analysis and presents a discussion of the findings, the limitations of the study and recommendations for further research. The conclusion, the list of references and appendices completes the research report.

1.10 Conclusion

This chapter provided an overview of the study, introduced the main focus of the study. The chapter began by outlining the background of the study, the subject Mathematics and the outline of the Advanced Certificate in Mathematical Literacy. It then described the rationale and the purpose of the study. Followed by key research questions guided this study. The chapter concluded by giving a brief overview of the thesis. The next chapter presents the reviewed literature and the conceptual frame work.

CHAPTER 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter begins with an overview of the subject Mathematics, followed by an outline of Mathematical Literacy. Next, a review on professional development programmes such as the ACE in general and the ACE ML programme in particular, and how these programmes were structured in developing teacher knowledge is discussed. This is followed by a discussion of the state of developing professionalism of teachers in South Africa, and the initiatives taken by the DoE in improving quality education within the schools. Next, teachers' knowledge is discussed including the specific mathematical knowledge that is needed for ML. In conclusion the conceptual framework on teacher knowledge is discussed.

2.2 Overview of Mathematics

Science and Mathematics teachers in South Africa have experienced low-quality education (Bansilal & Rosenberg, 2011). This is due to the Colleges they attended being poorly resourced since money was allocated according to race, hence the system was ineffective in providing of quality teacher education (Adler, 1997). Furthermore, the National Teachers Education Audit of 1995 and the survey of the Mathematics and Science Teachers of 1997 discovered that there was an absence of demonstrable skills in most instructor organisations particularly, in recently impeded schools of training (Mkhize, 1999). These results were the worst in Mathematics education because of the apartheid policy (Bansilal & Rosenberg, 2011). This also led to South African learners performing poorly in Mathematics because their teachers had poor Mathematics content knowledge (Kriek & Grayson, 2009). In the same way, these poor results were prolonged by the large group of teachers who did not receive an adequate training in the field of Mathematics and science during the apartheid era (James, Bansilal, Webb, Goba & Khuzwayo, 2015).

Current studies clearly indicate that South Africa learners' poor performance in Mathematics could be attributed to a lot of factors. Some of these factors include: poverty, poor school infrastructure, lack of motivation of teachers and learners, unqualified teachers, and poor attitude of learners towards Mathematics (Bansilal & Rosenberg, 2011). Other researchers argue that "South African learners' poor performance in Mathematics can be likened to lack of appropriate learner support materials, poor socio-economic background of learners, medium of instruction, lack of motivation, poor quality of teachers and inadequate study orientation" (George & Adu, 2018, p. 137).

Currently, these poor results in Mathematics have received much attention (Umugiraneza, Bansilal & North, 2017). For instance, year 2015 grade 12 results in Mathematics, learners who accomplished 50% or more was just 20% Department of Basic Education (DoBE) (DoBE, 2011). Consequently, Umugiraneza et al. (2017) note that 80% of the learners were just ready to accomplish an imprint was beneath 50 percent. This is additionally apparent when taking a look at learners' execution results in national and worldwide investigations, for example, ANA and TIMSS, South African learners perform far below the universal average (Arends et al., 2017). In recognising the determinants of instruction quality, these poor outcomes in Mathematics normally lead to inquiries concerning whether Mathematics education is as compelling as it could be (Umugiraneza et al., 2017). Arends et al. (2017) contend that to pass judgment on learners regardless of whether instructing is successful, must be assessed against advancement made by teachers.

However, these poor results in Mathematics indicate that the South African education system has not yet met the needs of its citizens (Van der Nest, Long & Engelbrecht, 2018). The DoBE has historically aimed to changing the curriculum in order to ensure quality education (Molapo & Pillay, 2018). Trying to overcome the situation of a poor-quality education system, curriculum 2005 was presented in 1998 (DoBE, 2011, p. 9). "This educational programme was modified in 2000 and in 2002 the NCS for FET was created. In 2009, an assigned group checked on the educational programme and separated from issues identified with learning materials and educator preparation, the educational modules archives were regarded as needing streamlining" (DoBE, 2011, p. 9).

> It was found that some of these documents contradicted each other while at other times there were repetitions. Also, some of the OBE methods of teaching and assessment were a challenge for teachers, from both advantaged as well as disadvantaged backgrounds, who felt insecure and less confident in their classrooms (Brijlal, 2013, p.16).

The audit recommended that the DoBE phase out (OBE) Outcome Based Education, it was replaced by a solitary archive called (CAPS) Curriculum and Assessment Policy Statement which was first implemented in 2012 (DoBE, 2011).

Bansilal (2013 argues that, in South Africa, authorities have been concerned with the low rates of participation in Mathematics in the Further Education and Training Band. The research also shows that learners in developing countries such as South Africa perform very poorly in Mathematics when compared to other countries (Kriek & Grayson, 2009). Thus, learners have a fear of taking Mathematics as a subject. This is evident in the study of Brijlal (2013) that from 2000 to 2005, 40% of the students writing the matric examination did not choose Mathematics as a subject. Additionally, the restricted quantity of numerically capable students entering the workforce every year shows an imperative to the development of the nation (Umugiraneza et al., 2017).

2.3 Mathematical Literacy

ML was newly introduced in South Africa as an alternative subject to Mathematics in Grades 10 to 12 (Thembela, 2013). Since 2006, enrolment in ML has increased year-on-year, overtaking enrolment in Core Mathematics, a scientific Mathematics qualification that was the alternative offering in 2010. “Approximately 360 000 learners (58% of the cohort) wrote Grade 12 examinations for ML in 2016, with the remainder writing Core Mathematics” (DoBE, 2017, p. 10). In a ML classroom, mathematical abilities are utilised to examine the significance and ramifications of data in a setting (Bansilal, 2013). Its motivation was for the learners to utilise Mathematics to comprehend the world, but not to learn Core Mathematics (Bansilal, Mkhwanazi & Mahlabela, 2011).

Nel (2012) contends that ML was taken mainly by weaker learners with low Mathematics marks in Grade 9, grade 12 school leavers without Mathematics, as well as the large number of learners who fail the subject each year. This is affirmed by Jansen (2011) and Child (as cited in Bansilal, Webb & James, 2015) who criticised ML as a simpler form of Mathematics. In contrast, Bennie (2005, p. 7) introduced the “Maths Learn philosophy of teaching and learning”, with the belief that all learners can learn Mathematics. On the other hand, according to Brijlal, (2013):

> There has been a growing concern that the formal Mathematics curriculum does not prepare and equip learners with the necessary skills and knowledge to perform the jobs successfully, especially

with the quantitative and mathematical demands of everyday life. A good example would be of compiling and reading spreadsheets, reading off plans and maps and drawing up budgets and working with financial documents (Brijlal, 2013, p.14).

However, the subject ML was also introduced, as an intervention to improve numeracy skills of South African citizens in response to poor performance in Mathematics (Spangenberg, 2012)

There are various definitions and interpretations of ML which subsequently leads to particular interpretations and debates. The following are some of the definitions. The Department of Basic Education (DoBE, 2011) defines ML as:

> [t]he competence developed through Mathematical Literacy allow individuals to make sense of, participating in and contribute to the twenty-first century world - a word characterized by numbers, numerically based arguments and data represented and misrepresented in a number of different ways, such competencies include the ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events and use and apply technology. Learners must be exposed to both mathematical content and real-life contexts to develop these competencies. Mathematical content is needed to make sense of real-life context; on the other hand, contexts determine the content that is needed. (DoBE, 2011, p. 8).

The above definition of ML shows that in order for an individual to teach ML effectively, mathematical knowledge is essential. This raises a concern about the kind of content needed by the teachers to teach ML and what teaching strategies they should use.

Scholars have attempted to contrast the two subjects, Mathematics and ML. This is highlighted in the following definition:

> The subject ML is meant to be taught in a manner which allows learners to engage in problems and situations that can help them develop the critical mind-set that is envisioned. It involves the learners being able to explore the nature of the problem and thereafter, either using practical methods or mathematical formulas that they themselves may derive to solve the problems (Brijlal, 2013, p.14).

Curriculum documents emphasise that in ML, context and content should be intertwined in any teaching and learning situation (Bansilal et al., 2011). According to the DoE (2007):

> When teaching and assessing Mathematical Literacy, teachers should avoid teaching and assessing content in the absence of context. At the same time teachers must also concentrate on identifying and extracting from the context the underlying mathematics or content (DoE, 20O7, p.7).
>
> The stipulation about the relationship between content and context offers us as mathematics educators an exciting opportunity to deepen our own understanding about how students engage with mathematics concepts which are embedded in real-life contexts. Assessment at school level in ML is guided by the ML assessment taxonomy which specifies 4 levels in the hierarchy (DoE, 2007, p. 27).

On the other hand, Venkat, Graven, Lampern and Nalube (2009) as cited in Bansilal et al. (2011) criticise the taxonomy, that combining content and context content and these two aspects become complex. Despite the critics, any educational aspect that achieves these objectives will build up learners' abilities at arriving at the expectation of the curriculum (Bansilal et al., 2011). Moreover, learners won't be afraid when they reach these settings in their present or future lives, yet will utilise them to make educational choices (Bansilal et al., 2011)

The ML curriculum statement (DoBE, 2011) indicates that the subject is centrally concerned with real-world contexts connected to future life roles that would be useful for learners to engage with in Mathematical ways. Such statements suggest that the curriculum proposes pedagogic agendas which consider the relationship between contexts and content to be dialectical where each has a role in deepening the understanding of the other (Graven & Venkat, 2010).

> According to CAPS, Mathematics is a language that makes use of symbols and notations for describing numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects themselves (DoBE, 2011, p. 10).

Similarly, according to Long et al. (2014) the reason for ML isn't that learners find out more and learn a more difficult level of Mathematics but the emphasis is on the utilisation of Mathematics to examine the importance and ramifications of quantitative data displayed in some genuine circumstances.

Brijlal (2013) contends that ML is meant to be taught in a manner which allows the engagement of the learners in problem solving and the situations where they are help develop the critical mind-set that is envisioned. He further maintains that it involves learners being able to explore the nature of the problem and thereafter, either using practical methods or mathematical formulas that they themselves may derive to solve the problems.

Bansilal et al. (2015, p. 2) define "four attributes of contexts that needs to be attained and used in ML: 1). Contextual language- this refers to words or phrases, which hold a particular meaning within the context; 2). Contextual signifiers refer to the signifiers used in the context to convey specific information, and which have a meaning that is bound by the parameters of the context; 3). Contextual rules are bound to the context and need to be interpreted within the context by the pupil, and 4). Contextual graphs are graphs used to present information about the context."

As stated earlier, ML is about involving mathematical skills which are used to explore the implications and meaning of the content in the context (Bansilal, 2013). Moreover:

> The aim of Mathematics is to equip learners to be skilled citizens, meeting the demands they will encounter in their future lives. The process to achieve this aim involves the mastering of mathematical content knowledge through solving contextualized problems (DoBE, 2011, p. 8).

Thus, since ML is based on the real world of numeracy, it is vital that ML teachers possess a fundamental understanding of mathematical concepts (Bansilal, Mkhwanazi & Mahlabela, 2012). Hence, this shows that pedagogic content knowledge and content knowledge as referred to by Ball et al. (2008) is a key facet of ML knowledge.

2.3.1 Assessment in ML

The study of Moodaly (2013) showed that teachers were not well-equipped to design suitable tasks for ML learners. This suggests that teacher educators need to focus on developing skills in designing tasks. It is suggested that through teacher development courses teachers develop their assessment techniques and teaching (Umugiraneza et al., 2017). According to the DoBE (2011):

> Assessment is a continuous planned process of identifying, gathering and interpreting information about the performance of learners, using various forms of assessment. It involves four steps: generating and collecting evidence of achievement; evaluating this evidence; recording the findings and using this information to understand and thereby assist the learner's development in order to improve the process of learning. Assessment should be both informal (assessment of learning) and formal (assessment of learning). In both cases regular feedback should be provided to learners to enhance the learning experience (DoBE, 2011, p. 96).

Appraisal likewise, assumes a fundamental job in successful teaching and learning, and additionally empowers teachers to analyse learners' challenges, upgrade understudy inspiration, assess their teaching, and plan the following teaching and learning ventures to be taken (MacLellan, 2004). This means that teachers cannot use examples and assess knowledge out of the context that learners live in. McLellan (2004) argues that assessment tasks need to acknowledge that people from different social class, ethnicity, age and gender respond differently to the task. According to Jaworski and Wood (2008), learning occurs through engagement in tasks. They further assert that what learners learn is largely defined by the tasks they are given.

Long et al. (2014) assert that ML and its assessment have generally been brought into the South African secondary school curriculum recently. As per the points of ML appraisal, the subject must quantify the degree to which learners can understand situations dependent on bona fide and practical, commonplace and new genuine settings by illustration on both numerical and non-scientific procedures and contemplations (DoBE, 2011).

Jaworski, and Wood (2008)) claim that the quality of instruction depends to a large extent on whether teachers select cognitively demanding tasks. Nonetheless, the teachers must be aware of the assessment scientific classification when teaching appraisal undertakings (DoBE, 2011). These dimensions are level one: knowing, level two: applying routine technique in a commonplace setting, level three: applying a multi-step system in an assortment of settings and level four: thinking and reflecting (Moodaly, 2013). Be that as it may, assignments require the basic proliferation of realities, while at the opposite end of the range; undertakings require point by point investigation and the utilisation of changed and complex techniques and methodologies (DoBE, 2011).

The ML curriculum document clearly indicates that content and context cannot be divorced. The document further suggests that teachers should avoid teaching and assessing content in the absence of the context (DoBE, 2011). The use of context is complicated due to the language barrier to both teachers and learners (Moodaly, 2013). In contrast, North (2010, p. 2) found that “many of the contexts used were ‘pseudo contexts”. There were settings that were either misleadingly built; improper to the Mathematics being investigated in that unique situation or refocused to attract consideration regarding explicit scientific ideas and far from genuine circumstances. The results of North’s study (2010) show that there is a need for stakeholders to examine these issues more closely. The implication for teachers is that the programmes must create opportunities for prospective teachers to engage with these issues during their training (Bansilal, 2014).

Zaslavsky (2008) asserts that the role of a teacher in selecting and designing appropriate tasks for enhancing learning is the availability of appropriate resources such as textbooks, teacher guides, and enrichment materials that are easily accessible.

Long et al. (2014) consider the ramifications of the motivation behind the test and the development of rubrics so they work rationally in light of a legitimate concern for substantial estimation like properties and therefore give solid data to teachers. It might be seen that things are functioning admirably and are a decent marker of the leaners' capability. It might likewise be the situation that a few things featured are viewed as tricky. Likewise, Long et al. (2014) allude to models that put emphasis on things working and the scoring rubrics.

“Most learners who select ML have performed poorly in Mathematics at Grade 9 level, learners are probably going to have numerous misinterpretations about the Mathematics in the fundamental abilities subjects, which would obstruct them from working with certain ML undertakings” (Bansilal et al., 2015, p. 3). In this way, ML teachers must encourage Mathematics at Senior Phase level also, with the goal that coherence can be shaped, and teachers will almost certainly manage learners through the change between stages.

2.4 ACE and ACEML programmes

In 2003, a professional-development programme, ACE, was introduced by Higher Education Institutions in SA (Kekana & Gaigher, 2018). In this study, the formal teacher development programme highlighted is the ACE Programme. The ACE programme was intended to empower officially qualified teachers to re-aptitude in new learning regions (Bansilal & Rosenberg, 2011). For example, some FET Mathematics and Physics teachers had one year of Mathematics or Science in a re-training ACE programme (Reeves & Robinson, 2010).

The national education department also recognized “the need to have adequately skilled teachers to support the implementation of the new school subject mathematical literacy (Bansilal & Rosenberg, 2011). Furthermore, the national education department likewise connected with establishments of advanced learning to provide teachers with programmes that would prepare them to teach ML (Bansilal & Rosenberg, 2011). The Faculty of Education at the UKZN responded to the challenge by offering teachers the opportunity to enrol for an ACEML to upgrade or retrain themselves to teach ML (Bansilal et al., 2012). Hence, Vilakazi (2010) affirms that re-training would enable teachers to teach Mathematical Literacy effectively.

Peacock and Rawson (2001) argue for ongoing projects to develop the skills and evaluate teacher's performance after they have been enrolled in teacher development programmes. Furthermore, Mushayikwa and Lubben (2009) point out that some of the staff developers have reported difficulties with regard to evaluating the effectiveness of the professional development programmes. The ACEML was the new training programme in KZN, and it was therefore important to evaluate its effectiveness (Thembela, 2013). According to James et al. (2015):

> The programme structure is one in which there are eight modules consisting of six discipline-specific modules and two generic modules. Four of the six modules are devoted to the development of content knowledge. The other two modules are devoted to the development of pedagogic content knowledge. The two generic modules focus on general professional development, on teacher developing an understanding of policy, conditions of service and the roles of the teacher (James et al., 2015, p. 2).

The studies of Thembela (2013) and Brijlal (2013) were intended to investigate and build up, from the perspective of the teachers in the ACEML, regarding how their professional development and knowledge were enhanced through enrolling on the programme. Furthermore, Bansilal et al. (2015) confirm that proficient improvement programs need to give a chance to ML teachers to reflect on their practice. Kriek and Greyson (2009, p. 186) argue that, "limited information is available about the factors that contribute to effective Mathematics and science professional development, as well as examples of programmes that lead to effective practice". In addition, Brijlal (2013) affirms that features of professional development which includes changes in content knowledge and teaching practices should eventually lead to improvements in learners' achievement.

Brijlal (2013) contends that ML teachers need to know more than just the Mathematics that is embedded in the ML curriculum and they need to understand the difference between Mathematics and ML to be clear about the purpose of ML in the learner's life. According to Bansilal (2012), ML has a different philosophy, a different purpose and a different content. This is further confirmed by Thembela (2013) where ML teachers saw a chance to increase teaching capability than as an open door for their very own proficient improvement as far as content learning, content-explicit instructional methods and building up an expert character is concerned.

Brijlal (2013) points out that the setting in which a teacher works is an essential aspect that must be considered in the development of professional development programs. Furthermore, Johnson, Hodges and Monks (as cited in Brijlal, 2013) caution that teacher developers should try to find out more about the contexts and reasoning behind the practices of teachers, when designing teacher professional development programmes or models. Kriek and Greyson (2009) suggest that holistic professional development was effective to help teachers to develop along three dimensions, namely; content knowledge, teaching approaches and professional attitude. Similarly, Brijlal (2013) argues that features of professional development which includes changes in content knowledge and teaching practices should eventually lead to improvements in learners' achievements. Hence, it is imperative that proficient improvement of all teachers is reasonably implanted, viably arranged and overseen (James et al., 2015). The researcher further recognises that proficient advancement of teachers is very settled in most countries. In this manner, more research is expected to decide the pertinence and job of professional development programs identified with the necessities of expert learning of teachers. James et al. (2015) examine the difficulties of structuring a MST proficient advancement program in the country.

Another of the crucial roles of the ACEML programme would have been to develop the confidence and competency in those teachers who participated in the programme (Thembela, 2013). According to Brijlal (2013):

> Teachers were given lots of materials in the form of hand-outs and textbooks, which many teachers were unable to teach themselves since they were unable to ascertain exactly what strategies to use with all the knowledge that they were confronted with. This can only be learnt if teachers are actively involved in the processes themselves (Brijlal, 2013, p. 17).

2.5 Professional Development

In South Africa, Kekana and Gaigher (2018) are of the opinion that:

> Professional development of science teachers is a priority, in view of poor learner performance in international assessments, poor Grade 12 results, the effects of curriculum changes since 1994, and

> as mentioned earlier, the heritage of inadequate teacher training in the apartheid era (Kekana & Gaigher, 2018, p. 2).

Most international studies indicate that teacher training is the key to improved curriculum implementation (Molapo & Pillay, 2018). Post-apartheid educational reform and restructuring had a significant impact on teacher education programmes (Adler, 2002). Thus, in South Africa, professional development was promising after the introduction of new policies in education (Bansilal & Rosenberg, 2011). Furthermore, since 1994, the democratic South African government under the leadership of African National Congress has introduced changes all over the country to address those challenges (James et al., 2015).

Teachers' improvement programs are offered in various delivery modes, for example, declaration programs, workshops, courses, activity research, training and coaching (Kekana & Gaigher, 2018). Thembela (2013) contends that teacher development is a process of teacher learning. As indicated by Kelly (as cited in Thembela, 2013), there are numerous intellectual models of learning and they all offer a shared conviction in that people develop aptitudes, information and understandings in a single setting. The author further affirms that teacher learning is the procedure by which teachers move to an expert specialist (Kelly, 2006). To be a specialist teacher implies having a functioning association with one's learning base, in this manner, having the capacity to develop one's very own insight base, as per each individual's particular conditions (Thembela, 2013).

The place in which a teacher works is an important aspect that must be considered in the development of professional development programs (Brijlal, 2013). Johnson, Hodges and Monks (2000) caution that teacher trainers should try to find out more about the contexts and reasoning behind the practices of teachers, when designing interventions for teachers.

Despite these efforts, professional development programmes and models which have been developed in South Africa, have been ineffective and have caused dissatisfaction with the way they fail to meet professional development needs of teachers (Bantwini, 2009). In the same way, Dass, (as cited in Kriek & Grayson, 2009) argues that in South Africa re-training of teachers had been inappropriately done. Thus, this means professional development has to be mapped according to the context of South Africa. Guskey (2002) affirms that:

> The majority of programmes fail because they do not take into account two crucial factors: (1) what motivate teachers to engage in professional development, and (2) the process by which change in teachers typically occurs (Guskey, 2002, p. 382).

Moreover, Mott (as cited by Bantwini, 2009) argues that most of the professional development programmes and models lack theories about the nature of knowledge and practice. Therefore, Bantwini (2010) suggests that more research is needed to determine the effectiveness of professional development programmes and models. In contrast, James at al. (2015) focused their examination on a teacher proficient advancement program that can viably bolster the expert improvement of teachers in the classroom. International studies also focus on Mathematics teacher education practices that can prolong quality in South African education (Potari, 2017). Currently in this country, Bansilal (2015) states that there are still few studies that have focused on the success rates of teachers in teacher development programmes. In Abre's study (2018) it was recommended that more CPD opportunities should be provided to science and Mathematics teachers to enable them to deliver on their mandate.

2.6 Challenges of ML teachers

The government is no longer financing the programmes to re-train ML teachers (Bansilal et al., 2015). Furthermore, assessment of the challenges associated with the ACE programmes suggests that the ACE programme focused on too many outcomes that could not be achieved (Bansilal, 2015). Currently, there is clear evidence that only a few students choose teaching as a career and even fewer choose Mathematics teaching as a specialty (du Preez, 2018).

ML teachers, likewise are persistently expected to teach both Mathematics and English in the meantime (Bansilal & Rosenberg, 2011). Furthermore, according to Brijlal, (2013):

> In fact, it has been opined that the challenge for many educators is helping learners to move from where they are unable to understand English to where they can communicate Mathematics in English (Brijlal, 2013, p. 90).

Teacher proficient advancement does not happen in a vacuum and teachers are required to learn and create on a low maintenance premise, while working, running families and being challenged by a variety of difficulties in their networks (James et al., 2015). These researchers further attest that, the specific models, strategies and educational content knowledge utilised by HEIs to re-able and re-train teachers need to consider these perspectives. The teaching setting in which teachers work under, physical, social and political, are different from those in administration may envision (Johnson & Monk, 2000). It is true that South Africa has passed through a period of political change and part of that change is the issue of equity and justice. These inequalities are revealed in the vastly different educational infrastructure which is available to schools in the country, which impacts directly to the practice of teaching and learning (Robinson, 2002). Johnson and Monk (2000) contend that teacher change and improvement are inadequately fit to demonstrating practices and difficulties for the individuals who were verifiably hindered. These difficulties in South Africa incorporate neediness, assets, learning societies, foundations of schools and low teacher capabilities (Kriek & Grayson, 2009). Furthermore, these challenges emerged from the fact that many teachers in the system have qualifications which did not originally equip them to teach the new curriculum (Reeves & Robinson, 2010).

In the context of Zimbabwe, at the turn of millennium, there was a remarkable decrease in the economy with both wellbeing and instruction administrations enduring the worst part of the monetary drop out (Mushayika & Lubben, 2009). Teachers ended up adapting to extensive classes of poorly arranged understudies with constrained reading material and likewise, the absence of help in teacher's improvement which resulted in less successful instruction (Mushayika & Lubben, 2009). On the other hand, the department of education (DOB, 2007) recommended that in-service programmes must be designed according to the needs of the teachers and that will result to effective innovations. Professionalism is determined by the uniqueness of the teaching context (Bansilal & Rosenberg, 2011). Furthermore, Bansilal and Rosenberg, (2011), explored how teachers who were re-trained to teach ML were adapting to the requests of teaching. It was additionally discovered that regardless of the situations ML teachers worked under, they were able to reflect on the improvement of their professionalism (Bansilal & Rosenberg, 2011). Furthermore, the aim of the programme was to improve the content knowledge and to reflect on it (Bansilal & Rosenberg, 2011).

The environment can restrict teachers to perform well in the classroom even if he/she is very experienced, and it will be naïve to separate the challenge of improving pedagogical content from within the teaching and learning that occurs (Robinson, 2002). Drawing from Robinson (2002), poor conditions impact on teachers' practice of their professionalism. Moreover, the selection of actual classroom practice is also constrained by the resources at hand and the nominative behaviour of the school a teacher works in (Johnson & Monk, 2000). This intervention, with its unmistakable spotlight on supporting teacher improvement inside networks of training in their particular school settings, experienced interruptions due chiefly to time limitations. Teachers attempted to find the time to get together for important participatory arrangement and assessment exercises that are basic to the exercise contemplative approach (James et al., 2015). According to the DBE (2014):

> Although the DBE has indicated that they would prefer more Grade 12 students to take up mathematics instead of ML, the reality is that the numbers of learners opting to study ML has steadily increased from 267,236 or 47.1% of Grade 12 candidates in 2008, to 324,097 or 57.3% of the candidates in 2013 (DBE, 2014, p. 9).

Bansilal et al. (2015) went on further to emphasise:

> This increase indicates that the education system requires an even larger number of ML teachers than those who were trained and are currently teaching ML. Considering that there are no pre-service ML teacher training initiatives run by the two HEIs in KZN; the situation is very serious indeed. HEIs and the DoE need to urgently work together to offer professional development programmes for practising teachers as well as to expand pre-service teacher programmes in ML (Bansilal et al, 2015, p. 7).

2.7 Support to ML teachers

> Teacher support is a vital ingredient in the work of education systems across the world. Generally, educators require support as they try to find their feet in the profession; make sense of reform initiatives; and implement policy (Nkambule & Amsterdam, 2018, p. 1).

These authors further noticed that teacher confidence is deficient; leaving teachers feeling unsupported and poorly prepared to confront the difficulties introduced by the new training framework. Umugiraneza et al. (2017) in their study asserted that “it is imperative to offer in-depth teacher support programmes at the schools where teachers work, so that they can learn while they teach”. The main argument of Adler and Taylor (2009) is that teacher education programmes struggle with what kind of support teachers can be offered to improve their pedagogical content knowledge and impact positively in the context which teachers work under. The study by Bansilal and Rosenberg (2011) uncovered that numerous teachers confronted individual difficulties of poor content knowledge and their teaching systems were constrained. It appears as though they required further help in enhancing their content knowledge. In contrast, according to Bansilal et al. (2015):

> The teachers also identified further help that they required in terms of specific curriculum and assessment issues related to the interpretation of curriculum documents and assessment policies. These point to the need for regular departmental workshops with ML teachers, so that they are kept abreast of changes and revisions to policies. These workshops could also target PCK skills associated with the teaching of contextual attributes (Bansilal et al., 2015, p. 14).

Considering that ML teachers enrolled with ACEML programme to revive themselves, thus they need much support in the work place in order to be able to mentor one another within the school (Bansilal & Rosenberg, 2011).

In the study of Bansilal et al. (2015) teachers were worried about follow up support. This demonstrates that the DoE and universities need to urgently cooperate and offer proficient improvement programmes for teachers to extend pre-service teacher programs in ML (Bansilal, 2015). Brijlal (2013) points out that, although the teachers felt that they acquired new content knowledge, they wished that they would be provided with regular opportunities to build up on their knowledge.

Similarly, Peacock and Rawson (2001) argue that peer coaching and support is essential to sustain changes in practice, and without subsequent classroom support is ineffective in promoting change. This is evident when teachers identified changes in their practice after previous workshops and support on extending their content knowledge (Peacock & Rawson, 2001). Through introspective reflection, teachers' pedagogical content knowledge can be developed (Johnson & Monk, 2000). In the same way, teacher reflection was dissected for the content and understanding of reflectivity during the time spent building their academic content knowledge (Halim, Meerah & Buang, 2010).

Halim et al. (2010) conducted action research analysing supervisory abilities of pre-service teachers and improvement of their PCK. The findings indicated that supervisory reflective skills had improved and their PCK improved (Halim et al., 2010). Workshops could likewise focus on PCK aptitudes related to the teaching of contextual attributes (Bansilal et al., 2015).

Different professional development models have been contrived in South Africa, for instance, activities for teachers' improvement in enhancing content knowledge and abilities and frame of mind for establishment stage such as the Mpumalanga Secondary Science Initiative (MSSI) (Kriek & Grayson, 2009). Although the models were created in South Africa, other existing programmes were studied from several countries such as Peel (Australia), Discovery (USA), Cognitive Guided instruction in the USA and the Japanese approach to professional development. These programmes were selected because they were sustainable over a long period of time. It is therefore not a short-term programme which is one of the weaknesses of many professional development programmes (Kriek & Grayson, 2009). Lastly, the Exeter input comprised of a progression of yearly multi week workshops, each concentrating on an alternate substantive zone, for example, maths and language. Training of teacher leader (TL) chosen from each learning area would then be in charge of the expert advancement of different teachers in a little group of the schools (Peacock and Rawson, 2001). This demonstrates successful education and creating instructive content knowledge cooperatively which was important. Additionally, mentoring ought to be utilised to help rehearsing ML teachers, who are battling with the ML content knowledge they are presenting to the learners (Bansilal et al., 2015).

Recommendation for the future would be for the universities to encourage ML teachers in order to obtain advanced scholarly capabilities. Likewise, ML teachers require more support with innovative reflective skill. Reflection about the points and motivations behind ML enables teachers to comprehend the idea of the subject.

> So as to help teachers in the classroom, the ACEMST program has been planned with a classroom bolster part, rather than the Proficient Practice module. For this situation, 'trained mentors visit teachers in their classroom and watch them teach, and also help them to plan their teaching programmes. These features have been incorporated in the ACEMST programme (James et al., 2015, p. 2).

This revealed that in-service training, content training workshops, PCK workshops and certified programs are an essential form of on-going training for teachers (Brijlal, 2013). Additionally, Lieberman (2009) asserts that teachers are being given a set of workshops that deny the variability of how teachers teach. Nonetheless, it bodes well that proficient advancement activities should concentrate on distinguishing the aim why teachers teach as they taught previously endeavouring to come up with new teaching style (Thembela, 2013).

2.8 Conceptual framework

High level of teacher knowledge is effective way of teaching (Taylor, 2008). In the same way, Ball, Hill and Schilling (2008) emphasise that teachers need good content knowledge and a high level of pedagogical content knowledge for effective teaching of mathematics.

The research shows that in ML classrooms, mathematical skills are used to explore the meaning and implications of the knowledge in the context (Bansilal, 2013). Therefore, ML subject is characterised and directed by real context uses of mathematical skill (Nel, 2012). Mathematics teaching is a specific calling which requires content of the subject and the strategies to teach it to be understood by the learners (Taylor, 2008).

2.8.1 Framework for looking at teachers' professional knowledge for teaching ML

Different authors define teacher knowledge differently. Shulman (1996) discusses the types of teacher knowledge which include content of the subject, PCK and curriculum knowledge. Furthermore, Ennis (1995) refers to content knowledge as concepts, skills and principles useful for curriculum construction which needs to be transformed in to pedagogical content knowledge. Demetriou and Willson (2007) classify teacher knowledge into two categories: codified knowledge or intellectual development and context specific knowledge or practical knowledge. This means there is a link between these types of knowledge.

In developing a framework that can be used to understand the professional knowledge of ML teachers in this research I drew upon the three domains of teacher knowledge: content knowledge, PCK and professionalism that were used in the study by Bansilal and Rosenberg (2011). These are described below.

2.8.2.1 Teachers' Content Knowledge

Content knowledge is described as the knowledge and understanding of central concepts of a discipline (Shulman, 1996). Therefore, the emphasis is placed on the need for teachers to have a deep understanding of what they teach. Thembela (2013) defines content knowledge as:

> Content knowledge in ML may be described as the ability to execute mathematical algorithms, know the subject and its organisational structures; be able to solve problems and apply rules and formulae that are used in the subject ML; answer questions; interpret graphs and maps; draw 3-

> dimensional and other shapes; and sufficiently understand the demands of the school curriculum (Thembela, 2013, p. 90).

Many research studies highlight the significance of teachers' 'applied learning in building up understudies' understanding (James, Bansilal & Webb, 2015; Bansilal & Rosenberg, 2011; Ball & Bass 2000, 2004; Adler et al., 2009; Kriek & Grayson 2009). James, Bansilal, Webb, Goba and Khuzwayo (2015) emphasise that teachers need to build up the essential knowledge of the subject that they teach. Bansilal and Rosenberg (2011) found that many of the ML teachers had poor subject content knowledge which meant that they were unable to design good activities and even struggled with writing lesson plans. Similarly, James et al. (2015) contend that a significant number of the teachers face individual difficulties of poor content knowledge.

Bansilal, Webb and James (2015) in their research about professional development programmes, identify, ML content knowledge which involves "knowledge of the basic skills topics and secondly, ML content knowledge which also includes knowledge of the application topics in the contextual settings" (Bansilal et al., 2015. p. 2). In other words: "Mathematical knowledge comprises two sub-domains of common content knowledge, which is mathematical knowledge and skills used in settings other than teaching and specialised content knowledge, which is mathematics knowledge and skill unique to teaching" (Bansilal et al.,2015. p. 2).

Thembela (2013) contends that ML teachers who were enrolled for ACEML programme are classified into the following three groups of knowledge:

> Firstly, there are those who could be assumed to be familiar with most of the mathematical aspects of the subject ML, because they had been teaching Mathematics at the time of their enrolment and had prior qualifications in teaching Mathematics. Secondly, as shown in this study, there was a group of teachers whose content knowledge had faded significantly. Such teachers had last studied Mathematics whilst they were students themselves. They required more revival and retraining in order to be able to teach ML. Thirdly, there are those whose content knowledge was limited because they had only studied Mathematics up to Grade 9 level (Thembela, 2013, p. 94).

Mohamed and Sulaiman (2010) consider curriculum as a "supporting document to the syllabus which contains the knowledge about the learning objectives and learning outcomes". Mohamed and Sulaiman (2010) give an example where the teacher had to teach the mathematical topic of motion along a straight line to his students; he arranged and combined learning outcomes accordingly. “Curriculum knowledge includes knowledge of the curriculum materials available for teaching a particular subject matter” (Shulman, 1997). In addition, curricular knowledge is:

> [r]epresented by the full range of a program designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of a particular curriculum or program materials in particular circumstances (Shulman, 1997, p.10).

For example, Mathematics teachers’ draws upon their knowledge of which books and topics should be taught in that particular time (Ball, Thames & Phelps, 2012). Moreover, emphasise educational programs learning includes attention to how themes are orchestrated both inside a school year and after some time, the methods for utilising educational programme assets, for example, reading material, to compose a programme concentrated on learners.

2.8.2.2 Teacher’s PCK

Van Driel, Verloop, and de Vos (1998) are of the view that professional development programmes should enable teachers to develop their PCK as a result of their participation in such programmes. Shulman (1996) refers to PCK as an in deep understanding of how the content of the subject is to be taught:

> The most useful forms of representation of ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations - in a word - the ways of representing and formulating the subject that makes it comprehensible to others (Shulman, 1996, p. 7).

PCK likewise incorporates a comprehension of what makes explicit subjects simple or troublesome which manages the earlier originations as well as misguided judgments that learners have created concerning the points and exercises taught regularly. Shulman (1996) recognised PCK as having the greatest impact on teachers’ classroom practice.

It is important for the teacher to know the learners he or she teaches and is highlighted by Shulman (1996) when he argues that learners of different ages, backgrounds and misconceptions can make the specific topic easy or difficult. Ball et al. (2008) adds that Mathematics teachers must envision what learners are probably going to think and what they will discover.

> Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages

> and backgrounds bring with them to the learning of those most frequently taught topics and lessons. One will find that all this expertise comes with years of experience and a wealth of knowledge. The teacher must therefore know what misconceptions learners have and be able to use different skill and strategies in imparting the subject matter and giving meaning to it (Brijlal, 2013, p. 26).

Brijlal (2013) argues that content knowledge is very closely linked to PCK in the way that it is rather difficult to divorce content knowledge from the pedagogic content knowledge. Thus, ML is always taught within a context and a peculiar situation arises when the content becomes embedded within a context, and a particular strategy or skill is required to teach the different content knowledge within a given context. Subsequently, it is fairly hard to isolate the content knowledge from the educational content learning. As indicated by Thembela (2015) in his examination, PCK additionally includes the capacity of the teacher to end up an intelligent expert, who can think once more into his or her very own teaching. Also, Bansilal et al. (2015) depicts PCK as the learning required by the ML teachers to effectively intercede the delivering the content to the learners. In this way, training methodologies are requested in the subject, and where ML teachers need to consider settings that are applicable to learners in clarifying ideas and in the planning of assignments.

> Task design forms a huge part of the PCK of ML teachers, because of the demand placed on ML teachers to find contexts that are relevant to their learners. In order to fulfil the mandate of ML, teachers have to find these contexts and then set tasks using these contexts (Thembela, 2013, p. 70).

Bansilal and Rosenberg (2011) emphasises that a knowledge gap, task language and information overload can only be selected from the teachers' stock of PCK.

> Curriculum documents in ML caution teachers that they should avoid teaching and assessing mathematical content in the absence of context. This strong emphasis on the use of everyday contexts invariably requires English language skills in order to describe, understand or answer questions about the context. In South Africa, it is mainly English that is the language of learning and teaching (Bansilal & Rosenberg, 2011, p. 8).

One of the largest problems cited by ML teachers in their study was limited proficiency in English. They further highlighted that 59 % of ML teachers indicated that the majority of their learners were second language English speakers, and consequently found it difficult to understand many of the tasks (Bansilal & Rosenberg, 2011).

> According to CAPS Mathematics is a language that makes use of symbols and notations for describing numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects themselves (DoBE, 2011, p. 10).

Brijlal (2013) argues that a ML teacher must therefore know what misconceptions learners have and be able to use different skills and strategies in imparting the subject matter and giving meaning to it. In addition, ML teachers who possess PCK must go beyond content knowledge to the strategies of teaching it (Brijlal, 2013). In the study of James et al. (2015) support the view that teachers ought to create PCK amid their professional development program. This is further supported by Nel (2012) who wrote that professional development of the ML teacher is not enough when ML teachers are only fed with content knowledge leaving behind the PCK. Bansilal et al. (2015) in their study, highlighted that a large majority of teachers need to strengthen their subject knowledge base, pedagogical content knowledge and teaching skills. Shulman (1996) also emphasizes the importance of an in depth understanding of how the subject matter is to be taught. This can only be achieved when the teacher has mastered the art of knowing the subject content, and the manner in which learners can learn the subject content (Brijlal, 2013).

"An important aspect of PCK in ML is task design. Tasks in ML serve a somewhat of a different purpose than Maths tasks" (Thembela, 2013, p. 98).

In the study by James et al. (2015) four attributes of contexts used in ML were identified. Knowing the contexts would involve understanding of language used in the context, signifiers, graphs and rules in different areas. According to Thembela (2013, p. 32) in his study these are contextual domains, "It also includes knowledge of the various contextual domains, (as specified in the curriculum documents), inter alia, the contextual language, rules, pictures and graphs etc. commonly used in the various contextual domains" (Thembela, 2013, p. 32).

2.8.2.3 Teachers' professional attitudes

Kriek and Grayson (2009) recognize the requirements of segments of professional attitudes. An imperative part of expert demeanours is the certainty shown by the teachers about the content they need to teach. Studies by Graven (2003) and Brijlal (2013) highlight the crucial role played by confidence in the development of a teachers' professional identity. Furthermore, a study by

Wenger (as cited in Nel, 2012) defines identity as a way of talking about how learning changes who ML teachers are and what they see. In same way, Brijlal (2013) also noted that effective participation in ACEML shapes not only what ML teachers do, but also their identity. James et al (2015) distinctively imply that interest in professional development does not ensure change in teachers' teaching practice.

Nel (2012) points out that ML is different in purpose and kind from Mathematics and so requires a shift in attitude. Furthermore, this was evident in ML teachers' activities involving task-based assessment and lesson presentations (Nel, 2012). Four ML-teaching practices are identified in a study by Venkat & Graven (2008) which differ according to the nature of the link between content and context:

> These are: the context-driven agenda to explore contexts that are relevant to pupils' current and future needs); and content and context driven agendas (to explore a context so as to deepen maths understanding and to learn maths new or General Education and Training (GET) and to deepen understanding of that context; a mainly content-driven agenda to learn mathematics and then to apply it to various contexts; and the content driven agenda to give pupils a second chance to learn the basics of mathematics (Venkat & Graven, 2008, p. 58).

Thus, Teachers who believe ML to be lower grade Mathematics will clearly display the content agenda stream only (James et al., 2015). This is evident in Jansen (2012) who claimed that ML is designed for the weaker learners since it is considered easier than Mathematics. In contrast, Thembela's (2012) study revealed that teachers who trained as ML teachers were able to identify exactly what the differences are between ML and Mathematics. Kriek and Grayson (2009) wrote that for teachers to be professional, they must be able to demonstrate how they blend professional attitude, content of the subject and PCK in order to make professional development holistic. According to Thembela (2013):

> With ML being a new subject altogether, it can be expected that no teacher would have had the necessary confidence in the subject. Another of the crucial roles of the ACEML programme would have been to develop this confidence and competency in those teachers who participated in the programme (Thembela, 2013, p. 20).

Brijlal, (2013) contends that when a person relates his or her learning experiences and attaches meaning to it then it shows some form of change in the identity of that person then only can one say that the “notion of identity related to being a professional has taken place.” In the same way, Bansilal and Rosenberg (2011) affirm that ML teachers must be able to see an identity transformation related to their knowledge and beliefs of ML practices, and be able to compare the difference before and after they have completed the ACEML programme. Thus, teaching the new subject brought change in identity and confidence to ML teachers (Thembela, 2013). Therefore, these concepts of teacher knowledge are relevant to the aim of this study. This study will also explore whether the content knowledge and skills studied in the ACEML programme helped to develop teachers into becoming competent in the classroom. It further aimed at investigating whether the programme contributed to their knowledge about the new curriculum as well as specific areas such as their lesson plans.

2.9 Conclusion

In this chapter I presented the historical background of the study. Secondly, the introduction of Mathematical Literacy as a new subject and thirdly, a review of professional development programmes such as ACE in general, including ACEML and how these programmes were structured in developing teacher knowledge. This was followed by the state of professional development in South Africa, looking at initiatives taken by the Department of Education with the aim of improving the quality of teaching and learning in schools. Moving to the core of this study, literature regarding teachers’ knowledge was discussed including the specific mathematical knowledge that is needed for ML. The literature review concluded with the conceptual framework which is based on concepts of teacher knowledge and noting how scholars have organized this knowledge. In the next chapter, I present a detailed account of the methodology I have used to gather data for this study.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In this chapter I discuss the methodology used to explore the role of ACML programme in professional development of ML teachers in Umgungundlovu district. I also discuss how the data was analysed. The chapter describes the research design, sampling of the participants for this study, and a discussion of the data collection methods: questionnaires and interviews. Also, the validity and reliability of the data is discussed.

3.2 The research aims and questions

Professional development programmes and models have been developed in South Africa but there are concerns about the extent to which these programmes contribute to teacher knowledge (Kriek & Grayson 2009). Furthermore, Kriek and Grayson (2009) found that "the state of Mathematics and science results in South Africa is a cause for concern as many Mathematics and science teachers have limited content knowledge and use ineffective approaches". Thus, more research is needed to determine the relevance of professional development programmes related to professional knowledge of ML teachers.

This study aims to examine whether the ACEML programme contributed to professional development and teacher knowledge of the ML teachers who completed the programme. Hence, the aim of this research was to find out the manner in which acquisition of content knowledge, PCK and confidence of the teachers has been facilitated by their engagement in the ACEML programme. The following research questions guided this study:

3.2.1 Research questions

1. How has ML teachers' participation in the ACEML contributed to their professional development in ML?

There are three sub-questions:

1.1 How has their participation in the ACEML programme contributed to their content knowledge in ML?

1.2 How has their participation in the ACEML programme contributed to their pedagogic content knowledge?

1.3 How has their participation in the ACEML programme contributed to their confidence?

2. What are some challenges experienced by ML teachers when teaching ML?

3. What further support do ML teachers need, after completing the ACEML programme?

3.3 Research methodology

3.3.1 Research approaches

The research design of this study uses aspects of both quantitative and qualitative approaches to enhance it with a supplemental data set (Maree, 2007). This involves a mixed method approach, according to Creswell (2006, p.7) "as a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in the research phases".

This study used a sequential mixed method design; the first phase was quantitative and qualitative in the second phase (Maree, 2007). The reasons for using mixed method within this study are to compare quantitative and qualitative data sets to produce well validated conclusions (Maree, 2007). The second phase adopts a qualitative approach using semi structured interviews to allow participants to share their views about and experiences with the ACEML programme (Maree, 2007). Therefore, in this study qualitative data supplemented the quantitative data because it is flexible and in-depth (Rule & John, 2011).

3.3.2 Research paradigm

According to Cohen et al. (2011), mixed methods is driven by pragmatism, which means the paradigm is essentially practical rather than idealistic, it is practice driven and it may be both singular and a multiple version of the truth and reality. This study considers the pragmatic paradigm as the philosophical foundation for justifying the combination of quantitative and qualitative approaches (Maree, 2007). Furthermore, according to Maree (2007) a pragmatic paradigm believes that the truth is what works. Thus, I believe, that through semi-structured interviews and questionnaires, teachers who participated in the ACEML programme provided rich details of their reality and experience of the programme towards their professional development and teacher knowledge. Moreover, a pragmatic approach offered me a better understanding of the research problem, and to treat it in a practical, contextually responsive and consequential manner (Creswell, 2006). Therefore, this paradigm allowed me to understand the reality of teachers' experiences of professional development and teacher knowledge after they enrolled on the ACEML programme.

3.4 Mixed-methods approach

Teddlie and Tashakkori (2009) suggest that mixed methods research can adopt different designs.

The first phase of this study adopts a quantitative approach using a questionnaire. Maree (2007) defines a survey as an assessment of the current status, opinions, beliefs and attitudes by the participants. In this study, I administered questionnaires in 2013 to those teachers who had completed ACEML at UKZN from the years 2009 and 2010 to explore their beliefs about professional development.

The second phase adopts a qualitative approach using semi structured interviews to allow participants to share their experiences and views about ACEML programme (Maree, 2007). Qualitative approaches are utilised to generate a deeper understanding of the experiences of ML teachers on how they are developed professionally.

3.5 Data collection methods

A sequential mixed methods approach was used to collect data. Firstly, quantitative data was collected using questionnaires. This was then integrated with the qualitative data obtained from the semi-structured interviews which were used to validate and give human experiences to the numbers and statistics gathered from the questionnaires. This data was cemented using content analysis drawn from the semi-structured interviews. Questionnaires were administered to 50 ML teachers and a total of 41 were completed. Five participants were interviewed using semi-structured interviews. These two data collection methods were used because they complemented each other.

3.5.1 Questionnaires

In this study, I administered questionnaires which I designed in 2013 to a sample of 50 teachers who had completed the ACEML programme at UKZN between 2009 and 2010 to explore their views about teacher knowledge. The questionnaire was designed by the researcher. The purpose of the questionnaire was to produce data in response to the first and second research questions.

The data collected from the seven-page questionnaire is presented in its four sections. The first section dealt with personal information of the participant, covering issues like teaching qualifications and reasons for joining the program. The second section was designed to identify the impressions of the participant about the ACEML programme. The third section focused on the development of content knowledge and teaching strategies, while the last section comprised of general questions regarding the ACEML programme, where beliefs and an identity with ML were the main issues of concern. The questionnaire contained a "series of questions, statements or items are presented and the respondents are asked to answer or respond to them in a way they think best" (Cohen et al., 2011, p.320).

The questionnaire in the first phase had Likert scale type questions and open-ended questions that, "allow the researcher to make a true assessment of what the respondent really believes" (Cohen et al., 2011, p.357). Most questionnaires were hand delivered by the researcher to each participant, but some of the participants were given the questionnaires by their colleagues after prior arrangement had been made.

The questionnaire was used because it has a number of advantages which are beneficial to this study. These advantages include the fact that the questionnaire:

- Allowed minimum expenses of both time and money.
- Allowed more candid answers.
- Allowed the collection of answers which were classified and
- Allowed the gathering of information contained in the responses which were quantified (Maree, 2012).

The questionnaires also enabled the researcher to classify and quantify the findings of the study. There are several kinds of questions and response modes in questionnaires hence, this study used a rating scale for questions related to impressions about the programme, about teacher knowledge in ML and general questions about the ACEML programme. Furthermore, closed and open-ended questions were highly useful in that they generated frequencies of responses to qualifications of the participants. It was quicker to code and analyse closed ended questions than word base data (Cohen et al., 2011). A closed question provided for a set of responses from which the respondents had to choose one or more than one response (Maree, 2012).

Open ended questions were also used in the study since the questionnaire was exploratory and there were so many different responses about the improvement of teachers' content knowledge of ML. However, Cohen et al (2011) affirm that questionnaires do not allow the investigator to follow through on misunderstood questions or the willingness of the respondent to provide the information required. Thus, this is where data from the semi structured interviews can supplement the data generated by the questionnaire because they are flexible and in-depth (Rule & John, 2011).

3.5.2 Semi-structured interviews

"A semi-structured interview is an open situation which has greater flexibility and freedom" (Cohen et al., 2011, p. 355). However, the semi-structured interview also needs careful planning, even though it is designed to be flexible. The semi-structured interviews aimed at exploring authentic and rich responses from the participants, about some claims they made in the questionnaires.

Obtaining in-depth information from the respondents arose as a result of the questionnaires. The second phase, which involved interviews with five purposively selected teachers that involved the analysis of the first phase questionnaire. These five teachers were chosen from the original sample of 50. This allowed for an in-depth analysis of trends and patterns across the sample. According to Cohen et al (2011, p. 357) "semi-structured interviews allow for open-ended responses. It allows for flexibility and the interviewer can probe the interviewee in order to get an in depth understanding or a clear understanding".

The purpose of carrying out semi-structured interviews with the participants was to supplement and triangulate the data produced from the questionnaires.

During the semi-structured interview, the participants' views of the curriculum were elicited and their views on the content offered in the course. The researcher also probed the participants about the extent to which the ACEML program helped them in teaching the content at grades 10/11/12 level at school.

Each interview was planned to last between 20 to 30 minutes. Time taken for the interview depended on the participants' elaborations when responding to the questions. The venues and times of the interviews were discussed with the participants. A tape recorder was used to record the semi-structured interviews which and were later transcribed by the interviewer.

3.6 Purposive sampling

Rule and John (2011) argue that the selection of data is influenced by the purpose of the study and is done through sampling. Thus, the aim of this research was to explore the role of ACEML programme in developing teacher knowledge of ML teachers in Umgungundlovu district. The participants of the study were drawn from the graduates of the ACEML and who were ML teachers in Umgungundlovu district and who have completed the UKZN ACEML programme. The first phase of the study consisted of the administration of questionnaires which I designed to a sample of 50 teachers. In quantitative research, a larger sample is recommended, because it gave greater reliability about the contribution of ACEML programmes towards mathematical literacy teachers (Cohen *et al.*, 2011).

The population of the ML teachers in Umgungundlovu District included teachers from urban and rural, government and private schools. Due to this wide variety of teachers it was not possible to choose a representative sample. Purposive sampling was implemented to select fifty respondents. Sampling refers to a situation when population elements are selected based on the fact that they are the correct source of data (Maree, 2007). ML teachers were easily accessible to me in the uMgungundlovu district since I teach in this district. According to Cohen et al. (2011) this type of sampling is occasionally called opportunity sampling and "involves choosing the nearest individuals to serve as respondents and continuing that process until the required sample is obtained" (Cohen et al., 2011, p. 113).

The second phase of this study is qualitative; thus, purposive sampling was also implemented to select five participants from the original 50 teachers selected. As defined earlier, "Purposive sampling means that participants are selected because of some defining characteristics that makes them holders of the data needed for the study" (Maree, 2012, p. 79).

3.7 Accessibility and ethical considerations

It was necessary to obtain gatekeeper's permission from the KZN Department of Education for the researcher to carry out research in the schools. This was achieved through the letter written to the Department of Education requesting this permission. Then, an application was made to the UKZN Human Sciences Research Ethics Committee in respect of ethical clearance that is required to conduct the research. Having received a letter of authorization from the Department of Education and UKZN Human Sciences Research Ethics Committee I then sought permission from the principals of the schools. In addition to this, I contacted the teachers through letters requesting their consent to participate in the study. I gave participants from both the quantitative and qualitative samples informed consents letters to fill in and sign, acknowledging that they agree to voluntarily participating in the study and the use of the data for any further research. The five participants were extremely helpful in arranging times and setting venues for interview sessions.

Ethics in research is very important, particularly with research involving humans (Bertram, 2010). Therefore, participants were also re-assured of the anonymity and confidentiality by using pseudonyms instead of their names and hence, their identity would not be revealed in any way by the study. They were also informed of their right not to participate, their right to withdraw from the study at any given point and that they will not be coerced in any way to give any information against their will.

Participants were informed about confidentiality about both their participation and the information collected from them and that their participation will not harm them in any way. Furthermore, they were informed that the data will be securely stored by the supervisor for a period of five years. The participating teachers were advised to complete questionnaires out of school hours and semi-structured interviews were conducted during weekends and after school hours.

The rights and interests of the participants were protected and sensitivity was shown towards them based on common trust, and there was no need to write their names (Maree, 2007). Furthermore, all information supplied was treated with confidentiality and the outcomes of the research made available on request. Tape recordings and data were kept under lock and key and will be destroyed after completion of the research study.

3.8 Data analysis

Data analysis is an important aspect of organising and explaining the information that has been collected. It took me almost a month before I had managed to collect all 50 of the questionnaires as a result of disruptions and strikes at schools. However, only 41 questionnaires were analysed since 9 participants did not return the questionnaires.

The data was analysed manually, no software program was used, and it was represented in tables and graphs. However, Section A dealt with personal questions and they differed from individual to individual. Section B comprised of Likert-scale type questions. This section was about ML teachers' impressions while they were enrolled with the ACEML program. Data was summarised in tables and graphs "to see at a glance where differences and similarities lie between individuals" (Cohen et al., 2011, p. 266). Section C consisted of narrative type questions where the participants had to explain or give reasons. These responses were also tabulated on an excel spread sheet and were summarised providing the background of each teacher and a basic understanding of how the respondents perceived the ACEML program.

The interviews were tape-recorded and transcribed into narrative format and I was then able to examine more clearly the perceptions of the five participants of the ACEML programme. There were many themes that began to emerge from the data analysis. The participants described their experiences in their two years of study, the new content knowledge that they were confronted with, the old content knowledge that they were unfamiliar with and how new meaning became attached to it (Rule & John, 2011). Participants identified a vast number of changes taking place in their participation, practices and their identities. Most importantly, was their growth in content knowledge, PCK and identity. Participants also indicated that learning boosted their confidence and they related this confidence to engaging in the UKZN community of practices. Hence, I once again note Wenger's (1998) learning components namely practice, identity, meaning and communities.

3.9 Validity and reliability

Validity is an important key to effective research. If a piece of research is invalid then it is worthless (Cohen et al., 2011). In this study, the findings for both questionnaires and interviews were integrated to ensure validity. The questionnaires were shown to the researcher's colleagues for comments and responses, to ensure that the constructs were clearly conceptualised and unambiguous. Consequently, the questionnaires were amended with regard to timeframes, language, terminology, readability and clarity and piloted with five teachers from Umgungundlovu district that were not part of the sample before they were administered to the 50 participants in the sample. The purpose was to ensure coherency and consistency of the questions.

3.10 Triangulation of data

According to Maree (2012):

> Triangulation is the most popular mixed method design; the researcher uses both quantitative and qualitative methods in order to best understand the phenomenon of interest. It is most suitable when a researcher wants to collect both types of data at the same time about the single phenomenon in order to compare and contrast the different findings to produce well validated conclusions (p.74).

A combination of qualitative and quantitative methods together means that the weaknesses of one approach are balanced out by the strengths of the other, thus bringing about triangulation (John & Rule, 2011). In the same way, Creswell (2006) recommends:

> Merging or converging the two datasets by actually bringing them together, connecting the two datasets by having one build on the other and embedding one dataset within the other so that one data provides a supportive role for the other (p.7).

Hence, the need for mixing the qualitative data with the quantitative data is to form a more complete picture of the problem.

3.11 Limitations of the study

Generalization of the results was impossible as the data was collected from a small number 50 of the respondents. Out of fifty questionnaires administered to the participants only forty-one were returned. The study used purposive sampling where participating teachers were accessed from

Umgungundlovu District only. This ended up the research having ML teachers from the same circuit in Umgungundlovu. Thus, the researcher was limited according to the participants' availability and accessibility (Cohen et al., 2007). Another limitation the research consisted of questionnaires and interviews. There were no classroom observations, where the researcher could observe the ML teachers first hand and verify the extent to which the teachers' content knowledge, PCK and professional development had improved since completing the ACEML programme. Moreover, class room practice reported by ML teachers could not be proved.

My position as a post level one teacher, using other colleagues as research participants may have had an influence on the manner in which they responded to and cooperated with me as some of the participants knew that I had also been enrolled with ACEML programme. Data is self-reported data; thus, it will only reveal what teachers say about what they have learnt in the ACEML programme. Furthermore, as much as the teachers were asked to be honest when responding to the questionnaire and the interview, the 'Hawthorne effect' could not really be guaranteed. The teachers could have modified their responses to give the researcher answers that they thought was expected and not exactly what they felt. The Hawthorne effect is defined by Shuttleworth (2009) as "a process where human subjects of an experiment change their behaviour simply because they are being studied" (Shuttleworth, 2009, p. 67). Lastly, this study is based on the teachers' perceptions of the contribution of the ACEML programme. Thus, exaggeration is possible to increase positive results and minimised social desirability bias.

3.12 Conclusion

In this chapter, I presented a description of the data collection instruments, sampling, access to the participants and ethical issues. A presentation of the analysis and procedures was made. I concluded the chapter with some of the limitations that I thought may impact on the research findings. The next chapter discusses the analysis and interpretation of the findings.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

A sequential mixed methods approach was used to collect data which was discussed in Chapter 3. This chapter presents the results of this study. First quantitative data collected from questionnaires is presented. This is integrated with the presentation of qualitative data collected from semi-structured interviews which were used to validate and give human experiences to the numbers and statistics gathered from the questionnaires. Most of the quantitative data is presented using bar graphs, tables and in percentages; this information will be cemented using content analysis drawn from the semi-structured interviews

The data collected from the questionnaire is presented in its four components. Section A, biographical information; Section B, impressions about the programme; Section C, about the teachers' perspectives of the content in Mathematical Literacy; and section D, general questions.

4.2 Biographical information

The first section of the questionnaire aimed to obtain background information on the respondents to help ascertain if the ACEML programme influenced the ML teachers' professional development.

4.2.1 Teaching experience

ML teachers were asked to provide their teaching experience in the last few years. Figure 1 presents the most frequent subjects or learning areas ML teachers taught were: Mathematics (Maths), Business Studies (BS) and Economic & Management Sciences (EMS), Physical Science (physics), Accounting (ACC), Natural Sciences (NS), English (ENG), Agricultural Sciences (AS) Geography and Life Sciences (LS).

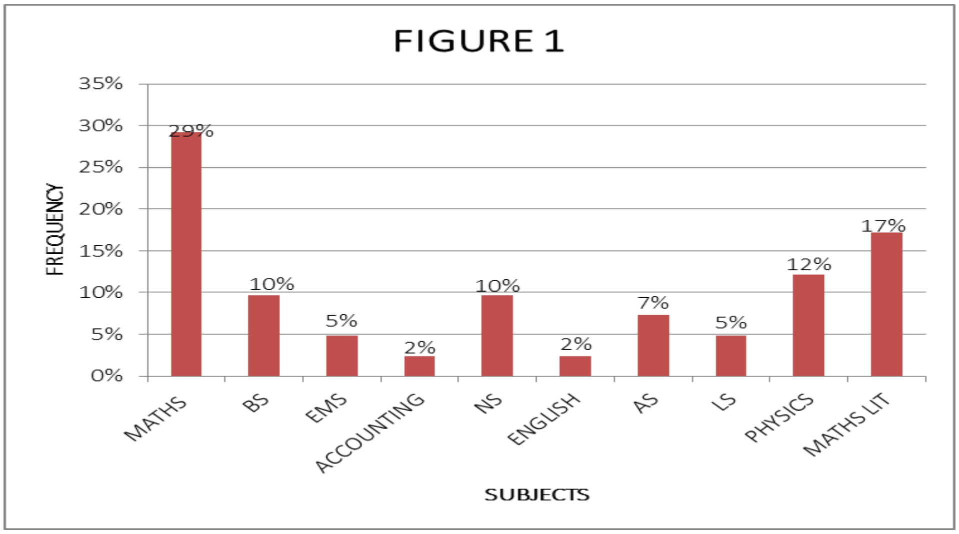

Figure 1: Subjects ML teachers taught

Figure 1 indicates that the highest percentage (29%) of the respondent taught Mathematics before enrolling in the ACEML programme. This is followed by 17% respondent who indicated ML but did not indicate the subject taught before enrolling to ACEML programme. Perhaps they did not understand the question. 20% indicated Physical Science, 10% indicated NS and another 10% came from BS. 5% indicated LS and EMS. The lowest percentage of 2% indicated English and Accounting.

4.2.2 Post level prior to enrolling for the ACEML program

Respondents were asked to provide their post level and qualification they had before enrolling with the ACE ML program. Figure 2 presents the different posts levels that respondents in the ACEML program have at their schools.

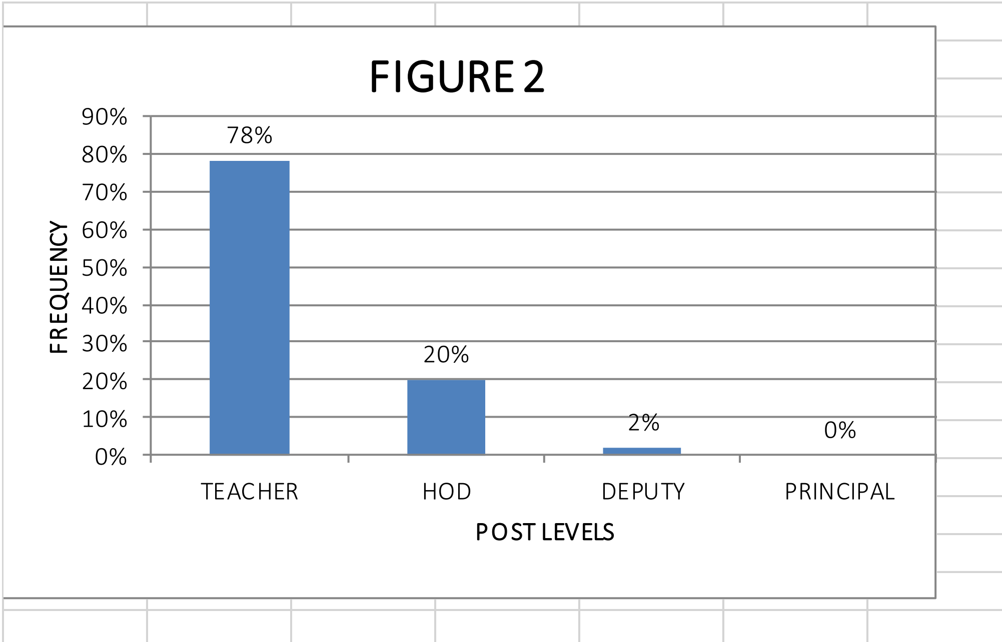

Figure 2: Post levels ML teachers have at their schools

Figure 2 indicates that 78% of the teachers were post level 1, 20% post level 2 and 2% was post level 3. There was no post level 4 at all, Post level 4 is a principal post where they spend time in managing the school rather than teaching in the classroom. Post level 1 had a high percentage in doing the programme and shows that level 1 teachers who spend a lot of time teaching have a greater need for development when compared to the School Management Team (SMT).

4.2.3 Respondents qualifications

Respondents were asked to give their qualifications they had before participating in ACEML program. The graph in Figure 2.b below shows teachers' responses to the question on their teaching qualifications in the previous years.

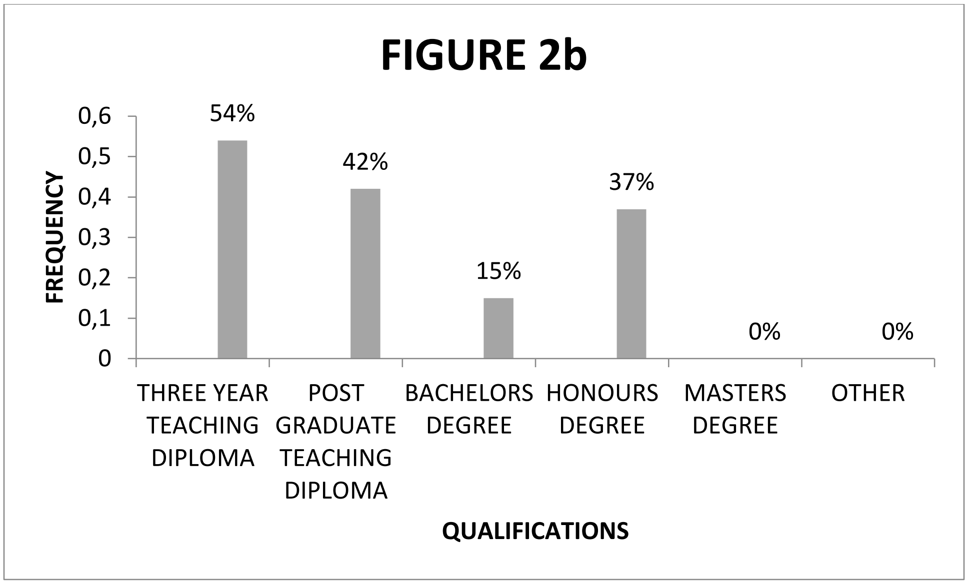

Figure 2b: ML teachers' qualifications

Figure 2b indicates the majority of (54%) respondents had a three-year teaching diploma, while 42% had a postgraduate teaching diploma and 37% had honours degree. Only 15% of the participants had a bachelor's degree and none of the respondents hold a degree higher than an honour's degree. These responses are also testimony to the fact that academic qualifications alone were insufficient for teaching this new subject. These qualifications needed to be reinforced by the ACEML programme.

The graph in Figure 3 below shows teachers' responses to the question on whether they teach ML or not after enrolling in the ACEML programme.

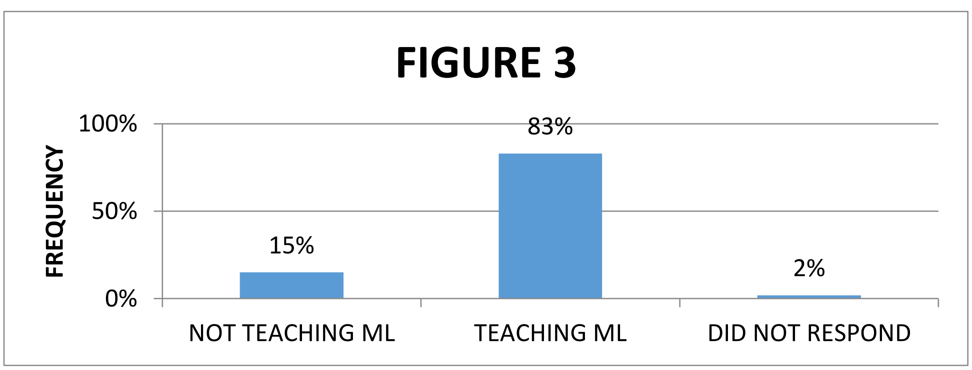

Figure 3: Teachers who teach ML

The graph in figure 3 indicates that out of 41 participants 83% teach ML in their schools. This shows that the programme is reaching the targeted population and can therefore bear the desired fruit of increasing subject content knowledge of ML teachers. 15% responded they do not teach ML in their schools and 2% did not respond. Some of the reasons given by the 15% who are not teaching the subject presently were the following:

T23: “My school does not offer ML at all because it is believed that ML is useless for a learner who intends to do engineering after grade 12 and they are aware that universities do not recognize ML in grade 12 learners.”

T15: “Though I am qualified to teach ML, I only teach mathematics because ML is not offered in my school.”

T19: “I was transferred to another school where they do not offer ML.”

T41: “I was promoted as an HOD for Languages, then I had to stick on only two subjects, English and Geography”

T20: “…there are many teachers for ML in my school and I think a number of teachers do teach ML are trained”

4.3 Impressions about the programme

Section B, as already mentioned earlier, sought to establish the respondent’ impressions about the programme whilst they were enrolled for ACEML programme. Respondent were given a statement they need to agree or disagree, and a Likert Scale of 1-5 was used as follows: 1 strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree. The graph in figure 4a below shows the responses on ML teachers’ impressions about the programme.

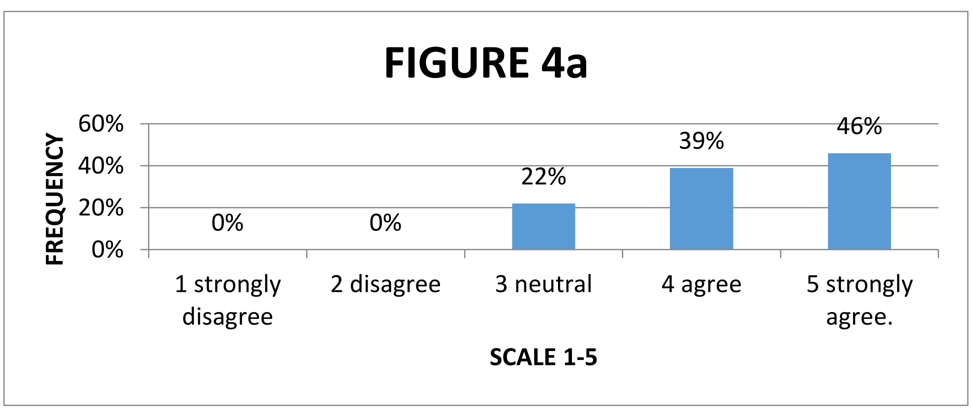

Figure 4a: Tutors’ level of content in ML.

In this question ML teachers were asked to give their impressions of the programme whilst they were enrolled for ACEML programme. Figure 4a indicates that 46 % of ML teachers were pleased with the content knowledge; furthermore, they felt that the tutors offered good explanations of the content. 39 % felt that tutors were always prepared to teach them. Teachers were positive or neutral except for the attitude of tutors because only 22 % of teachers said that tutors were not empathetic to their situation. It seems that most of teachers were pleased with the support of tutors, and they were empathic and treated them as colleagues.

The graph in figure 4b below shows the responses of ML teachers about the clarity and explanation of the content by the tutors.

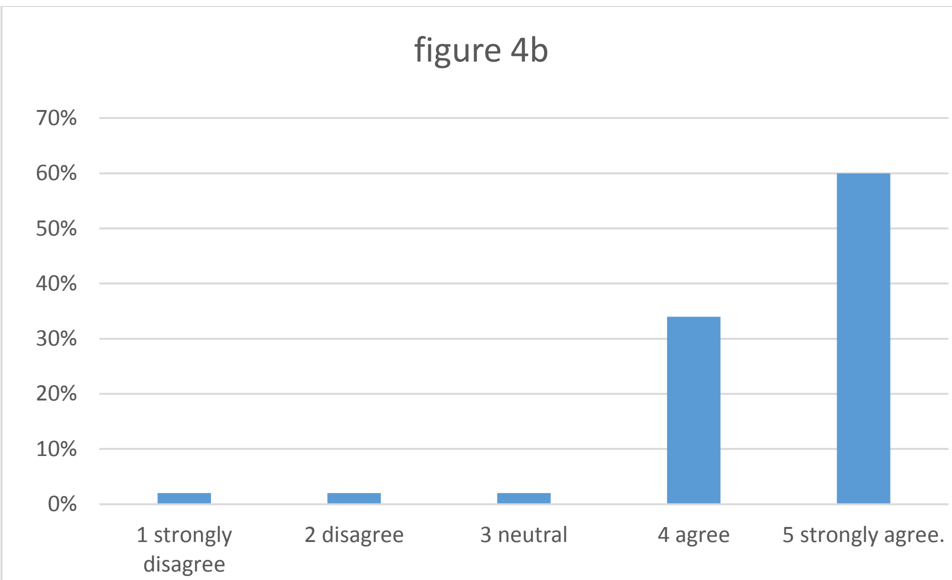

Figure 4b: Tutors explanation of the content.

Figure 4b indicates that 93% of ML teachers strongly agreed and agreed that tutors offered good explanations of the content. Only 7% who was neutral about the above statement.

In a question where respondents were asked to respond about the result of participating in the ACEML programme, ML teachers rated the degree to which they agree or disagree with the statements about improvement of their content knowledge.

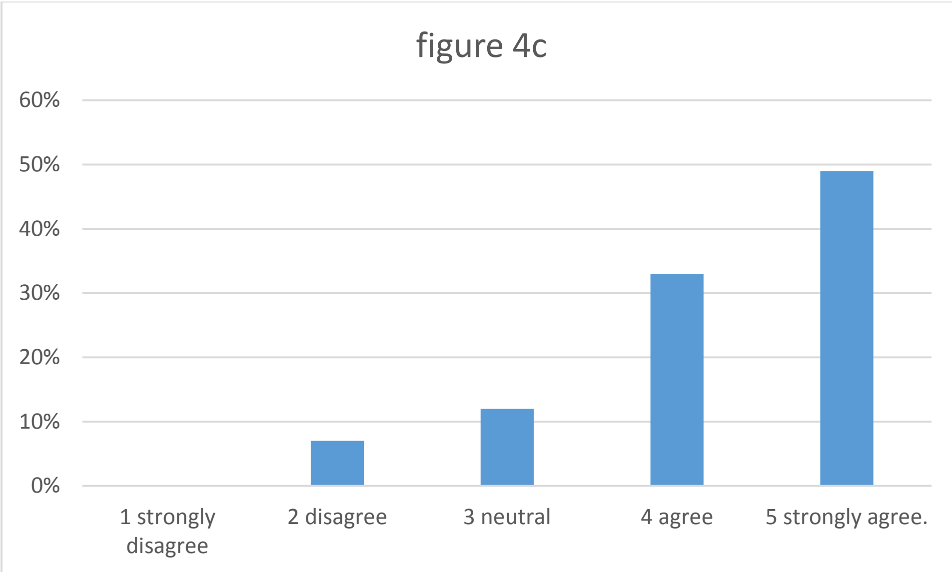

Figure 4c: Tutors preparedness during the ACEML programme.

The graph in figure 4c above shows 80% of ML teachers agreed their tutors were always well prepared during the ACEML programme. Only 7% of ML teachers disagreed that tutors were always prepared, and 13 % of the teachers was not sure or neutral.

The graph in figure below 4d shows the responses of ML teachers felt their tutors were considerate and empathetic to their situation.

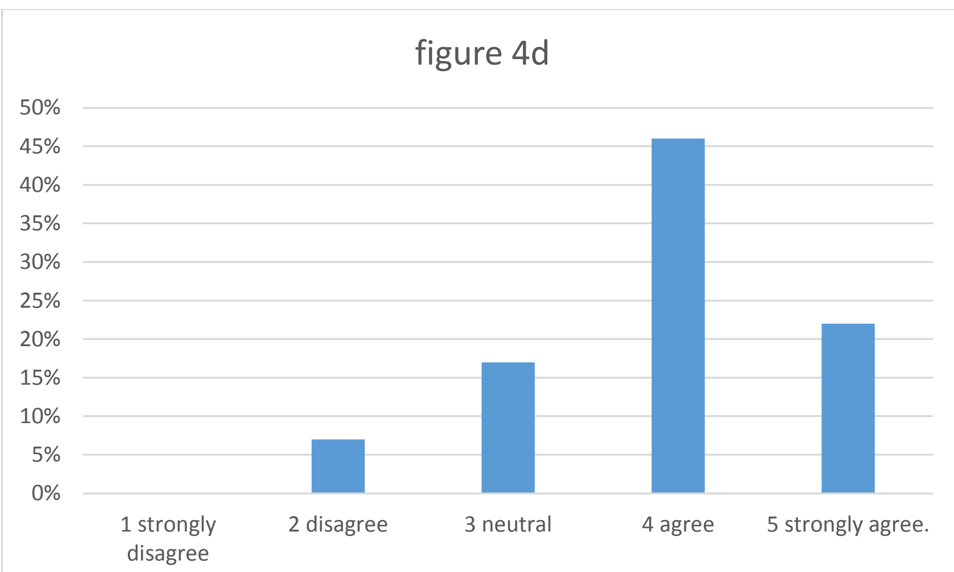

Figure 4d: Tutors' attitude during the programme.

Figure 4d indicates that 68% of the respondents were pleased with the support of tutors, and they were empathic. Only 7% of ML teachers said that tutors were not empathetic to their situation while 17% were neutral.

The graph in figure 4e below shows whether ML teachers felt their tutors treated them as adults and colleagues during ACEML programme.

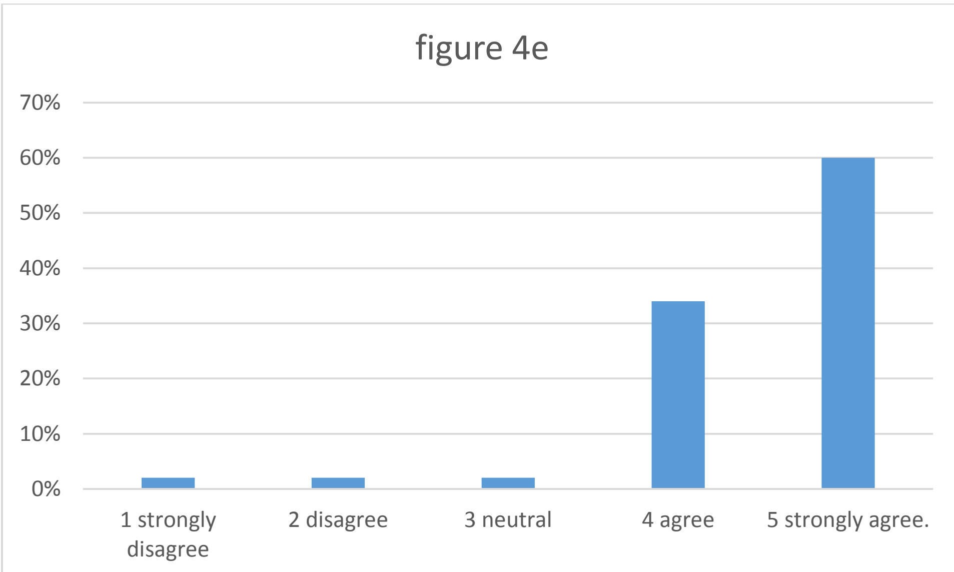

Figure 4e: Tutors' attitude to ML teachers.

In figure 4e, it seems that most of teachers were treated as colleagues because 94% of the respondents agreed or strongly agreed with the above statement. Only 4% did not see their tutors treating them as adults while 2% were neutral.

In a question where respondents were asked about participating in the ACEML programme, ML teachers rated the degree to which they agreed or disagreed with the statements about improvement of their content knowledge; teaching strategies; assessment skills; confidence and learners' results. The rating is shown in table 2 below:

Table 1: The result of participating in ACEML programme

As a result of participating in the ACEML programme	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
6.1 My content knowledge have improved	2%	-	8%	41%	49%
6.2 My teaching strategies have improved	2%	2%	8%	49%	39%
6.3 My assessments skills have improved	-	2%	10%	49%	39%
6.4 My confidence as an ML teacher increased	2%	2%	7%	39%	50%
6.5 The ML results of my learners have improved	2%	5%	20%	34%	39%

The bar graph in figure 5a indicates the responses of ML teachers where they were asked whether their studies had been made easier because of readable materials, supportive tutors, knowledgeable tutors and support from other students.

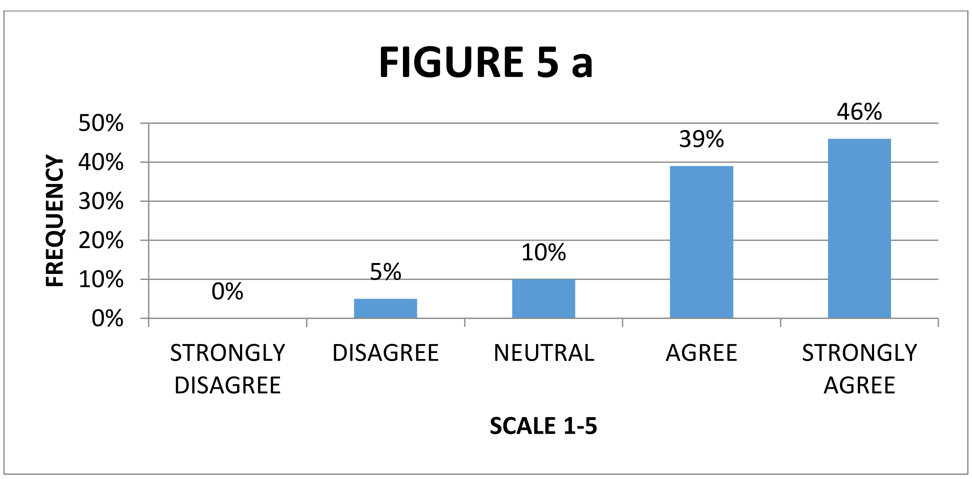

Figure 5a Material that was clear and useful.

Figure 5a indicates that 85% of the respondents either agreed or strongly agreed that the program was made easier because of understandable materials. 10% were neutral with only 5% of the respondents disagreed that guides were understandable clear and useful.

The bar graph in figure 5b indicates the responses of the ML teachers where they were asked that they found their studies made easier because the tutors were supportive.

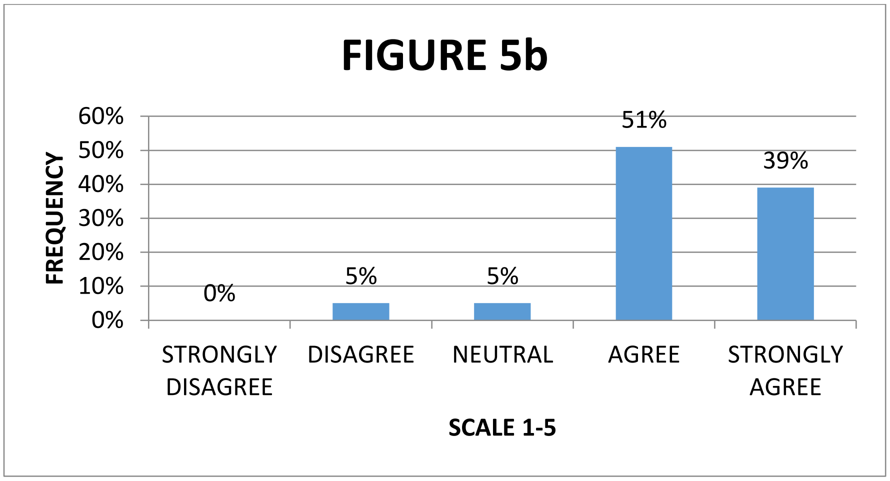

Figure 5b: Support of the tutors.

Figure 5b shows that 90% of the respondents agree or strongly agreed that the tutors were supportive.

The bar graph in figure 5c below indicates the responses of the ML teachers when they were asked if they found their studies were made easier because tutors were knowledgeable.

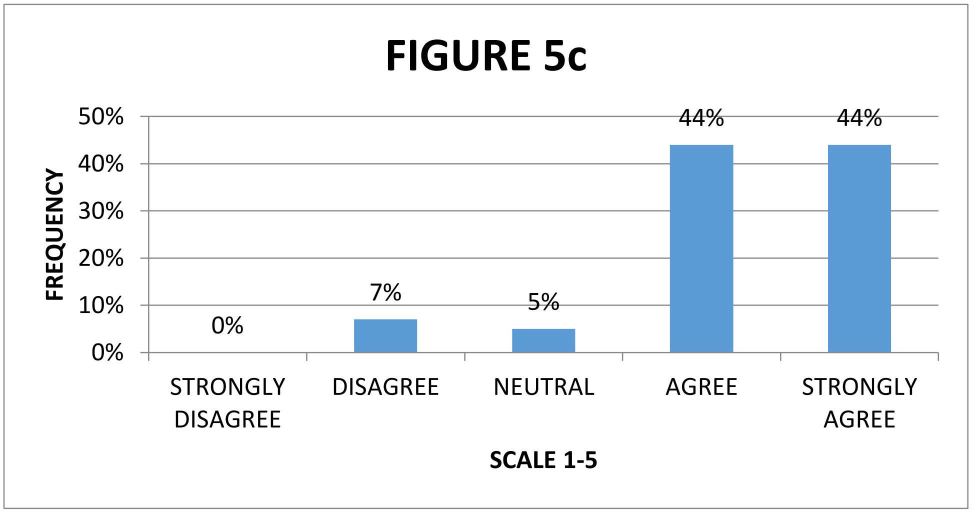

Figure 5c: knowledge of the tutors.

Figure 5c shows that 88% of the respondents agreed and strongly agreed that the tutors were knowledgeable with only 7% who disagreed and 5% were neutral.

The bar graph in figure 5d below indicates the responses of the ML teachers where they were asked if they found their studies were made easier because the assignments and tests were relevant to their teaching.

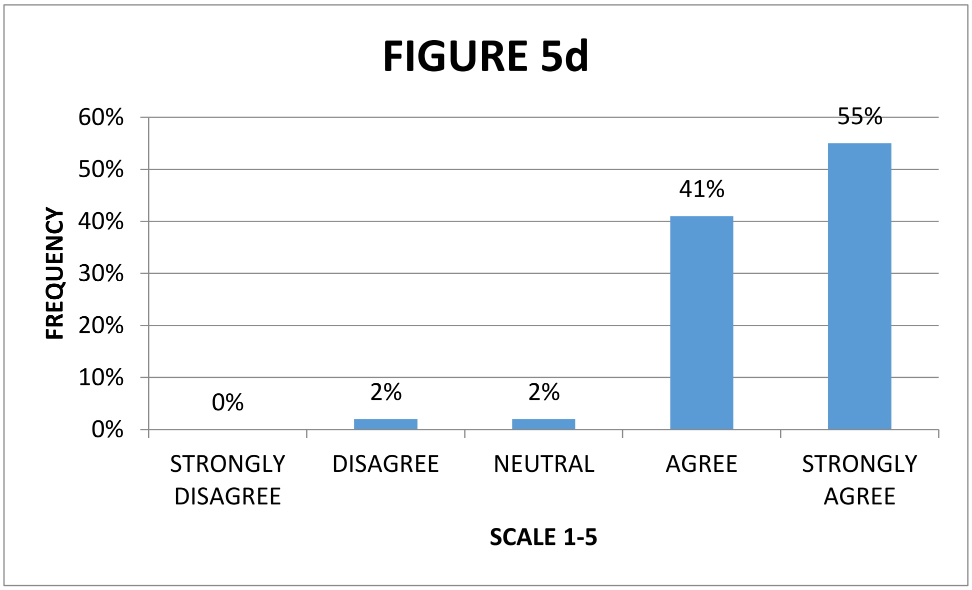

Figure 5d: Relevancy of tests and assignments to ML teachers' teaching.

The graph in figure 5d indicates that 96 % of the respondents agreed or strongly agreed that assignments and tests given to them were relevant to what they teach in the classroom. 2 % was neutral while the other 2% disagreed.

The bar graph in figure 5e asked the ML teachers if they found their studies were made easier because the other ML teachers in their group were helpful and supportive.

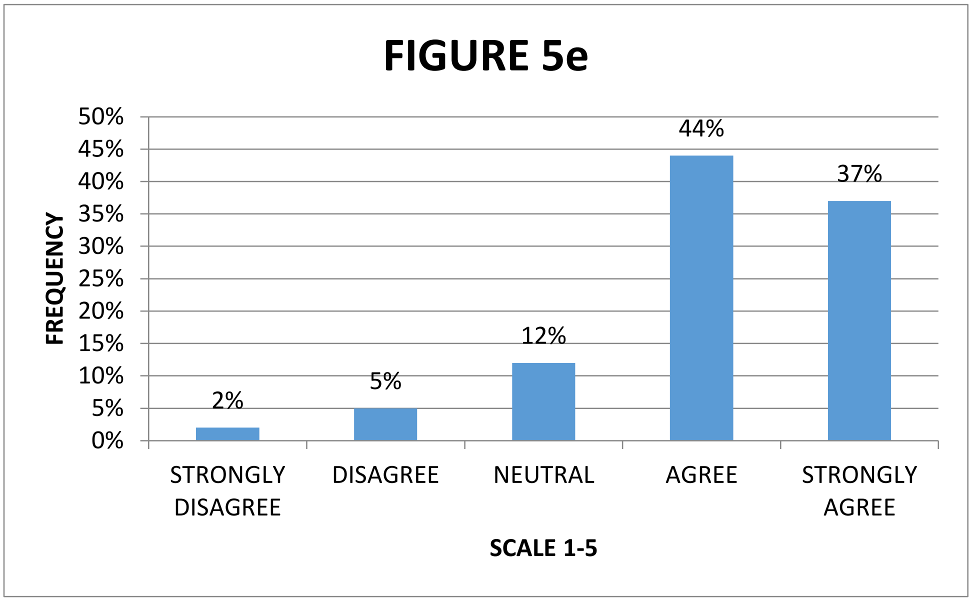

Figure 5e: Other students support to ML teachers.

Figure 5e shows that 44% of the respondents agree that other students in their class were supportive with 37% strongly agreeing. 12% was neutral with 7% of the respondents who did not feel support from the other students.

Table 3 on page 63 displays the responses of the ML teachers about the skills in grades 10,11 and 12, teaching the basic skills of ML, designing tests, projects/investigations, teaching the context in ML and designing classroom activities in ML. Scale 1-5 was used as follows: 1 poor, 2 not good, 3 ok, 4 good, 5 very good.

Rating skills are in the table below:

Table 2: Rating skills in teaching grade 10, 11 and 12, teaching context, basic skills, designing tests, investigation and activities.

Rating skills in the following:	1 poor	2 Not good	3 ok	4 Good	5 Very good
8.1 teaching grade 10 ML	-	5%	7%	46%	42%
8.2 teaching grade 11 ML	-	2%	20%	44%	34%

8.3 teaching grade 12 ML	-	5%	15%	51%	29%
8.4 teaching the context in ML	-	5%	17%	46%	32%
8.5 teaching basic skills in mathematics to ML learners	-	2%	5%	41%	55%
8.6 designing tests in ML	-	-	15%	60%	25%
8.7 designing projects/investigations in ML	-	10%	21%	54%	15%
8.8 designing classroom activities in ML	-	2%	12%	61%	25%

4.4 ML Teachers' Content Knowledge

Section C of the questionnaire was about the content in ML.

In the question where ML teachers were asked to give reasons for enrolling in the ACEML programme, the results show that they seek ML content knowledge. The responses below were obtained from the interviews with ML teachers:

Teacher A: "I did not want to miss the opportunity to develop my mathematical knowledge since I had last did mathematics when I was still in high school."

Teacher B said, "I wanted to gain knowledge of the subject because I was not sure what to teach exactly."

Teacher C stated, "Studying ACE ML has not only upgraded my salary, but personally, I have learnt a lot more about the subject."

Teacher D responded:

The reason was that I use to teach ML using Mathematics Knowledge. I've realized that ML is more, is more context-based which means I had to acquire the skill of linking the content knowledge and the contexts, Teacher E responded:

> I wanted to gain knowledge of the subject matter, confidence and how to assess. We were taught by Maths people who taught us Maths to teach ML and those courses used to last about 2 days, what can you learn within two days.

Teacher C said:

> I enjoyed the subject and I was granted the bursary to study ML in 2006. I was a senior primary educator but teaching in a combined school. I was given an opportunity to further my studies and move into an FET phase.

Furthermore, in terms of teachers' content knowledge in the questionnaire, question 27.2 ML teachers were asked if their content knowledge in the subject was relevant even prior enrolling with the programme ACEML. The ML teachers responded as follows:

17% of ML teachers strongly disagreed and 37% disagreed with the statement that their knowledge was adequate before joining the programme. In question 27.3, teachers were asked to respond to the improvement in their knowledge of the ML content for example applications and concepts as a result of their studies. 46% of ML teachers strongly agreed with 27% agreed that the programme was responsible for improving their content knowledge.

85% of the respondents disagreed with the statement that any teacher can teach ML without being enrolled to the programme and 15% of them were neutral.

The results above indicate that ML teachers' content knowledge was not adequate before joining the programme.

Table 2 on page 56 displays 90% of ML teachers agreed or strongly agreed that enrolling in ACEML programme contributed to improving their subject content knowledge. 8% of the participants were no sure as they rated neutral and only 2% who clearly indicated that their subject content knowledge did not improve. When ML teachers were interviewed, the following responses were given:

T2 in the questionnaire "I gained more insight in to the subject"

Teacher A responded by saying:

> Firstly, I would say that I benefitted a lot in this ACEML program because at first, I did not know what to teach exactly and I was confusing ML with mathematics, but now I know that ML has its own philosophy and structure which is completely different form mathematics.

Table 2 on page 56 indicates that 88% of the respondents were good or very good at teaching ML in grade 10. 7% were neutral with only 5% who indicated that they are still poor at teaching grade 10 ML. While 78% of ML teachers were good or very good in teaching grade 11 ML, 20% showed that they were only okay. Only 2% indicated that they are poor at teaching grade 11 ML. It is surprising that of the ML teachers, 80% indicated that they were good or very good in teaching grade 12 ML. 15% showed that they were ok while 5% are still poor at teaching grade 12 ML. Perhaps this 5% are the same participants who indicated that they were still poor in teaching grade 10 ML.

The data shows that the majority of respondents (96%) were very good and confident in teaching the basic skills of Mathematics to ML learners. 5% were not sure with only 2% rated that they were not good at teaching basic skills of Mathematics and no one rated they were poor.

ML teachers were asked to give any other comments based on the skills they had rated themselves on.

A summary of responses is:

90% of the respondents in the questionnaire show that ML teachers wanted to improve their mathematical basic skills by enrolling with ACEML programme.

Participants in the interview were asked to give details about the improvement of their skill level. Below are some of the responses that show an improvement in the skills level of the respondents:

Teacher C said:

> Firstly, I would say that I benefitted a lot from this ACEML program because at first, I didn't know what to teach exactly and I was confusing ML with Mathematics…but now I know that ML has its own philosophy and structure.

Teacher A responded, "I know exactly what to teach in terms of the ML content."

Teacher E said, “I’m clear about the content knowledge of the subject and I’m confident to teach it in the class.”

Professional development of ACEML teachers.

The responses below were drawn from ML teachers and show that participation in the ACEML programme contributed to their professional development:

Teacher C “My mathematical knowledge has improved and I have moved from M + 3 to M + 4 which resulted in my salary scale to increase.”

T5 in the questionnaire “My assessment and teaching strategies has improved after enrolling with ACEML programme.”

T6 in the questionnaire “I am no longer confusing ML with Mathematics.”

The above suggests that academic qualifications were insufficient for effective teaching of ML. As the results indicate that 54% of the respondents had a three-year teaching diploma and the ACE ML program allowed them to move to the next level of their REQV qualification. These responses reveal that some of the ML teachers were also motivated to engage in the ACEML programme so that their salaries would increase, at same time their professional development was improved.

Moreover, the responses highlighted that while 44% of respondents taught other subject prior the programme, thus ACEML programme was the opportunity to revive their mathematical knowledge. This also shows that teachers are attracted to professional development programmes, given their belief that it will expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with learners.

Respondents in the questionnaire were asked to respond to the relevancy and helpfulness of the ACML programme towards their teaching. Most of the responses were as follows:

T11 in the questionnaire “Enrolling with ACEML programme impacted to my professional development.”

Respondents were asked about the module they liked the most. The results show that 100% of ML teachers were interested in content knowledge of the learning area as they liked all four areas of content knowledge in ML (numbers, data handling, probability, measurements and finance).

Actually, the results show no clear preferences except for data handing which 17% of ML teachers chose. Perhaps they were pleased with all the modules because they contributed to different aspects of their teaching.

Respondents were asked about the least useful module. The findings show that 100% of ML teachers highlighted that no module was the least useful to them and all of them were important. Most respondents mentioned that some modules did not deal with content knowledge such as policies, professionalism and so forth.

Respondents in the questionnaire were asked to write down anything they thought resulted to effective teaching of the subject ML. 100% of the respondents mentioned those modules that dealt with the content knowledge such as numbers and operations, space, shape and measurements and functional relationships, however; no one spoke about data handling. The following comments emerged:

T11 in the questionnaire said, "My subject matter knowledge in ML was adequate after I had passed the following modules: shapes, finance, probability, data handling and numbers."

T12 in the questionnaire said, "Through measurements, I gained personal experience because I am able to calculate the number of tiles needed for my floor before I even go to tile shop."

T13 in the questionnaire stated, "My content knowledge improved and my teaching and assessment strategies improved."

T14 in the questionnaire responded, "I am able to know my personal finances."

T15 in the questionnaire stated, "I understand government policies."

T16 in the questionnaire said, "Professionalism module changed my attitude. I now a contributing citizen."

Respondents were asked about other in-service ML courses or workshops that they have attended in the past two years. In the questionnaire all 41 respondents indicated that they usually attend workshops organised by the DoE and are usually run by subject advisors. The data shows that 44% of the respondents were neutral when they rated the workshops they attended with 46% of the respondents rated that the workshops were good. Only 10% indicated that were not happy with these workshops.

In the interviews ML teachers responded as follows:

Teacher A responded:

> Though at the beginning of the year we used to attend the workshops organized by our subject advisor based on general orientation but are not enough because they are only two hours to cover the entire content of the subject. Thus, very little is covered in those workshops.

Teacher B responded:

> We receive workshops once at the beginning of the year where we are given program of assessment, work schedule and mark sheets. My HODs used to give us some templates to fill in the reason's learners have failed and give kind of support we need on that. However, we never received any support on that.

Teacher E said, "We attended the workshops that were not enough."

In the questionnaire ML teachers were asked about the section/topic/concept in ML they are most comfortable teaching. The results indicated that 27% of the respondents were comfortable with all sections. 22% of the respondents indicated that were most comfortable with space, shapes and measurements. The results also show 20% respondents were comfortable with data handling and evenly split with measurements. 17% of the respondents were comfortable with probability with only 10% comfortable with finance. The results also indicate that 2% were comfortable with numbers and another 2% with functional relations topic.

In the questionnaire respondents were asked if there was any section/topic/concept in ML they felt not comfortable when teaching in the class. 75 % responded positively in this question because they said that since they were enrolled in the programme their confidence had improved and no section was too difficult to teach. 25% of the respondents indicated that there are sections they are still not comfortable with when teaching ML. The following responses were given:

T1 in the questionnaire responded, "I did not like this section at all because I did not do geometry during my high school level."

T2 in the questionnaire responded, "Financial maths gives me a challenge because I did not do commerce."

T3 in the questionnaire said, “I am not used to word problems since I had been teaching mathematics before enrolling with ACML.”

T4 in the questionnaire stated, “Inflation and CPI is challenging to my teaching.”

T5 in the questionnaire said, “I am not comfortable with teaching taxation.”

T6 in the questionnaire responded, “Finance has a lot I am not comfortable with since I never did commerce at my high school level.”

T7 in the questionnaire stated, “I did not learn anything about packaging and assembly when I was enrolled with ACEML therefore, I am not comfortable with teaching it.”

T8 in the questionnaire responded, “I not comfortable with teaching compound interest.”

T9 in the questionnaire said, “The entire finance section is boring me because most of the time its context is unfamiliar to the learners.”

T10 in the questionnaire said, “I lack strategy of making my learners understand models.”

T11 in the questionnaire stated, “I am not comfortable with teaching scale to my learners but my colleagues assist me on that.”

In the interviews of the qualitative phase, the participants had the following to say:

Teacher C responded, “I think all modules were useful in my professional development.”

Teacher D responded, “I think all modules were useful in my professional development especially space shapes and measurements, data handling, functional and relationship and numbers and operations.”

Teacher E responded, “All modules were useful to my professional development.”

Respondents were asked to rate the ML Learning Outcomes (LO) from 1-4, where 4 is the most preferred and 1 is the least preferred.

Table 3 below indicates the preferences of LO

Ratings 1 to 4	1	2	3	4
Learning outcomes				
LO1 Number and Operations	10%	-	22%	68%
LO2 Data Handling	7%	22%	-	83%
LO3 Functional Rel.	2%	10%	-	88%
LO4 Space & Shape	-	5%	-	95%

The data above shows that 22% of the respondents preferred numbers and operations in ML with 68% who indicated that it was the most preferred it. Only 10% indicated that number and operations were least preferred. Furthermore, the data in the table indicates that 22% of the respondents preferred functional relationships in ML with 83% who indicated it was the most preferred learner outcome. Only 7% of respondents indicated that functional relationships were the least preferred. The table indicates that 10% of the participants preferred space, shapes and measurements in ML with 88% who indicated it was the most preferred. Only 2% indicated that space, shapes and measurements were the least preferred. 95% of the respondents preferred data handling in ML the most with only 5% who indicated that they preferred it.

ML teachers gave reasons for rating the learning outcomes that they rated as a four. Most of the teachers commented that they rated four because these learning outcomes deal with content knowledge in ML.

Some of the respondents in the questionnaire indicated that LO 1 is most preferred to them:

T16 in the questionnaire said, "I rated 4 in numbers and operations because it fits to any sections in ML e.g. a learner can draw graphs, can calculate percentage, can write a ratio in any section taught."

T17 in the questionnaire responded, "I rated 4 in numbers and operations because I have a mathematics background and I understand it very well."

T18 in the questionnaire stated, "I rated 4 in numbers because is our daily life e.g. counting money etc."

83% of the respondents rated four in LO 2 but it is surprising that no one gave reason of rating it four. The following are some of the reasons of rating learning outcomes 4:

T10 in the questionnaire stated, "I rated 4 to all sections because enjoy teaching them and I am proud of teaching it because I understand the content."

T19 in the questionnaire said, "I rated 4 in all section because I see myself as an expert after enrolling with ACEML programme."

88% of the respondents rated fourth in LO 3 and they gave the following some of the reasons:

T9 in the questionnaire responded, "I rated 4 in space, shapes and measurements because it is practical, learners enjoy it."

T12 in the questionnaire responded, "I rated 4 in space, shapes and measurements because it is easily linked with the real context e.g. calculating area of the wall that need to be painted."

The result shows that Data Handling is the most popular learning outcome for ML teachers as 95% of the participants gave a rating of four and the following reasons were given as follows:

T1 in the questionnaire said, "I rated 4 in data handling because it also involves probability where learners can experiment."

T2 in the questionnaire said, "I rated 4 in data handling because learners enjoy calculating measures of central tendency as well as measures of spread."

T3 in the questionnaire stated, "I rated 4 in data handling because it is easily linked with the familiar context to the learners."

T4 in the questionnaire said, “I rated 4 in data handling because my learners pass it easily.”

T5 in the questionnaire “I rated 4 in data handling because learners enjoy drawing bar graphs and they can score lots of marks in this section. I call this section a mark booster.”

This data clearly tells us that data handling is the easiest learning outcome to teach in ML and learners can easily pass it more than the other sections.

The data indicates that 83% of ML teachers taught grade 12 after enrolling with the ACEML programme. Only 15% of the respondents indicated that they do not teach ML in grade 12. The intention was to find out whether teaching ML in this grade was due to the needs of the curriculum within the school or the teacher volunteered to teach ML in grade 12.

T1 in the questionnaire stated, “It is because the SMT trusted me that I can teach ML in grade 12 after enrolling with ACEML.”

T2 in the questionnaire said, “Members of the SMT believed on my knowledge that I have obtained through ACEML.”

T3 in the questionnaire said, “It was voluntary as I would like to know the results of this research and what the university will do about it.”

T4 responded, “The school had no option to send me to the program because I was the only one who teach ML in the school.”

T5 in the questionnaire said, “I teach grade 12 because duty load said so.”

T6 in the questionnaire said, “I teach grade 12 because I trusted myself that my content knowledge has improved as well as my teaching and assessment strategies developed after enrolling ACEML programme.”

T7 in the questionnaire responded, “Teaching grade 12 was voluntary because I wanted to go for grade 12 external marking.”

T8 in the questionnaire stated, “I was place in grade 12 because SMT were pleased with my learners’ results produced in grade 12.”

T9 in the questionnaire stated, “It was not voluntary but it was my turn to teach grade 12 as we are all given a chance to experience teaching grade 12.”

T10 in the questionnaire said, “I teach grade 12 because they are my learners from grade 11, therefore I know the areas that need to be reinforced to them.”

The following explanations were given for those respondents who did not teach ML in grade 12:

T41 in the questionnaire said, “No I do not teach ML in 12 because I teach two classes of grade 10 and one of mathematics in grade 11, and as an HOD, I cannot teach more 3 classes.”

T40 in the questionnaire responded, “I am not currently teacher ML because there are other teachers who teach ML and I teach Physical science.”

T39 in the questionnaire said, “I do no teach grade 12 ML because of the school circumstances which I cannot disclose to anyone.”

4.5 Context of ML

ML teachers were asked to rate their skills on teaching the basic skills of mathematics to ML leaners. Table 2 (see p. 56) also shows 78% of the respondents were good and confident at linking context with ML content while 17% of the respondents rated neutral. Only 5% indicated that they were still not good at this skill.

ML teachers were asked to give any other comments based on the skills they had rated themselves on.

A summary of responses are:

Teacher A in the interview responded, “Professionalisms and teaching and learning. Because it is where we were taught how to apply mathematical knowledge with real life situation.”

T4 in the questionnaire said, “I am now able to link content with ML content.”

Section D of the questionnaire was about general and had a series of statements where teachers indicated their levels of agreement or disagreement with each. This implies that most teachers felt that without doing the programme they would not have had adequate content knowledge. In terms of improvements in classroom practice, the teachers were not as emphatic as they were about the improvements in their content knowledge. Thus, it seems that these 9% ML teachers did not learn new teaching strategies and 27% were neutral about their confidence of teaching ML without studying it.

4.6 Teaching strategies

Respondents were asked about to their improvement in their teaching strategies, Table 1 (see page shows that 88% of the respondents agreed or strongly agreed that a variety of teaching strategies are used and have effectively been applied after enrolling with the ACEML programme. 8% rated neutral with only 4% who disagreed or strongly disagreed that their teaching strategies improved.

Respondents were interviewed and asked to give details about the improvement in their skill level. Below are some of the responses that show an improvement in the skills level of the respondents:

Teacher A and Teacher B responded that they have developed teaching strategies and they assess learners, they give feedback and it is where they are able to find out why learners have failed the task. Then they would come up with more strategies and feed forward.

Teacher C said, "My teaching strategies such as linking content and context are developing day by day."

Teacher D responded:

> Knowing what to teach and how to teach it give me a clear understanding of what resources are needed for that particular section I teach e.g. when I teach BMI I would bring along bathroom scale and measuring tape in the class. This shows that my teaching strategies were developed and improved.

Teacher E said, "But since workshop did not help most of us that much then after training I gained a lot as to how to approach the subject and therefore have gained confidence."

Respondents were asked about the relevancy and helpfulness of the ACML programme towards their teaching. Most of the responses were as follows:

T1 in the questionnaire said, "Enrolling with ACEML helped me to understand the method of teaching and with the basic skills of mathematics."

T8 in the questionnaire said, "My methodology and approaches has developed."

T9 in the questionnaire stated, "Yes, it was helpful to enrol with the ACEML programme because I now able to do my own personal banking."

T10 in the questionnaire responded, “Yes, it was helpful but I am still straggling with designing investigation.”

T11 in the questionnaire responded, “Enrolling with ACEML programme impacted to my professional development.”

In this light, it can be concluded that assignments and tests used in the ACEML programme are an important component of professional development. This is attested to since 96 % of the respondents found assignments and tests to be relevant to their teaching.

In question 27.5 of the questionnaire 83% of the respondents agreed or strongly agreed that their classroom strategies improved while 22% remained neutral or disagreed with the statement.

The responses above show that ML teachers were now able to conduct activities that they previously had difficulty doing. After their enrolments in the ACEML programme, the teachers have the abilities and skills to teach ML and have gained the knowledge that they previously lacked as highlighted in the responses from interviewed teachers.

4.6.1 Assessment

Respondents were asked to respond to their assessment skills. Table 2 (see p. 56) indicated that 88% of ML teachers indicated that their assessment skills had improved after enrolling in the ACEML programme. 10% gave a rating of neutral with only 2% who indicated that their assessment skills need improvement. 89% of the respondents also indicated that participating in the ACEML programme they are now confidant in teaching ML. 7% gate a neutral rating with 4% who felt that their confidence still needs to be improved.

The data in Table 2 (see p. 56) also shows that 85% of ML teachers felt confident that they were able to design tests, 15% of the respondents were neutral about designing a test with no one who rated not good or poor. While 69% of the respondents felt that enrolling with ACEML programme had an impact on their skill of designing investigations and projects, only 21% indicated that they still have doubts about designing investigations and projects and 10% rated that they are not good.

ML teachers were also asked to rate their skills on designing classroom activities in ML. The results indicate that % of the respondents rated that they were very good and confident in designing class activities. 15% was not sure with only 2% of the respondents indicated clearly that they are not good at designing class room activities.

ML teachers were asked to give any other comments based on the skills they had rated themselves on.

A summary of responses are:

T1 in the questionnaire said, “ACML programme helped me to understand levels of assessment in ML.”

T3 in the questionnaire responded, “Most of the activities that I give to my learners are taken from the text book.”

T4 in the questionnaire responded, “I use newspapers and text book for class activities.”

T5 in the questionnaire stated, “I use past papers from the Department of Education to design tests and class activities.”

T6 in the questionnaire said, “I still need help in designing investigation.”

T7 in the questionnaire stated, “I’m also able to assess my learners and I developed this skill in teaching and learning module that was offered in the ACEML program.”

Respondents were also asked how often they design classroom worksheet/activities in a semester. 95% of the respondents were designing classroom worksheet/activities in a semester, with only 5% indicated that they design 1 to 3 per week.

The data shows that every ML teacher uses tests as one of the assessment tools. 85% of the respondents indicated that they design 1 to 3 tests in a semester with only 15% of them indicating that they design 4 or more a semester.

ML teachers were asked to respond to how often in a semester they design project/ investigations. The results show that 85% of the participants were designing project/ investigations in a semester with no one designing 4 or more in a semester. Only 15% indicated that they do not design them at all. Perhaps this 15% of the respondents do not follow the assessment policy as a guide to a number of formal assessment tasks to be designed in a semester.

ML teachers also commented on the following:

T41 in the questionnaire said, “I use cut and paste from the department of education past papers.”

T40 in the questionnaire stated, “I follow the department policy on assessment. Normally there is a programme guides on how many tasks should be given per semester.”

T38 in the questionnaire stated, “Most of formal test are provided by the department of education”

T39 in the questionnaire stated, “In every after lesson I give activity, but most of them are taken from the text book.”

T35 in the questionnaire said, “I avoid designing investigation because I am not good in designing rubrics.”

T28 in the questionnaire responded, “Most of the activities are taken from the text book, but according to the depart policy, I give 4 or more per week.”

In the interviews the participants responded as follows:

Teacher A responded:

> I am still struggling to design project and investigation and university did not teach us how to design them. I fail to design rubrics; my assessment criteria and instructions would be not clear. I even do not know how to differentiate between investigation and project.

Teacher D responded, “I lack knowledge of levels of taxonomy and I never consider them when assessing.”

Teacher E responded:

> We need enough time for workshops on developing us on the areas we lack. As it is noticeable that English language is a barrier to ML learners who take it as a second language and I thing long scenarios in paper two should be reduced.

These responses clearly indicate that ML teachers do not design class activities, investigations and tests on their own but they depend on the previous examination papers and text books. One of the participants clearly indicated that he lacks the skill of designing rubrics.

4.6.2 ML textbooks

Participants were asked to respond about the text books they use most often and the reasons for using them. The data indicates that 13 types of text books are used by ML teachers when teaching. 41% of the ML teachers use Spot on text books for activities followed by 12% of ML teachers use Viva Africa. 10% use Platinum and Successful textbooks with 7% using the class room. 5% used successful and Focus textbooks. Only 2% of ML teachers use for each of the following text book: Viva Africa, Study and Master, Solution for all, Clever and Top class.

Respondents were asked to give reasons why they chose the textbooks they had indicated. The following reasons were as follows:

T32 in the questionnaire responded, "I use Platinum because it is on line with the department needs and there is a number of interesting activities."

T33 in the questionnaire responded, "I use Platinum because it has a lot of examples, content is in line with needs of the department is teacher and learner friendly."

T34 in the questionnaire responded, "Viva Africa has a lot of class activities, it is colourful, pictures are clear for the unfamiliar context and it also caters for diverse classroom."

T35 in the questionnaire said, "I use Class room because it is in line with examination problems."

T36 in the questionnaire stated, "Spot on is in line with work schedule, content knowledge is relevant and it also provides solutions."

T37 in the questionnaire said, "I use Via Africa because it has interesting pictures with relevant context and activities are clear."

T38 in the questionnaire responded, "I use a variety of text books to compare the content knowledge and to give a variety of activities to my learners."

T39 in the questionnaire responded, "I use a variety of textbooks, magazines and other resources."

T40 in the questionnaire said:

> I use Spot On because it is easy to use, language used is understandable; it has a lot of activities and examples; it is in line with the DOE work schedule; it has a relevant content and links it with context.

The findings show that the most popular text book is Spot on. Below are some qualitative insights into why the Spot-on textbook is the most popular:

Teacher B stated, “Spot on is in line with work schedule, content knowledge is relevant and it also provides solutions.”

Teacher C said:

> I use Spot On because it is easy to use, language used is understandable; it has a lot of activities and examples; it is in line with the DOE work schedule; it has a relevant content and links it with context.

Teacher B responded.

> I fail to link ML content knowledge with the context properly I often rely on the text books but some of the text books have insufficient content knowledge especial on the new sections we are unfamiliar with on CAPS curriculum. Sometimes in those text books you would find spelling error, invalid or insufficient examples. I can even show you some errors I find in Shutter’s top-class maths lit grade 12 text book on page 345 in the section of taxable income.

Teacher B said, “I have become more aware of how topics per grade and per textbook progress.”

Teacher C said, “Knowing the content knowledge helps me to be able to choose the right text book and I use Via Africa text.”

Teacher C responded, “I remember in some instances I would had to sit and study the subject policy document and some text books.”

Teacher C stated:

> I rely on the variety of text books because presentation and examples are differing. Some give more explanation and some give less and not all of them are recommended by the Department of Education.

The responses above show that teachers prefer relevant and easy to use text books as shown by the qualitative insights given by the teachers. Spot On is mostly preferred textbook because of the relevant content it provides. This shows teachers' ability to select the best textbooks for their learners and is therefore closely linked to professional development.

4.6.3 Learners performance

Teacher D stated:

> After completing my ACE ML programme, I was able to implement this new learning area. My grade twelve results in ML improved, in 2010 my learners obtained 79 per cent, in 2011 they obtained 85 per cent, in 2012 they obtained 90 per cent and in 2013 they obtained 100 per cent.

Teacher D responded:

> Language barrier to learners is a challenge, thus they fail to understand the scenarios or the context on paper two during the examination. This means learners' levels of comprehending and understanding is very low.

Teacher D said, "My learners also fail the tests from the department of education but they pass those I had been set myself."

Teacher E responded:

> As I teach from grade ten to twelve I have noticed that learners lack mathematic background from previous classes. Since ML require an application of mathematics knowledge e.g. substitution and BODMAS. I find it difficult to build up that lost background because I have to rush time to complete the work to be tough on the work schedule. It is difficult to teach when learners do not have resources such textbook and calculators. I am not happy because I only produce quantity not quality.

Teacher C said, "Enrolling with ACEML programme helped me to know my learners, I know their misconceptions."

Teacher B responded:

> I now look at learners as a whole if I developed myself then learners must also be developed in each phase, i study and encourage and stay motivated to go to the next level which is what I would like to see happening to my learners, professionally.

T1 in the questionnaire said, "Yes it was helpful and I deliver content knowledge with confidence to my learners."

This also shows that what attracts teachers to professional development is their belief that it will expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with the learners.

As ML teachers' content knowledge has improved that means they teach ML with confidence as they are able to apply a number of teaching strategies and assessment skills. Perhaps this leads to the improvement of their learners' results in ML as 73% agreed or strongly agreed. Only 7% of ML teachers revealed that they still need support in improving their leaner's performance while 20% gave a neutral rating.

Respondents were asked about the challenges that they experience in teaching ML. Most teachers commented on the issue of a language barrier where learners do not understand the question and struggle to understand the language used in that context. Also, the context is sometimes unfamiliar to the learners. Paper Two is problematic because it requires a learner to apply mathematical knowledge to the context.

In the questionnaire respondents were asked to respond any misconceptions in ML that they found many learners experiencing. The following misconception were highlighted: learners do not understand how to apply BODMAS correctly e.g. they substitute correctly but do not apply BODMAS correctly where some would substitute l and b but omit h, could not convert hours to minutes. They could not convert millions to numbers, so that the two numbers are written in the same format. They are also confused by the terms: maximum, minimum, decrease, increase, discount, unable to reverse the calculation of VAT, fail to find the radius from the given diameter, could not interpret calculated answers logically in relation to the problem, confuse radius and diameter, and could not read information off the graph.

In the qualitative interviews the participants had the following to say:

Teacher C said, "Learners confuse radius with diameter; learners confuse bar graph and histogram they struggle to do substitution properly."

Teacher C responded, "My grade twelve results in ML improved, in 2010 my learners obtained 79%, in 2011 they obtained 85%, in 2012 they obtained 90%, in 2013 they obtained 100%."

While the following advice was given by the participants:

T31 in the questionnaire said, “In the case of substituting to the certain formula, learners should be encouraged to derive their own method to come up with the solution.”

T33 in the questionnaire stated, “My learners converting metric units used to confuse the basic conversion rule, therefore, I try to make sure that I assess this skill in varies sections I teach.”

T1 in the questionnaire responded:

> Authentic 3D shapes need to be brought in the classroom when teaching area, volume, perimeter and surface area in order to avoid the misconception of length X breath or length X height.

T2 in the questionnaire said, “Every section taught should be link with the familiar then the unfamiliar context.”

T3 in the questionnaire stated, “Teachers should avoid teaching ML with mathematics, e.g. a learner can calculate interest without using complicated formula such as A=P (1+i*N).

T10 in the questionnaire stated, “When marking test, I analyse each question in order to identify common misconception.”

T20 in the questionnaire responded, “Basic mathematics skills should be reinforced to the learner.”

T5 in the questionnaire responded, “Sections like area should be tough in a practical way.”

T7 in the questionnaire said, “Learners should be given more activities on the section they have shown misconceptions.”

T18 in the questionnaire said, “I see misconception before is even seen by the learner than I discuss it with them.”

T6 in the questionnaire responded, “Learners should be given a chance to teach one another and be able to identify the misconception on their own.”

T23 in the questionnaire responded, “Mathematical knowledge should be stressed on GET phase.”

4.7 Confidence in ML Teachers

The data shows that the majority of (96%) respondents were very good and confident in teaching the basic skills of mathematics to ML learners.

Twenty-seven (66%) of the ML teachers strongly disagreed that ML could be taught by any teachers without being part of the professional development programme. 32% rated neutral in this question and only 2% agreed that any teacher can teach the subject ML without being enrolled with the ACEML programme.

Thirty-eight (92%) of ML teachers strongly agreed or agreed that they are confident to implement ML in grade 10 to 12, and they are also confident to face those people who criticize the introduction of the subject. 8% rated neutral.

Teacher C in the interview responded, “After completing my ACEML program I was able to implement this new learning area.”

Teacher C in the interview responded:

> New sections such as box and whisker, time and assembly diagrams added on CAPS curriculum is challenging. We were never taught them while we were enrolled for ACEML and I am not completely confident when teaching these sections.

Teacher E in the interview responded, “At the beginning it was difficult to teach the subject the planned schedule was very broad and the push to finish the subject, I could not cope as I would like to.”

Teacher D in the interview responded, “Yes, I find it very easy and interesting to teach ML since I have completed the ACEML programme and I am confident.”

In question 27.7 of the questionnaire, 80% of ML teachers indicated that enrolling with the ACEML programme resulted to them understand educational policies better than prior to their studies. It is understood most government policies in education are better after enrolling in the ACEML programme and they can confidently engage in any ML related debate.20% of the respondents rated neutral.

4.8 Support for ML teachers

The fact that few teachers are comfortable teaching all sections and topics shows that further support is needed. Responses from interviews show that ML teachers need further support. Below are some of the responses given by ML teachers in the interviews concerning the further support that they need after completing the ACEML programme.

Teacher A in the interview responded:

> Though at the beginning of the year we used to attend the workshops organized by our subject advisor based on general orientation but are not enough because they are only two hours to cover the entire content of the subject. Thus, very little is covered in those workshops.

Teacher B in the interview responded:

> We receive workshops once at the beginning of the year where we are given program of assessment, work schedule and mark sheets. My HODs used to give us some templates to fill in the reasons learners have failed and give kind of support we need on that. However, we never received any support on that.

Teacher C in the interview responded:

> In the cluster, we used to moderate learners work together and it is where we get time to discuss areas we need to support each other on. We check the pace to complete the work schedule; we check the standard of the paper in terms of the levels of taxonomy and discuss strategies to make learners pass.

Teacher D in the interview responded:

> We used to meet with the HOD at least once a month where we have some general discussions related to the subject e.g. work schedule, programme of assessment, CASS grid and lesson plans. Every beginning of the year we used to have two hours workshops organized by the subject advisor. These workshops mainly focus on the material to be used during the year.

Teacher E in the interview responded:

> In every after formal assessment the department of education gives us diagnostic analysis form to fill in the reason learners have failed and the kind of support that we need. What worries me I never receive any help or support on that. Also, according to the department of education, IQMS is meant for developmental support but I never received any support on that and I think the concern is about the 1% increment on our salaries.

Teacher A in the interview responded:

> I think we should be provided with the follow up programs by the universities. We also need a support from the Department of Education to develop teachers on the areas we lack such as assessment strategies in ML.

Teacher B in the interview responded:

> We need quality workshops on these new and if universities could design and develop the program to cover new sections on CAPS. It shows that curriculum in South Africa keeps on changing, thus our knowledge should keep on changing as well.

Teacher C in the interview stated:

> We need enough time for workshops on developing us on the areas we lack. As it is noticeable that English language is a barrier to ML learners who take it as a second language and I think long scenarios in paper two should be reduced.

Teacher D in the interview responded:

> We need to support one another within the school, neighbouring schools and on cluster. Department of education suggested that teachers must have computers but I could not use it because I am computer illiterate. I would network with other teachers from different places. We also need to be provided with past papers in order to familiarize learners with the style used by the department of education, especially on paper two where reasoning skill is more required. But I doubt because we were told by the subject advisor that there are no past papers for the CAPS and the style is going to be completely changed, therefore this could lead to poor performance in ML result.

Teacher E in the interview responded:

> We need enough time for workshops on developing us on the areas we lack. As it is noticeable that English language is a barrier to ML learners who take it as a second language and I thing long scenarios in paper two should be reduced.

Most of the interviewed ML teachers showed that there was need for support programmes after the ACEML programme to help them develop other skills related to ML. The identified theme is that of workshops and university designed programmes to increase the teachers' subject content knowledge. The above responses show that follow up programmes are a necessary support initiative that will make teaching ML easier.

In the questionnaire participants were asked about the person they approach when they have problems with understanding some aspect of ML. The data indicates that 50% of ML teachers believe in learning communities because they get help from other teachers in the cluster meetings, while 48% approach expert subject advisors. 40% of the participants indicated that they approach other teachers within the school with only 35% of the participants approach their head of the department (HOD). This shows that ML teachers also believe in team teaching.

Question 27.4 in the questionnaire 71% disagree or strongly disagree that ACML programme could have been replaced by the department workshops, with 17% giving a neutral rating. Only 12% of the participants agreed or strongly agreed with the statement.

T7 in the questionnaire said, "Teaching probability because the support that I got was not enough to me."

In the qualitative interviews the participants had the following to say:

Teacher A responded, "Yes, but there are some challenges, such as new sections."

Teacher B responded, "Yes, because my content knowledge improved but CAPS curriculum added some new sections which a bit problematic."

Teacher C responded, "Yes, but new sections such as box and whisker added on CAPS curriculum is challenging,"

4.9 Conclusion

In this chapter I presented the quantitative and qualitative data generated in this study. The quantitative and qualitative findings were then compared to see if ML teachers' participation in the ACE ML programme contributed to their professional development and teacher knowledge. The results obtained in this study serve to confirm that ML teaches lack subject content knowledge and pedagogical content knowledge which is a problem. The responses from interviewees show that the intervention was helpful. After enrolling in the ACEML programme ML teachers reported an increase in content knowledge and pedagogical content knowledge and that they were more confident to teach the subject.

CHAPTER 5

DISCUSSION OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The previous chapter four, presented the data collected using both quantitative and qualitative, from 41 teachers who were retrained to implement ML. In this chapter, the results and findings in response to the three research questions are presented and discussed. Thereafter, I discuss some broad issues that arose from this study, followed by some implications of the study for the various stakeholders and finally, I provide recommendations for further research.

5. 2 Results and findings for research question 1

Research Question 1: How have ML teachers' participation in the ACEML programme contributed to their professional development in ML?

There were three sub-questions:

1.1 How has their participation in the ACEML programme contributed to their content knowledge in ML?
1.2 How has their participation in the ACEML programme contributed to their pedagogic content knowledge?
1.3 How has their participation in the ACE ML programme contributed to their confidence?

Drawing from the data presented in the previous chapter, I present some themes that are related to each sub-question.

5.2.1a Contribution to their content knowledge in ML

From Table 1 (see page 53) it can be seen that almost all (90%) of the respondents showed that their content knowledge was enhanced because they were part of the training program. The following participants when they were interviews Teacher A, Teacher C and Teacher E responded. "I know exactly what to teach in terms of the ML content"; "I'm clear about the content knowledge of the subject and…"; "My mathematical knowledge has improved". This is also seen in questionnaire, question 27.3 where 73% of ML teachers agreed or strongly agreed that being part of the programme, their content knowledge was improved. These above responses show that ML teachers' content knowledge was not adequate before joining the programme. The study by James et al. (2015) also revealed that "many of the teachers face personal challenges of poor content knowledge". This was due to the fact that only 17% of the participants taught ML before enrolling with the programme.

In the interviews, Teacher A, Teacher C and Teacher E also indicated that their mathematical knowledge has improved. It is likely, these ML teachers taught Mathematics at the season of participating as had earlier capabilities as Mathematics teacher. However, these teachers improved their existing content knowledge (Thembela, 2013).

Teacher D indicated that she did not know what to teach exactly before enrolling with the programme. James, Bansilal, Webb, Goba and Khuzwayo (2015) emphasize that teachers need to develop the necessary knowledge competence of the subject that they teach. 29% of the respondents taught Mathematics before enrolling with the ACEML programme and the rest were taught other subjects such as NS; EMS; Accounting and so forth. This was affirmed by Teacher D in the interview. Teacher D responded, "I used to teach ML using Mathematics Knowledge". These teachers are the individuals who should be acquainted with the scientific part of the ML (Thembela, 2013). The way that Teacher D had been teaching ML preceding selection, observed the program to be useful in elucidating the particular content that should be taught in ML. This study revealed that for enrolling in the programme, ML teachers gained specialized content knowledge, which is Mathematics knowledge and skills unique to teaching (Bansilal et al., 2015). Thus, in the interview, Teacher D clearly stated that she was in needy of the relevant content to as she taught Mathematics before enrolling with the programme. This is revealed in Shulman's (1996) seminal notion where he describes content knowledge as follows: Content knowledge is a knowledge and understanding of a central concept of a discipline. In the questionnaire, 85% of the respondents disagreed with the statement that any teacher can teach ML without being enrolled to the programme and 15% of them were neutral. Probably this 15% are those teachers who believe ML is a lower level of Mathematics. Furthermore, these teachers also assumed that teachers who had studied Mathematics would be better teachers of ML.

This study also revealed that some of the ML teachers' content learning had blurred as they last considered Mathematics while they were at school themselves. In the interview, Teacher A responded "I did not want to miss the opportunity to develop my mathematical knowledge since I had last did Mathematics when I was still in high school". These ML teachers needed to refresh their knowledge to become ML teachers. This demonstrates that teachers are pulled into proficient advancement programs, given their conviction that it will extend their insights and aptitudes, add to their development, and upgrade their competencies with teaching students. This is affirmed by Teacher D in the interview:

> After completing my ACE ML programme, I was able to implement this new learning area. My grade twelve results in ML improved, in 2010 my learners obtained 79 per cent, in 2011 they obtained 85 per cent, in 2012 they obtained 90 per cent and in 2013 they obtained 100 per cent.

Many research contemporaries call attention to the significance of teachers' reasonable learning in building up understudies' understanding (James, Bansilal & Webb, 2015; Bansilal & Rosenberg, 2011 Ball and Bass 2000; 2004; Adler et al. 2009; Kriek and Grayson, 2009). To add to that, Brijlal (2013) in his study affirms that features of professional development which includes changes in content knowledge and teaching practices should eventually lead to improvements in learners' achievement.

ML teachers experienced the programme to be imperative in improving their content of the subject ML. Thus, teachers were able to select the best text books for their learners. Textbooks with an adequate content that is supposed to be taught in ML can contribute to learners' good results (George & O Adu, 2018). In the interview Teacher C responded, "Knowing the content knowledge helps me to be able to choose the right text book and I use Via Africa text". Furthermore, Teacher B clearly indicated that through the programme she was able to identify some of the text books with insufficient content knowledge, especially in the new sections where they are unfamiliar with the CAPS curriculum:

> Sometimes in those text books, you would find spelling error, invalid or insufficient examples. I can even show you some errors I find in Shutter's top class maths lit grade 12 text book on page 345 in the section of taxable income.

ML teachers improve their content knowledge in terms of solving problems. 100% of ML teachers were interested in content knowledge of the learning area as they all liked the 4 areas of content knowledge in ML (numbers, data handling, probability, measurements and finance). These four modules are devoted to developing content knowledge (James et al., 2015). This is seen in Section C of the questionnaire, where T11 responded that "My subject matter knowledge in ML was adequate after I had passed the following modules: shapes, finance, probability, data handling and numbers". The improvement resulted on her being part in the programme. Improvement in content knowledge in terms of solving problems is also seen (Section C of the questionnaire) by T12, "Through measurements, I gained personal experience because I am able to calculate the number of tiles needed for my floor before I even go to tile shop". From her experience of measurement module during the program. T12 further confirms that she benefitted a lot from the finance module and she is now able to manage her personal finances. These responses show ML teachers improved the skills and knowledge to perform the jobs successfully, especially with the quantitative and mathematical demands of everyday life. A good example would be of compiling and reading spreadsheets, reading off plans and maps and drawing up budgets and working with financial documents (Brijlal, 2013, p.14).

However, the results of the study show that some of the topics were challenging to the ML teachers. Participants were asked about the section/topic/concept in ML they were not comfortable with the teaching. In the questionnaire T2; T4; T5; T6; T8 and T9 clearly indicated that they were not comfortable with the finance sections. They had a lot to say about this challenging finance section. T3 who taught Mathematics before, highlighted that word problems used to give him a problem. T2 and T6 noted that as they did not do commerce at high school level, the financial section was a challenge for them. T2 related ML with commerce. According to Long et al. (2014):

> The purpose in ML is not about learning more and higher mathematics but the emphasis in ML is on the use of mathematics to explore the meaning and implications of quantitative information presented in many real-life situations.

T4, T5 and T8 specifically indicated inflation, interest, and taxation. T7 stated that "I did not learn anything about packaging and assembly when I was enrolled with ACEML, therefore I am not comfortable with teaching it". This response clearly shows that some of the concepts were unfamiliar to the ML teachers. The findings suggest that the teachers still require further support and assistance in coping with some of the content in ML.

The results also showed that the tutors played an important role in helping the teachers improve their content knowledge. ML teachers found that the tutors explained the content in a manner that was clear, precise and easily understandable. In the questionnaire, 85% of ML teachers strongly agreed (See Figure 5a) that tutors offered good explanations of the content and their studies were made easier because of knowledgeable tutors. ML teachers had much to say about the attitude of the tutors while they were still enrolled with the programme. Figure 5d (p.56) shows that most tutors were pleased with the degree of empathy shown by the tutors with less than 10% of the teachers who disagreed that the tutors were empathetic towards them. The teachers (See Figure 5c page 54) were also pleased with the knowledge and preparedness of the tutors.

ML teachers in this study felt that the improvement in knowledge through their studies was made easier because of readable materials provided by their tutors. This provided a sense of direction for the teachers and gave them ideas about how they could approach the teaching of the same topics. (Bansilal et al., 2015).

Tutors were very hardworking, supportive and went the extra mile to assist the teachers since the majority of the respondents did not have qualifications prior to the programme. This is seen in the questionnaire where 90% of the participants strongly agreed that tutors were very supportive. Johnson, Hodges and Monks (2000) caution that teacher trainers should try to find out more about the need of teachers, when designing interventions for teachers.

Another important factor that helped the teachers improve their understanding was the supportive collegial atmosphere that existed between the teachers as they studied together. Figure 5e in chapter four shows that 96% of the teachers found that the other teachers were supportive and helpful as they engaged with the content.

5.2.1b Contribution to their pedagogic content knowledge

The research indicates that professional development of the ML teachers is not enough when ML teachers only develop their content knowledge leaving behind the PCK (Nel, 2012). The findings of this study show that in the questionnaire, 88% of the respondents strongly agreed that a variety of teaching strategies have been used and applied effectively after enrolling with the ACEML programme. This statement is also confirmed by Teacher A and Teacher B in the interview, where they have developed teaching strategies and I assess learners, they give feedback and it is where they are able to find out why learners have failed the task then they would come up with more strategies and feed forward. Furthermore, T5 in the questionnaire said, "My assessment and teaching strategies has improved after enrolling with ACEML programme". One of the reasons for the teachers' improvement in PCK was that the assignments and tests were relevant to their teaching (Figure 7.4). According to Brijlal (2013), the teacher must use teaching strategies that are applicable to that particular content and that particular group of learners or class. In the same way, Ennis (1995, p. 389) emphasizes that:

> This knowledge consists of useful forms of representations for the subject content knowledge such as, analogies, illustrations, learning cues, drills, the ways of presenting and formulating the subject that make it comprehensible to others.

These ML teachers built up the capacity to become an intelligent specialist, where they could investigate their own teaching and after this, think about their strong points and ineffective focuses (Thembela, 2013).

This is also found in a study by Bansilal and Rosenberg (2011) where ML teachers can reflect on their teaching. The responses above are the reflection of how the ACEML program developed the participants' PCK. ML teachers were now able to conduct activities that they previously had difficulty doing. Prior to the ACEML program most of the participants showed that they lacked the knowledge to effectively teach ML, this was the case regardless of their qualification. However, after their enrolment in ACEML, the ML teachers have the ability and skills to teach ML and have gained the knowledge that they previously lacked and as highlighted in the responses from interviewed teachers (Bansilal & Rosenberg, 2011).

Brijlal (2013) argues that ML content knowledge is very closely linked to PCK in the way that it is rather difficult to divorce them. Furthermore, in this research ML teachers responded that they have learnt content knowledge and are able to master it, they moved towards mastering new methods of practice, finding new ideas in delivering the new content. Thus, ML unlike Mathematics teaching requires teaching from a context. From Table 8, it can be seen that 95% of the teachers were confident about their skills in teaching ML using a context. This is affirmed by Teacher C in the interview saying, "My teaching strategies such as linking content and context are developing day by day". These discoveries are predictable with the findings of Bother (2010), where one of his members could change her substance information into structures that were instructionally very good. The researcher further contends that the teacher was likewise effectively sequencing the content to encourage learning. Four of the six modules are committed to the improvement of content knowledge (James et al., 2015). T1, T2 and T3 rated 4 in data handling and various reasons were given e.g. "learners enjoy calculating measures of central tendency as well as measures of spread, data handling because it also involves probability where learners can experiment". T3 also emphasised that in data handling, it is easily linked with the familiar context of the learners. According to James et al. (2015) and T2 is able to demonstrate the context-driven agenda to explore contexts that are relevant to learners' current and future needs. Table 2 in the questionnaire also shows 78% of the participants were good and confident in linking context with ML content. This is further evident in the interview with Teacher A who responded, "Through the programme we were taught how to apply mathematical knowledge with real life situation"

These responses reveal knowledge of the pedagogy, where the teacher faces the problem of converting the question to a learning experience (Nel, 2012). ML teachers develop knowledge of the application topics in the contextual settings. An actual existence readiness viewpoint underlines that ML looks to create students who will identity taking an interest in subjects, contributing specialists and self-overseeing individuals (DoBE, 2011). Hence, an educational programme that accomplishes these objectives will build up understudies' abilities at arriving at, utilising, translating and fundamentally surveying numerical data utilised and the settings. In this manner it is vital that by taking part in life-related applications, students won't be threatened when they experience these settings in their present or future lives, yet will utilise them to make educated choices (DoBE, 2011). This is confirmed in the questionnaire by T12, who responded, "Through measurements, I gained personal experience because I am able to calculate the number of tiles needed for my floor before I even go to tile shop". Thus, ML educators could pick settings that are significant to their students both in clarifying certain ideas and in the planning of assignments. Correspondingly, as per Long et al. (2014) the reason in ML isn't that student's find out more or learn a higher level of mathematics but the emphasis in ML is on the utilisation of mathematics to investigate the significance and ramifications of quantitative data introduced in some real life circumstances. In particular, content-explicit instructional methods envelop the capacity by educators to design assignments that will be suitable for their students (Thembela, 2013). There is proof in the questionnaire as T1 stated, "ACML program helped me to comprehend dimensions of evaluation in ML." Therefore, educators improved by their cooperation in the programme to most likely structure effective assignments.

One of the significant ways in which the teachers improved their PCK was in the area of learner misconceptions. Being able to identify and describe these misconceptions was an important task fulfilled by teachers because new learning experiences are built on previous learning and it is important for teachers to be in touch with possible learners learning difficulties. An important issue that was raised in this study was the importance previous knowledge of ML by the learners when they are taught. Teacher E mentioned during the interview that:

> "As I teach from grade 10 to 12, I have noticed that learners lack mathematic background from previous classes. Since ML require an application of mathematics knowledge e.g. substitution and BODMAS, I find it difficult to build up that lost background because I have to rush time to complete the work to be tough on the work schedule…"

Through his interest in the ACEML, he understood that he should think about past content knowledge since this helped him while considering the program. Thembela (2013) additionally noticed the requirement for information of the GET educational programs could assist ML teachers to determine the performance of the learners in grade 9. PCK essentially incorporates a comprehension of what it is that makes the learning of explicit themes simple or troublesome and the assumptions conveyed by students to the learning circumstance (Shulman, 1996). Hence, it is very encouraging to note that this aspect of PCK was evident in many of the ML teachers' responses.

The findings of this study indicate that after the ACEML programme ML teachers were able to differentiate between mathematics and ML. This is evident in the questionnaire where T6 responded, "I am no longer confusing mathematics with ML". The manner in which ML taught is not the same as in Mathematic (Bansilal & Rosenberg, 2011).

Teacher D in the interview affirmed that:

> Knowing what to teach and how to teach it give me a clear understanding of what resources are needed for that particular section I teach e.g. when I teach BMI I would bring along bathroom scale and measuring tape in the class. This shows that my teaching strategies were developed and improved.

This ML teacher was able to choose appropriate material. The findings of the study also show that ML teachers are able to integrate content learning with contextual understanding. This claim is observed in the questionnaire by T4, “I use newspapers and text book for class activities”. This recommends educators should likewise focus on recognising and removing the hidden Mathematics or content from the setting (DoBE, 2011).

The solid emphasis on the utilisation of regular settings requires an English language aptitude to portray, comprehend or answer enquiries concerning the specific situation. When he was interviewed, Teacher E reacted, "English language is a boundary to ML learners who accept it as a second language". These discoveries are reliable with Bansilal and Rosenberg's (2011) discoveries which featured that 59 % of the respondents detailed that the vast majority of their learners were not first language English speakers, and subsequently, thought that it was hard to comprehend a considerable number of the assignments. Through participating in the programme, ML teachers were able to notice that task language is one of the areas that need to be considered when designing the task. However, English language second speakers fail to understand the question asked. These authors further emphasize that in South Africa, it is mainly English that is the language of learning and teaching” (Bansilal & Rosenberg, 2011). In the interview, Teacher E also commented, I think long scenarios in Paper Two should be reduced.” This statement seemed to disagree with the demands of the SAG document. SAG emphasises that Paper Two should focus predominantly on Level 3 and Level 4 questions (Venkat et al., 2009). The above comment by Teacher E also proves two of the three concerns identified in the study of Thembela (2013) that task language utilized in an assignment may be a barrier for learners who cannot express themselves in English language. Besides too much information, assignments with excessively pointless data, distract students from recognizing the purpose of a task.

> “Teachers therefore need to develop effective ways of teaching, using both the language of mathematics and the language of teaching, and learning code switching in the present multicultural society” (Brijlal, 2013, p.90.).

As highlighted earlier, 88% of the ML teachers indicated that they had improved in the development of tasks. T1 in the questionnaire claimed the ability to design tasks, “The ACML programme helped me to understand levels of assessment in ML”; T7 said, “I’m also able to assess my learners and I developed this skill in teaching and learning module that was offered in the

ACEML programme". Also, in the interview, Teacher E responded, "My assessment and teaching strategies has improved after enrolling with ACEML programme". As noted in Ball et al. (2008), Mathematics teachers "require a lot of other mathematical knowledge and skills, knowledge and skills not typically taught to teachers in the course of their formal mathematics preparation" (Ball et al., 2008, p.403). The difference amongst tasks in ML and Mathematics should be identified by ML teacher.

On the other hand, the findings of this study indicated that some of the ML teachers seemed to be not sure of their teaching and assessing in ML. This is revealed in the questionnaire when T6 responded, "I still need help in designing investigation". Furthermore, T35 commented, "I avoid designing investigation because I am not good in designing rubrics". This is also evident in the interview where Teacher A responded:

> I am still struggling to design project and investigation and university did not teach us how to design them. I fail to design rubrics, my assessment criteria and instructions would be not clear. I even do not know how to differentiate between investigation and project.

As seen in the interview, Teacher D in chapter 4 clearly indicated that he lacks knowledge of levels of taxonomy and he never considers them when assessing. In the questionnaire, T5 responded, "I use past papers from the Department of Education to design tests and class activities". Moreover, T41 said, "I use cut and paste from the department of education past papers". These responses indicate that ML teachers believe and relied on the paper set by the DoE. Again, studies prior to 2008, showed scholastic evaluates that had effectively raised worries that a portion of the papers for ML did not seem to adjust well to the scientific categorization against which appraisals should be planned, with an overrepresentation of inquiries concentrated on the lower levels (Venkat et al., 2009). Brijlal (2013) affirms that features of professional development must include changes in teaching practices and contribute effectively to leaners achievement. Similarly, James (2000) cited in James et al (2015) affirms that the arrangement of an expert advancement programme and educators' support in it doesn't ensure change in their teaching practice (James, 2000). It is clear that teachers need more assistance and support in the crucial area of task design. They need to design tasks for classroom activities as well as for assessment activities so this is an area that many teachers identified that they would welcome assistance.

The study of Van Driel, Verloop, and de Vos (as cited in James et al. (2015) supports the view that teachers should develop PCK during their professional development programmes. This is further supported by Nel (2012) who wrote that professional development of the ML teacher is not enough when ML teachers are only fed with content knowledge leaving behind the PCK. Bansilal et al. (2015) in their study highlighted that a large majority of teachers need to strengthen their subject knowledge base, pedagogical content knowledge and teaching skills.

"Teaching methods include the capacity to design proper assignments for surveying students in that subject just as distinguishing any misinterpretations which learners may hold. Clearing up such misguided judgments likewise, frames some portion of substance explicit instructional methods" (Thembela, 2013, p. 98). The discoveries of this research demonstrate that ML teachers improved by their cooperation in the ACML programme to almost certainly remove students' confusion that may emerge from teaching ML. In the interview, Teacher C responded, "learners confuse radius with diameter". This comment shows that ML teachers were able to identify there was a content gap, and it shows that the teacher could not address learners' misconception in the early stage of the lesson. This is identified in the study of Brijlal (2013) as knowledge of mathematics deals with learner's methods of finding answers through algorithms and intuitive reasoning.

These above findings confirm Ball et al. (2012) findings that when teachers assign tasks, they have to foresee what learners are probably going to do with it and whether they will think that the tasks are simple or hard. ML teachers could recognize learners reasoning. This is likewise affirmed by Brijlal (2013), who argues it is imperative for ML educators to recognize their very own misinterpretations just as that of their own learners while preparing assignments and this is one of the requests of a content explicit instructional method. ML assignments require cooperation between explicit scientific comprehensions. Ball et al. (2008) includes that, Mathematics teachers must foresee with what learners are probably going to think and what they will find confusing.

Brijlal (2013) argues that ML teachers must therefore know what misconceptions learners have and be able to use different skills and strategies to impart the subject matter and giving meaning to it. This is evident by T10 in the questionnaire who commented, "I teach grade 12 because they are my learners from grade 11, and therefore I know the areas that need to be reinforced to them".

To teach ML effectively, the teacher must make sure that knowledge of senior phase curriculum is considered.

5.2.1c Contribution to their confidence

ML teachers who participate in the ACML programmes would update their content, strategies and skills of teaching, and develop more confidence.

The results of this research indicate that some of the respondents view themselves as experts in the teaching of ML after completing the ACEML programme. T19 in the questionnaire indicated clearly that he/she sees him/herself as an expert after enrolling with ACEML programme. The confidence levels of the ACEML teachers was so high that in the questionnaire 85% of them felt that they were the only ones who could teach ML and that although Mathematics teachers had the mathematical knowledge, they did not have the pedagogical content knowledge to teach ML successfully. The 85% of the ML teachers couldn't help contradicting the announcement that teachers believe any teachers can encourage ML without being selected to the program. Also, the data in the questionnaire shows that the majority of 96% respondents were very good and confident in teaching the basic skills of Mathematics to ML learners. Similarly, Teacher E in the interview, indicated "I'm clear about the content knowledge of the subject and I'm confident to teach it in the class". Thus, the other critical aim of the retraining programme was the development of the confidence to the participating teachers (Thembela, 2012).

The findings also revealed that ML teachers realized that ML and Mathematics are two deferent subjects with different aims. This is evident in the questionnaire where T6 responded, "I am no longer confusing ML with Mathematics". Furthermore, T16 commented, "Professionalism module changed my attitude, I now a contributing citizen." Teacher D responded:

> I use to teach ML using Mathematics Knowledge. I've realized that ML is more is more context based which means I had to acquire the skill of linking the content knowledge and the context.

This is evident in the study by Nel (2012) who pointed out that ML is different in purpose and type from Mathematics and so requires a shift in attitude. T2 clearly stated that he gained more insight in ML.

Furthermore, ML teachers felt that Mathematics teachers could not teach the subject as well as the ACEML students. Only two ML teachers did not concur with the rest. In the interviews, Teacher A responded:

> My school does not offer ML at all because it is believed that ML is useless for a learner who intends to do engineering after grade 12 and they are aware that universities do not recognize ML in grade 12 learners.

Teachers who believe ML to be lower grade Mathematics will clearly display the content agenda stream only. Jansen (2012) claims that ML is designed for the weaker learners since it is considered easier than Mathematics. Some schools do not even offer ML as an alternative to Mathematics. Teacher B commented, "Though I am qualified to teach ML, but I only teach Mathematics because ML is not offered in my school."

ML teachers felt confident that they could implement the newly introduced subject ML as they were adequately trained to teach it. This is seen in the interview where Teacher C responded, "After completing my ACEML programme, I was able to implement this new learning area". This is confirmed by many studies in Chapter Two where it indicates that there were only a few Mathematics teachers who comprehended the subject and who were happy to encourage the subject with FET learners. Consequently, there was a huge need to train teachers to teach the new ML subject (Goba et al., 2011. Accordingly, numerous teachers from other learning zones were utilised to present their numerical proficiency (Nel, 2012). Additionally, Vilakazi (2010) contends that this re-skilling and re-preparing would empower teachers to present Mathematical Literacy properly. An adjustment in the educational programs normally impacts contrarily on the certainty of the subject teacher. With ML being another subject inside and out, it very well may be normal that no one thought of the essential trust in the subject. In this way, the job of the retraining programme was to build up the certainty and competency in those teachers who took an interest in the program.

Most of the respondents in the questionnaire openly indicated that through enrolling with the program, they have become more confident in teaching ML. This was also seen in the interviews, by participants' eager from grade 10 to 12. Teacher E responded, "As I teach from grade ten to twelve I have noticed that learners lack mathematic background from previous classes. Teacher D responded, "Yes, I find it very easy and interesting to teach ML since I have completed the

ACEML programme and I am confident". As previously mentioned in the study of Thembela (2013), ML teacher needs to integrate knowledge and ideas for learners to better understand what they are learning. This is proven by Teacher C in the interview when he/she commented, "Enrolling with ACEML programme helped me to know my learners, I know their misconceptions a lot as to how to approach the subject and therefore have gained confidence".

The findings in this study show that some of the ML teachers get help from their colleagues. These ML teachers use self-directed professional development for improving their pedagogical content knowledge in adapting subject content to make it relevant to the local context (Mushayika & Lubben, 2009). In the interview Teacher A and Teacher D had a same comment that their HODs used to give them some templates to fill in the reasons learners have failed and give kind of support they need on that. They further commented that they never received any support on that. This is also evidenced by Teacher C who responded:

> In the cluster, we used to moderate learners work together and it is where we get time to discuss areas we need to support each other on. We check the pace to complete the work schedule; we check the standard of the paper in terms of the levels of taxonomy and discuss strategies to make learners pass.

These responses prove that ML teachers also found that through their ongoing discussions with their colleagues within their own and other schools, they were able to share knowledge and learn co-operatively and the same time would work with the learners in their own classes. The findings of this study also indicated in the questionnaire that 81% of the participants strongly agreed that students were confident in supporting one another during the ACEML programme. These findings are consistent with the study of Bansilal and Rosenberg (2011), where they claim that most ML teachers Participated in the program with the aim of reviving and improving their knowledge in order to become qualified ML teachers. However, much support is needed such as in the teachers' work place with opportunities for mentoring and peer support. The place in which a teacher works is an important aspect that must be considered in the design of professional development programmes (Brijlal, 2013). Additionally, Peacock and Rawson (2001) point out that training of lead teachers selected from the districts would then each be responsible for the professional development of other teachers in a small cluster of the schools.

This is also proven in Wenger (1998) and Graven's (2002) theory which suggests that learning is enhanced when the participants become part of the community of practice. Hence, after participating in the ACEML programme, ML teachers were working together with other teachers in small clusters of the schools and at the same time, their identities and confidence was developing. This study also confirms that ML teachers by engaging in Professional Practice module resulted on being able to reflect on their own teaching.

This study shows that 83% of the participants indicated that they teach ML in their schools. This shows that after the ACEML programme, ML teachers were brave enough to teach the subject with confidence is reaching the targeted population and can therefore bear the desired fruit of increasing subject content knowledge of ML teachers. The teachers even preferred to be identified as ML teachers rather than by the subjects that they had taught previously. In the interview, Teacher C responded, "I enjoyed the subject" and in the questionnaire, T3 clearly indicated, "It was voluntary as I would like to know the results of this research and what the university will do about it." T1 commented, "It is because the SMT trusted me that I can teach ML in grade 12 after enrolling with ACEML." Also, T2 responded, "Members of the SMT believed in my knowledge that I have obtained through ACEML." These results also emerged in the research done by Nel (2009). In her research, some teachers were seen possessing what Nel called a dual identity (Nel, 2009). In the interview, Teacher D clearly stated that he was promoted as an HOD for Languages than he had to stick to only two subjects; English and Geography but he liked ML. Teacher B also indicated in the interview that even if ML is not offered in her school, it does not change that she is qualified in teaching ML. When Teacher C was interviewed, he stated that he was a primary school teacher before enrolling with the programme and after he had completed the ACEML qualification, he was confident enough to teach in the FET phase.

The results of this research indicate that enrolling with the ACEML programme positively influenced teachers' professional development. Wenger (as cited in Brijlal, 2013) also feels that when a person relates his or her learning experiences and attaches meaning to it, then it shows some form of change in the identity of that person and then only, can one say that the "notion of identity related to being a professional has taken place." In the same way, Bansilal and Rosenberg (2011) affirm that ML teachers must be able to see an identity transformation related to their knowledge and beliefs of ML practices, and be able to compare the differences before and after they have completed the ACEML programme. This is confirmed by Teacher E in the interview where she responded, “At the beginning, it was difficult to teach the subject. The planned schedule was very broad and the push to finish the subject, I could not cope as I would like to”. This is also seen in the questionnaire where T6 commented, “I teach grade 12 because I trusted myself that my content knowledge has improved as well as my teaching and assessment strategies developed after enrolling ACEML programme”. Thus, when the identity is developed to the teacher, that teachers is likely to develop confidence as well (Thembela, 2013).

5.3 Research Question 2: What are some challenges experienced by ML teachers when teaching ML?

5.3.1 New topics

It was revealed in this study that CAPS introduced some new ML topics, and these topics were introduced after the ML teachers’ enrolment to ACEML programme. In the questionnaire, participant T7 and T10 mentioned that models were new to them. In the interview, Teacher C also responded:

> New sections such as box and whisker, time and assembly diagrams added on, CAPS curriculum is challenging. We were never taught them while we were enrolled for ACEML and I am not completely confident when teaching these sections.

According to Nel (2012), the ACEML was initiated to assist ML teachers acquire adequate curriculum of the subject ML. On the other hand, the findings in this study show the curriculum change is a challenge for ML teachers. Brijlal (2013) points out that it is very important to develop teachers in order to face the challenge of the curriculum reform. This is also argued by James et al (2015) that a new curriculum brings changed expectations of what and how teaching and learning should take place for quality education to be achieved. Therefore, the findings of this study show that there must be an in-service programme designed for specific needs by considering the capacity of teachers have for effective innovations (DoE, 2007). Moreover, in-service training, content training workshops, pedagogic content knowledge workshops and certified programmes are an essential form of on-going training for teachers (Brijlal, 2013).

The data also helped identify that teachers were generally not pleased with many of the ML workshops offered by the DoE. In the questionnaire, participants were asked to talk about other in-service ML courses or workshops that they have attended in the past two years. In this section, all 41 participants indicated that they usually attend workshops organised by the DoE which are usually run by subject advisors. The data shows that 44% of the respondents were neutral when they rated the workshops they attended with 46% of the respondents rating the workshops as good. Only 10% indicated that were not happy with these workshops. Teacher A responded:

> Though at the beginning of the year we used to attend the workshops organized by our subject advisors based on general orientation but are not enough because they are only two hours to cover the entire content of the subject. Thus, very little is covered in those workshops.

However, teacher development programs had been developed but it is discovered that they are still ineffective in South Africa (Bantwini, 2009). The results of this research indicate that through participation in the ACEML program, ML teachers were able to identify the type of professional development suitable for them. Hence, by involving themselves in the workshops they would notice that content, strategies and skills of teaching are not sufficient for them.

Guskey (2002, p. 382) affirms that, "The majority of programmes fail because they do not take into account what motivates teachers to engage in professional development". The ACEML programme seems to be effective for the ML teachers because it was relevant to their needs. The findings indicated that, 44% of respondents were from other subjects, however, enrolling with the ACEML programme would refresh their knowledge especially in numeracy. This also shows that ML teachers were attracted to professional development programmes, with the belief that it will expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with learners. However, Kriek and Grayson (2009, p. 186) argue that "limited information is available about the factors that contribute to effective Mathematics and Science professional development, as well as examples of programmes that leads to effective practice".

The findings of this study show that ML teachers who attended workshops indicated that these workshops were not effective. During the curriculum reform period, many of these teachers were expected by the Department of Education to attend curriculum implementation workshops to develop the required knowledge and skills for implementing the new curriculum. However, these workshops proved to be insufficient for the professional development of the teachers (James et al., 2015). This is confirmed in the interview by Teacher B who responded, "We receive workshops once at the beginning of the year where we are given program of assessment, work schedule and mark sheets”. This is consistent with the findings of Brijlal’s (2013) study she argues that teachers were given lots of materials in the form of hand-outs and textbooks, which many teachers were unable to teach themselves as they were unable to ascertain exactly what strategies to use with all the knowledge that they were confronted with. Additionally, Cheung (as cited in James et al., 2015) suggests that interventions such as a three-hour workshop will not have a -term impact on classroom practice and that professional development must be intense and sustained. The ACEML was devised exactly as an intervention. The research indicated that some programmes are selected because they are run over a long period of time (Kriek & Grayson, 2009). Furthermore, one of the weaknesses of many professional development programmes is they are only run for a short period of time (Kriek & Greyson, 2009).

The study identified that there are some content areas which many teachers find challenging to teach and need further support and help.

In question 27.2 of the questionnaire 54% of ML teachers strongly disagreed with the statement that their knowledge was adequate before joining the programme. This is confirmed in the interview by Teacher E who commented, “But since workshop did not help most of us that much then after training I gained a lot as to how to approach the subject and therefore have gained confidence”. In section C of the questionnaire, ML teachers described they struggled in some areas such as finance, interest, scale, taxation, inflation and models.

The findings indicates the majority of participants (54%) had a 3-year teaching diploma, while 42% had a post graduate teaching diploma and 37% had an honours degree. Only 15% of the participants had a bachelors’ degree and none of the participants hold higher than honours degree. These responses are also testimony to the fact that academic qualifications alone were insufficient for teaching this new subject. These qualifications needed to be reinforced by the ACEML programme. In the interview, Teacher C responded, “My mathematical knowledge has improved and I have moved from M + 3 to M + 4 which resulted in my salary scale to increase.” This is confirmed by Thembela (2013) that to be part of the program was an opportunity for ML teachers to move to the next level of their qualifications. Additionally, Bansilal & Rosenberg, (2011, p.108) are of the opinion that, “ACEML was designed to enable underqualified teachers with 3 years of teacher training experience to upgrade to the requisite South African qualified teacher status of 4 years postsecondary teacher education, or enable already qualified teachers to reskill in a new learning area”. This resulted on the majority of teachers believed to be able to implement the new subject ML (Nel, 2012).

The above findings suggest that academic qualifications were insufficient for effective teaching of ML. As the results in the questionnaire indicate that 54% of the participants had a three-year teaching diploma and the program would move them to the higher level of REQV. This response shows that ML teachers were motivated to engage in the ACEML programme so that their salaries would increase.

One of the challenges highlighted by the ML teachers who were interviewed was learners who study in English as a second language. These learners usually fail to understand the questions asked in ML question paper. This is confirmed by Teacher E in the interview who responded;

> We need enough time for workshops on developing us on the areas we lack. As it is noticeable that English language is a barrier to ML learners who take it as a second language and I think long scenarios in Paper Two should be reduced.

5.4 Research Question 3: What further support do ML teachers need, after completing the ACE ML programme?

Responses from interviews show that ML teachers need further support. Below are some of the responses given by ML teachers in interviews concerning the further support that they need after completing the ACEML programme.

Teacher A commented:

> I think we should be provided with the follow up programmes by the universities. We also need a support from the Department of Education to develop teachers on the areas we lack such as assessment strategies in ML.

Teacher B said:

> We need quality workshops on these new and if universities could design and develop the programme to cover new sections on CAPS. It shows that curriculum in South Africa keeps on changing, thus our knowledge should keep on changing as well.

Teacher C responded:

We need enough time for workshops on developing us on the areas we lack. As it is noticeable that English language is a barrier to ML learners who take it as a second language, and I think long scenarios in Paper Two should be reduced.

Teacher D responded:

We need to support one another within the school, neighbouring schools and on clusters. Department of Education suggested that teachers must have computers but I could not use it because I am computer illiterate. I would network with other teachers from different places. We also need to be provided with past papers in order to familiarise learners with the style used by the Department of Education, especially on Paper Two where reasoning skill is more required, but I doubt because we were told by the subject advisor that there are no past papers for the CAPS and the style is going to be completely changed, therefore this could lead to poor performance in ML result.

Teacher E responded:

> We need enough time for workshops on developing us on the areas we lack. As it is noticeable that English language is a barrier to ML learners who take it as a second language and I thing long scenarios in paper two should be reduced.

Adler and Taylor (2009) argue that teacher trainers struggle with what kind of support teachers should be offered to improve their teacher knowledge and impact positively in the context which teachers work under. The findings in this study indicate that workshops were used as a support to implement ML. In the interview, Teacher A and E clearly indicated that they used to attend the workshops organised by our subject advisor based on a general orientation. However, these workshops are not enough because they only allocate two hours to cover the entire content of the subject. Teacher A and Teacher B further commented that very little is covered in those workshops. This is also argued in the study of James et al. (2015), where they reported that during the curriculum reform period, many of these teachers were expected by the Department of Education to attend curriculum implementation workshops to develop the required knowledge and skills for implementing the new curriculum however, the workshops proved to be insufficient for the teachers to effectively implement the curriculum and they received inadequate support. This is noted by Nkambule and Amsterdam (2018) that teachers support that is inadequate, leaving teachers feeling unsupported and ill-equipped to face the challenges presented by the new curriculum and education system.

Alternatively, Peacock and Rawson (2001) argue about ongoing projects to develop the skill of evaluating teacher's performance after they have been enrolled in teacher development programmes. Umugiraneza et al (2017) asserted that it is imperative to offer in-depth teacher support programmes at the schools where teachers work so that they can learn while they teach.

The findings in this study show that some of the ML teachers get help from their colleagues which is an internal source of support within the school (Nkambule & Amsterdam, 2018). These ML teachers use self-directed professional development for improving their pedagogical content knowledge to adapt subject content to make it relevant to the local context (Mushayika & Lubben, 2009).

In the interview Teacher D responded as follows:

> My HODs used to give us some templates to fill in the reason's learners have failed and give kind of support we need on that. However, we never received any support on that.

This sentiment shows that ML teachers expressed their concerns about the fact that in general, HODs have a wide scope of responsibilities, which ultimately compromises the quality of support provided to educators.

Teacher C responded differently from Teacher A and Teacher D and commented:

> In the cluster, we used to moderate learners work together and it is where we get time to discuss areas we need to support each other on. We check the pace to complete the work schedule; we check the standard of the paper in terms of the levels of taxonomy and discuss strategies to make learners pass.

These findings clearly show that after enrolling with the ACEML programme, teachers were able to take responsibility for their own learning and development.

These findings are consistent in the study of Bansilal and Rosenberg (2011) ML teachers were eager to gain new knowledge and after the program they were still need peer support within the school. Similarly, Peacock and Rawson (2001), point out that lead teachers selected from the districts for training would then each be responsible for the professional development of other teachers in a small cluster of the schools.

The fact that few teachers are comfortable teaching all sections and topics shows that further support is needed. Responses from interviews reveal that ML teachers need further support. Below are some of the responses given by ML teachers in interviews concerning the further support that they need after completing the ACEML program. Teacher E responded:

> In every after formal assessment the department of education gives us diagnostic analysis form to fill in the reason learners have failed and the kind of support that we need. What worries me, I never receive any help or support on that.

Participants expressed negative views on the support from external sources.

> Teachers A in the interview commented that” According to the Department of Education, IQMS is meant for developmental support but I never received any support on that and I think the concern is about the 1% increment on our salaries”.

Teacher B responded: “We receive workshops once at the beginning of the year where we are given program of assessment, work schedule and mark sheets”. This was also discussed by Teacher B who commented, “We need quality workshops on these new and if universities could design and develop the program to cover new sections on CAPS.” In the same way, Teacher E responded, “We need enough time for workshops on developing us on the areas we lack.” Therefore, it is imperative that this kind of teacher development serves the purpose to them (Kekana & Gaigher, 2018).

The findings of this study indicated that after enrolling with ACEML programme, teachers need follow-up support from both external and internal sources. Teacher A suggested:

> I think we should be provided with the follow up programs by the universities. We also need a support from the Department of Education to develop teachers on the areas we lack such as assessment strategies in ML.

However, ML teachers need support to refresh and restore their content knowledge (Hechter, 2011).

5.5 Implications of the study

The ACEML programme has had significant implications on the teachers, schools, universities and the Department of Education.

5.5.1 Implications of the study in relation to the teachers

The ML teachers concurred that by effectively finishing the ACEML programme it had added to their expert improvement. All the participants in this research guaranteed that they could encourage ML content in the unique context. Through their interest in the ACEML, the teachers found that they can work as a team. This is additionally confirmed by Teacher C who responded: "In the group, we used to direct learners cooperate and it is the place we motivate time to talk about zones we have to help each other on.” ML teachers felt certain that they could actualize the recently presented ML as they were satisfactorily prepared to teach it. This is found in the interview where

Teacher C commented, "In the wake of finishing my ACEML programme, I could execute this new learning zone". Through the ACEML program, teachers figured out how to locate another home, a subject with which they could distinguish. The greater part of them showed solid convictions in the subject and its significance, accepting new characters with the new ML, and relinquishing their past personalities with the previous subjects.

5.5.2 Implications of the study in relation to the subject ML

The findings of this study prove that after the ACEML program, ML teachers were able to differentiate between ML and Mathematics. 85% of the ML teachers disagreed with the statement that teachers believe that any teacher can teach ML without being enrolled to the programme. Teacher D supported this by stating, “I used to teach ML using Mathematics Knowledge but now I am clearer.”

5.5.3 Implications of the study in relation to the country

Mathematical Literacy was presented in South Africa as an obligatory school subject for all learners who are not doing Mathematics in grades 10 to 12 (Thembela, 2013). Most of ML teachers affirmed that they can withstand any debate arising about the subject ML. Inventive presentation methodologies can empower learners to connect Mathematics and measurements to reality and prepare learners to be specialists and problem solvers. As a developing asset economy, the restricted quantities of scientifically capable learners entering the workforce every year fails to meet the development of the country. Thus, the nation should enhance the learning results of Mathematics. To do this, Mathematics teaching and assessment practice must be enhanced (Umugiraneza and Bansilal, 2017). Learners are relied upon to apply their insights to obtain new observations and aptitudes and to apply scientific thinking to issues and have the ability to take part in the present and tomorrow's economy of the country.

5.6 Limitations of the study

Out of fifty questionnaires sent to the respondents only forty-one were returned. The study utilised purposive sampling where respondents were sourced from Umgungundlovu District only. This brought about the research obtaining participants from the same circuit in Umgungundlovu. In this manner, the researcher was constrained by the respondents’ accessibility and availability (Cohen et al., 2011). Another limitation of the study was it consisted of a questionnaire and semi-structured interviews. There were no classroom observations where the researcher could watch the ML teachers direct and confirm the degree to which the teachers' content knowledge, PCK and expert advancement had been progressed.

My position as a post level one teachers using colleagues as research participants may have influenced the manner in which they co-operated with me, and the manner in which some of the participants knew that I had also been enrolled with them in the ACEML programme. The data was self-reported, thus, it only revealed what teachers said about what they have learnt in the ACEML programme. Furthermore, as much as the teachers were asked to be honest when responding to the questionnaire and the interviews, the "Hawthorne effect" was not really guaranteed. The teachers could have modified their responses to give the researcher answers that they thought were expected and not exactly what they felt. The Hawthorne effect is defined by Shuttleworth (2009, p. 1) as "a process where human subjects of an experiment change their behaviour simply because they are being studied." Lastly, this study is based on the teachers' perceptions of the contribution of the ACEML programme to their professional development. Thus, exaggeration is possible to increase positive results and minimized the criticisms.

5.7 Recommendations

There must be in-service programmes intended for explicit needs by assessing the limitations the teachers have for compelling advancements, proficient improvement must be exceptional and continual.

It is prescribed that professional development courses should concentrate on helping teachers to expand their collection of teaching and appraisal procedures. Henceforth, to build up a sound comprehension of Mathematics and measurements with their learners, teachers need to constantly update their current teaching techniques and assessment.

Some of the methods of teachers' advancement such as once-off workshops are viewed as inadequate as they don't upgrade student execution. Nonetheless, it is prescribed that workshops can fill an alternate need for instance, the introduction of teachers in new strategies.

Teachers ought to be offered time to get together for vital participatory arranging and assessing exercises that are fundamental to the exercise of methodology. Preparation of pioneer teachers chosen from each area would then each be responsible for the expert advancement of different teachers in a little bunch of the schools.

Considering that there are no pre-service ML teacher preparation activities continually offered by the two HEIs in KZN, the circumstance is serious for sure. HEIs and the DoE need to earnestly cooperate to offer proficient advancement programs for reskilling teachers and to increase pre-service teacher programmes in ML. Updating teachers on content and setting is imperative to produce quality education for the learners at school.

English across the curriculum ought to remove any poor language aptitudes as an obstruction to learning as learners find it difficult to comprehend the questions in that unique context. The vast majority of the learners who accept English as their first additional language can't convey what needs to be. Subsequently, the arrangement is to teach ML learners in English.

5.8 Conclusion

The aim of the study was to explore the role of the Advanced Certificate in Education in Mathematical Literacy programme in developing teacher knowledge and professional development of mathematical literacy teachers in Umgungundlovu district.

In this research, the aim of the ACEML program in prolonging professionalism to ML teachers was indicated in in a number of ways. ML teachers also reported that by enrolling to the programme they see themselves as new teachers regarding their professionalism.

Teachers gave an account of their enhanced substance learning, on new content knowledge and on a few misguided judgments recently held that were revised through their participation in the ACML programme. ML teachers could execute the new subject effectively and with certainty after they had completed the programme. ML teachers felt that without participating in the programme, they would be still teaching ML using Mathematics knowledge or teach in anyway.

The ACEML programme gave teachers different methodologies that they could use in the classroom and they commented that their learners had made progress. ML teachers likewise detailed that they could distinguish learners' misguided judgments and their insights into their learners occurred. It is through their interest, that usage of such training techniques was resuscitated and viably linked in their learners' learning.

Through the ACEML programme, teachers could separate Mathematics and ML, a subject which they could recognise. The vast majority of them showed solid convictions in ML and its significance. In this way, expecting new characters with ML and surrendering their past personalities with the previous subject that they taught before. Most ML teachers affirmed that they could defend themselves on any discussions that would be criticising the implementation of the subject ML.

Teacher professional development is a progressing procedure all through the teaching profession every teacher. The program has given a critical upgrade to develop ML teachers. Also, their systems, expertise and confidence.

It is trusted that the results of this study will add to teachers' improvement and that this research will add to the working of a numerically proficient country. The ACEML programme was the initiator of professional development inside the post-politically-sanctioned racial segregation period in South Africa. It fills in as an improvement for an on-going arrangement of workshops and teacher development programmes that develop teacher content knowledge, educational abilities, and sponsors and reinforces the nature of teaching and learning in the country.

REFERENCES

Abreh, M. K. (2018). Heads of departments' perception of teachers' participation in continuous professional development programmes and its influence on science and mathematics teaching in Ghanaian secondary schools. *African Journal of Educational Studies in Mathematics and Sciences, 14*, 85-99.

Adler, P. S. (2002). Social capital: Prospects for a new concept. *Academy of management review, 27(1)*, 17-40.

Adler, J. (2000). Conceptualising resources as a theme for teacher education. Journal of Mathematics Teacher Education, 3(3), 205-224.Dreyer, L. M. (2017). Constraints to quality education and support for all: A Western Cape case. *South African Journal of Education, 37*(1). Constraints to quality education and support for all: A Western Cape case.

Adler, R. J., & Taylor, J. E. (2009). *Random fields and geometry*. Springer Science & Business Media.

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

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content Knowledge for Teaching What Makes It Special? *Journal of Teacher Education, 59*(5), 389-407.

Ball, D. L., Hill, H. C., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for research in mathematics education,* 372-400.

Ball, D. L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. *Multiple perspectives on the teaching and learning of mathematics, 4,* 83-104.

Bansilal, S. (2014). Exploring the notion of Mathematical Literacy teacher knowledge. *South African Journal of Higher Education, 28*(4), 1156-1172.

Bansilal, S. (2015). A Rasch analysis of a Grade 12 test written by mathematics teachers. *South African Journal of Science, 111*(5-6), 1-9.

Bansilal, S. 2012. Exploring success rates in a professional development programme for in-service teachers. Alternations 19(2): 236−256.

Bansilal, S. 2014. Exploring the notion of Mathematical Literacy teacher knowledge. *South African Journal of Higher Education, 28*(4): 1156–1172.

Bansilal, S., & Debba, R. (2012). The role of contextual attributes in a Mathematical Literacy assessment task. *African Journal of Research in Mathematics, Science and Technology Education*, *16*(3), 302-316.

Bansilal, S., & Rosenberg, T. (2011). South African rural teachers' reflections on their problems of practice: taking modest steps in professional development. *Mathematics Education Research Journal, 23*(2), 107-127.

Bansilal, S., Goba, B., Webb, L., James, A., & Khuzwayo, H. (2012). Tracing the impact: A case of a professional development programme in Mathematical Literacy. *Africa Education Review*, *9*(1), S106-S120.

Bansilal, S., Mkhwanazi, T.W. and Mahlabela, P. (2012). Mathematical literacy teachers' engagement with contextual tasks based on personal finance. *Perspectives in Education, 31*(3), 100–111.

Bansilal, S., Webb, L., & James, A. (2015). Teacher training for mathematical literacy: A case study taking the past into the future. *South African Journal of Education*, 35(1).

Bantwini B.D. (2010). How teachers perceive the new curriculum reform: Lessons from a school district in the Eastern Cape Province, South Africa. *International Journal of Educational Development, 30*(1):83–90.

Baumgartner, W. L., Spangenberg, E. D., & Jacobs, G. J. (2018). Contrasting motivation and learning strategies of ex-mathematics and ex-mathematical literacy students. *South African Journal of Higher Education, 32*(2), 8-26.

Bennie, J., & Hrysomallis, C. (2005). Resistance training considerations for the sport of squash. *Strength and Conditioning Journal, 27(3),* 30.

Bertram, A. R. (2010*). Enhancing science teachers' knowledge of practice by explicitly developing pedagogical content knowledge.* Doctoral dissertation, Monash University.

Botha, J. J. (2010). *Exploring Mathematical Literacy: The Relationship Between Teachers Knowledge and Beliefs and Their Instructional Practices*. Doctoral dissertation, University of Pretoria.

Brijlal, P. (2013). *An exploration of the contribution of the ACE in Mathematical Literacy programme towards the professional development of teachers in KwaZulu-Natal.* Unpublished M.Ed. dissertation: UKZN.

Christiansen, I. M. (2007). Mathematical literacy as a school subject: Mathematical gaze or livelihood gaze? *African Journal of Research in Mathematics, Science and Technology Education, 11*(1), 91-105.

Clark, R. (2012). *Maths vs. Maths literacy: the continuing debate.* Retrieved on 28 March 2012 from http://www.thoughtleader.co.za/readerblog/2012/01/09/maths-vs-maths literacy-the-continuing-debate.

Cohen, L., Manion, L., & Morrison, K. (2011). Research methods in education (7th ed.). London: Routledge.

Creswell, J. W. (2009). Mapping the field of mixed methods research.

Creswell, J. W. (2006). Research design: Qualitative, quantitative and mixed methods approaches (5th ed). Thousand Oaks, CA: Sage Publications.

Wilson, E., & Demetriou, H. (2007). New teacher learning: substantive knowledge and contextual factors*. The curriculum journal, 18(3),* 213-229.

Department of Basic Education. (2011). Curriculum and Assessment Policy Statement, Further Education and Training Phase grades 10-12, Mathematical Literacy. Pretoria.

Department of Basic Education. (2017). Curriculum and Assessment Policy Statement, Further Education and Training Phase grades 10-12, Mathematical Literacy. Pretoria.

Department of Education. (2003). National Curriculum Statement Grades 10-12 (General), Learning Programme Guidelines, Mathematics. Pretoria.

Department of Education. (2007). National Curriculum Statement Grades 10-12 (General), Learning Programme Guidelines, Mathematical Literacy. Pretoria.

du Preez, M. (2018). The factors influencing Mathematics students to choose teaching as a career. *South African Journal of Education*, *38*(2), 1-13.

Ennis, C. D. (1995). Teachers' value orientations in urban and rural school settings. *Research Quarterly for Exercise and Sport, 66(1),* 41-50.

George, A., & Adu, E. O. (2018). Motivation and attitude of grade nine learners towards mathematics in King Williams Town Education District, South Africa. *Ghana Journal of Development Studies*, 15(1), 135-150.

Goba, B., James, A., Bansilal, S., Webb, L., & Khuzwayo, H. (2011). A case study of a teacher professional development programme for rural teachers.

Graven, T., & Venkat, H. (2010). Exploring the nature and coherence of mathematical work in South African Mathematical Literacy classrooms. Research in Mathematics Education, 12(1), 53-68.

Graven, M. (2003). Communities of practice: Learning, meaning and identity. *Journal of Mathematics Teacher Education*, *6(2),* 185-194.

Guskey, T. R. (2002). Professional Development and teacher change, teachers and teaching: Theory and practice. Journal of Education, 8(3), 381–391. https://doi.org/10.1080/135406002100000512.

Halim, L., Meerah, T. S. M., & Buang, N. A. (2010). Guiding student teachers to be reflective. *Procedia-Social and Behavioural Sciences, 18,* 544-550.

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for research in mathematics education,* 372-400.

James, A., Bansilal, S., & Webb, L. (2015). Teacher training for mathematical literacy: A case study taking the past into the future. *South African Journal of Education, 35*(1).

James, A., Bansilal, S., Webb, L., Goba, B., & Khuzwayo, H. (2015). Teacher professional development programmes in MST for developing contexts. *Africa Education Review, 12*(2), 145-160.

Jansen, J. (2012). Sinking deeper into mediocrity. The Times, 23 February: p.15.

Jaworski, B., & Wood, T. L. (Eds.). (2008*). The mathematics teacher educator as a developing professional.* Rotterdam: Sense Publishers.

Johnson, S., Hodges, M., & Monk, M. (2000). Teacher Development and Change in South Africa: A critique of the appropriateness of transfer of northern/western practice. Compare: *A Journal of Comparative and International Education*, 30(2), 179-192.

Kekana, M., & Gaigher, E. (2018). Understanding Science Teachers' Classroom Practice after Completing a Professional-development Programme: A Case Study. *EURASIA Journal of Mathematics, Science and Technology Education, 14, 8.*

Kelly, P. (2006). What Is Teacher Learning? A Socio-Cultural Perspective. Oxford Review of Education, *32*(4), 505-519.

Kriek, J., & Grayson, D. (2009). A holistic professional development model for South African physical science teachers. *South African journal of education*, *29*(2).

Lieberman, P. (2009). *Human language and our reptilian brain*: *The subcortical bases of speech, syntax, and thought.* Harvard University Press.

Long, M. H., & Larsen-Freeman, D. (2014). An Introduction to Second Language Acquisition Research.

Maclellan, E. (2004). Initial knowledge states about assessment: Novice teachers' conceptualisations. *Teaching and Teacher Education*, *20*(5), 523-535.

Maddock, L., & Maroon, W. (2018). Exploring the present state of South African education: Challenges and recommendations. *South African Journal of Higher Education*, *32*(2), 192-214.

Maree, K. (Ed.). (2012). First steps in research. Pretoria: Van Schaik.

Maree, K. (2007). First steps in research. Van Schaik Publishers.

Mbekwa, M. (2007). An exploratory study into the introduction of Mathematical Literacy in selected Cape Peninsula High Schools. Pythagoras, 1, 220-232.Mkhize, N. (1999). Becoming a person in an impersonal world. Children First. Issue.

Mkhize, V. (1999). Transformation management and cultural diversity training through employee assistance programs. *Employee Assistance Quarterly, 14(3)*, 61-69.

Mkhwanazi, T. W., & Bansilal, S. (2014). Mathematical literacy teachers' engagement with contextualised income tax calculations. *Pythagoras*, *35*(2), 1-10.

Mkhwanazi, T., & Bansilal, S. (2012). Mathematical literacy teachers' engagement with contextual tasks based on personal finance. *Perspectives in Education*, *30*(3), 98-109.

Mohamed, Z., & Sulaiman, S. (2010). Systematic steps in teaching and learning Islamic education in the classroom. *Procedia-Social and Behavioural Sciences, 7,* 665-670.

Moodaley, V. (2013). VAT registration amendments: technical. *TAXtalk*, *2014*(46), 42-43.

Mushayika, E. and Lubben, F. (2009). Self-directed professional development: *Hope for teachers working in deprived environments? Teaching and Teacher Education*, *25* (2009), 375-384.

Molapo, M. R., & Pillay, V. (2018). Politicising curriculum implementation: The case of primary schools. *South African journal of education, 38*(1).

Nel, B. (2012). Transformation of teacher identity through a Mathematical Literacy re-skilling programme. *South African Journal of Education*, *32*(2).

Nkambule, G., & Amsterdam, C. (2018). The realities of educator support in a South African school district. *South African Journal of Education, 38*(1).

North, M. (2017). In pursuit of an orientation for life-preparation: a case study of the subject mathematical literacy in South African. *African Journal of Research in Mathematics, Science and Technology Education*, 21(3), 234-244.

North, M. (2010). How mathematically literate are the matriculants of 2008? A critical analysis of the 2008 Grade 12 mathematical literacy examinations. Conference Paper: AMESA 2010.

Parker, D. (2004). Mathematics and mathematics teaching in South Africa: challenges for the university and the provincial Department of Education. In R. Balfour, T. Buthelezi & C. Mitchell (Eds.), Teacher development at the centre of change (pp. 119-135). Durban: KZNDE Teacher Development Directorate & Faculty of Education, University of KwaZulu Natal.

Peacock, A., & Rawson, B. (2001). Helping teachers to develop competence criteria for evaluating their professional development, *International Journal of Educational Development, 21* (2): 79-92.

Pillay, A. (2017). How teachers of English in South African schools recognise their change agency. *South African Journal of Education, 37*(3).

Potari, D. (2017). Current research on prospective secondary mathematics teachers' knowledge. In The mathematics education of prospective secondary teachers around the world (pp. 3-15). Springer, Cham.

Ramrathan, L. (2017). Learner poor performance: provoking Bourdieu's key concepts in analysing school education in South Africa. *Southern African Review of Education with Education with Production*, *23*(1), 23-36.

Reeves, C., & Robinson, M., (2010). Am I qualified to teach? The implications of a changing school system for criteria for teacher qualifications. *Journal of Education, 50,* 7–33.

Robinson, M. (2002). Teacher reforms in South Africa: Challenges, strategies and debates. Prospects 11, (3), 289–99.

Rule, P., & John, V. (2011). *Your guide to case study research*. Pretoria: van Schaik.

Shulman, L. S. (1996). Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*,(2), 4–14.

Shulman, L. S. (1997). Disciplines of inquiry in education: An overview. In Richard M. Jaeger (Ed.). Complementary methods for researchers in education. Washington, D.C.: American Education Research Association, 3-19.

Shuttleworth, M. (2009). Research bias. *Retrieved February*, 18, 2012.

Sidiropolous, H. (2008). The implementation of a mandatory mathematics curriculum in South Africa: The case of mathematical literacy. Pretoria: Dissertation for the degree of Philosophiae Docter. University of Pretoria.

Sullivan, W. M. (2008). A new agenda for higher education*: Shaping a life of the mind for practice (Vol. 14).* John Wiley & Sons.

Taylor, N. (2008). What's wrong with our schools and how can we fix them? Paper presented at the CSR in Education Conference, TSiBA Education.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences.* Sage.

Thembela, T. E. (2013). *An exploration of the role of the Advanced Certificate in Education on the professional development of Mathematical Literacy teachers*. Unpublished M.Ed. dissertation, Durban: UKZN.

Umugiraneza, O., Bansilal, S., & North, D. (2017). Exploring teachers' practices in teaching Mathematics and Statistics in KwaZulu-Natal schools. *South African Journal of Education, 37*(2). University Press, New York

Van der Nest, A., Long, C., & Engelbrecht, J. (2018). The impact of formative assessment activities on the development of teacher agency in mathematics teachers. *South African Journal of Education*, 38(1).

Van Driel, J. H., Verloop, N., & De Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *35*(6), 673-695.

Venkat, H. & Graven, M. (2010). Opening up spaces for learning: *learners' perceptions of mathematical literacy in grade 10. Education As Change*, *12*(1), 29-44.

Venkat, H., Graven, M., Lampen, E. & Nalube, P. (2009). Critiquing the Mathematical Literacy assessment taxonomy: *Where is the reasoning and the problem solving? Pythagoras, 70*, 43-56.

Vilakazi, A.S. (2010). An exploration of Mathematical Literacy teachers‟ perceptions of, and performance in Mathematical Literacy tasks based on Algebra, a dissertation submitted for the degree of Master of Education, University of KwaZulu-Natal.

Webb, L., Bansilal, S., James, A., Khuzwayo, H., & Goba, B. (2011). An Investigation into the design of Advanced Certificates in Education on Mathematical Literacy teachers in KwaZulu-Natal.

Wenger, E. (1998). Communities of Practice. Learning, Meaning and Identity. Cambridge: Cambridge University Press.

Zaslavsky, O. R. I. T. (2008). Meeting the challenges of mathematics teacher education through design and use of tasks that facilitate teacher learning. *The mathematics teacher educator as a developing professional*, *4*, 93-114

APPENDIX A: MATHEMATICAL LITERACY QUESTIONNAIRE

ACE - Mathematical Literacy Questionnaire

Dear Participant

Thank you in advance for your participation in this survey and completing this questionnaire. Please answer the questions below as honestly as you can, in order to assist us consider arguments in support of teacher professional development through the ACE Mathematical Literacy programme. This questionnaire consists of 6 pages and 20 questions that are divided into FOUR sections.

Section A: About yourself

1. Complete the table by providing your teaching experience in the last few years:

Subject (s)	Grade (s)	Period
Maths	10, 11 & 12	1990 - 2006

2. Please make a cross [X] next to your current post level. Also make a cross next to your qualification(s) you had prior to enrolling for the ACEML programme: [You may tick more than one where applicable].

Current Post level	Three-year Teaching Diploma
Post level 1	Post-Graduate Teaching Diploma
Post level 2	Bachelors' Degree
Post level 3	Honours' Degree
Post level 4	Masters' Degree
Other: (Specify)	
....	Other: (Specify)

....

3. What are your reasons for enrolling in the ACEML?

From the options below, make a cross (X) next to the one that suits you most:

You were "underqualified" and the ACEML would allow you to upgrade your REQV qualification level.

You were qualified to teach another subject and the ACEML would RETRAIN you to teach ML.

You just wanted to refresh your Mathematical Literacy knowledge.

When the offer came, you were the only teacher in your school who could be persuaded to go and enrol.

You could not refuse because the school management selected you to go and enrol, giving you no alternate options.

Other (Specify)

....

....

4. Are you currently teaching ML? (Y / N) ....

4.1. If not, what is your reason for not teaching ML?

____

____

Section B: Impressions of the programme

Using the following scale 1 – 5 below, please indicate by circling the most correct response, the degree to which you agree with the statements listed below:

STRONGLY DISAGREE 1

DISAGREE 2

NEUTRAL 3

AGREE 4

STRONGLY AGREE 5

5. I found that the tutors in the programme:

5.1.	Knew the content very well	1 2 3 4 5
5.2.	Were able to explain the content well	1 2 3 4 5
5.3.	Were always well prepared	1 2 3 4 5
5.4.	Were considerate and empathetic to our situation	1 2 3 4 5
5.5.	Treated us as adults and colleagues	1 2 3 4 5

Any other comment: ____

6. As a result of my participation in the ACEML programme:

6.1.	My content knowledge has improved	1 2 3 4 5
6.2.	My teaching strategies have improved	1 2 3 4 5
6.3.	My assessment skills have improved	1 2 3 4 5
6.4.	My confidence as an ML teacher has increased	1 2 3 4 5
6.5.	The ML results of my learners have improved	1 2 3 4 5

Any other comment: ____

7. I found that my studies were made easier because:

7.1. The materials (guides) were readable, clear and useful 1 2 3 4 5

7.2. The tutors were supportive 1 2 3 4 5

7.3. The tutors were knowledgeable 1 2 3 4 5

7.4. There was a good link between what we learnt in the sessions and what we were assessed on 1 2 3 4 5

7.5. The other students in my class were supportive and helpful 1 2 3 4 5

Any other comment:
____

8. My studies were made easier because:

8.1. I had a supportive family network 1 2 3 4 5

8.2. I had support from my school management and colleagues 1 2 3 4 5

8.3. I found the contact sessions to be well paced and not too intensive 1 2 3 4 5

8.4. I had sufficient time to study 1 2 3 4 5

8.5. The centre is not very far away from me. 1 2 3 4 5

Any other comment:____.

9. The ACEML programme has a large dropout rate. Some reasons for this could be that students:

9.1. Do not have a supportive family network. 1 2 3 4 5

9.2. Do not have support from their school management and colleagues. 1 2 3 4 5

9.3. Find contact sessions to be too intensive and poorly paced. 1 2 3 4 5

9.4. Do not have sufficient time to study. 1 2 3 4 5

9.5. Have to travel far to the centres. 1 2 3 4 5

Any other comment: ____.

10. Have you ever considered dropping out of the programme? (Yes/No) ....

11. Briefly describe what stopped you from dropping out:

....
....
....
....

12.1. Which module(s) would you describe as most useful to you?

....
....
....
....

12.2. Which module(s) would you describe as least useful to you?

....
....
....
....

13. From each, some or all of your modules, write down anything you remember which you think has made a huge difference in your teaching and learning of ML.

....
....
....
....

Section C: Content in Mathematical Literacy

14. Has there ever been a time in your teaching of ML, where you felt uncomfortable with the teaching of any section / topic / concept that you were supposed to teach? (Elaborate on your response).

....
....
....
....
....

15. Which of the three Grades (Grade 10, 11 or 12) do you prefer to teach? Does your choice have anything to do with your confidence?

....
....
....

16. In the table below, rate the four ML Learning Outcomes from 1 to 4, where 1 is the least preferred and 4 is the most preferred, by placing numbers 1 - 4 in the relevant boxes:

LO 1: Number and Operations in Mathematical Literacy

LO 2: Functional Relationships in Mathematical Literacy

LO 3: Space, Shape and Measurement in Mathematical Literacy

LO 4: Data Handling in Mathematical Literacy

17. What are some of your reasons for rating the Learning Outcome that you have rated fourth.

....
....
....
....
....

18. After completing your ACEML, have you ever taught Grade 12 ML? (Yes / No) ....

19. Whether you have responded with a YES or a NO in the above question, briefly explain whether the situation you are in was voluntary or was imposed upon you by any circumstances.

....
....
....
....

Section D: General

20. Here are a series of statements. Indicate your level of agreement or disagreement with each one by making a circle around one number.

20.1. For you, any Mathematics teacher can confidently teach ML without having studied in the ACEML programme. 1 2 3 4 5

20.2. Your subject matter knowledge in ML was adequate even before you enrolled for the ACEML programme. 1 2 3 4 5

20.3. The ACEML programme has improved your subject matter knowledge (i.e. concepts and applications) through your studies. 1 2 3 4 5

20.4. The ACEML programme could have been replaced by two to three weeks' Departmental workshops. 1 2 3 4 5

20.5. The ACEML programme has introduced you to new teaching strategies that you have been able to use in your classroom teaching. 1 2 3 4 5

20.6. A formal ACEML qualification is not necessary for one to teach ML if one has some background in Grade 12 Mathematics. 1 2 3 4 5

20.7. You feel more confident in a ML class than you would have been if you had not studied the ACEML programme. 1 2 3 4 5

20.8. You can participate in any ML-related debate with confidence with peer educators as a result of studying in the ACEML programme. 1 2 3 4 5

20.9. You understand most Government policies in Education better after enrolling in the ACEML programme. 1 2 3 4 5

20.10. You can confidently defend the introduction of ML in the FET to any of those people who still criticise the introduction of the subject, after studying the ACEML. 1 2 3 4 5

20.11. You see yourself as belonging to a group of professionals after studying the ACEML. 1 2 3 4 5

20.12. Now that you have completed the ACEML programme, you really feel that you would not have been able to teach the subject effectively had you not enrolled for the ACEML programme. 1 2 3 4 5

20.13. You would recommend to any ML teacher that they should study in this programme. 1 2 3 4 5

20.14. You would not be ashamed and would instead prefer to be referred to as an "ML teacher" after studying the ACEML programme. 1 2 3 4 5

20.15. You would agree if someone were to say that your content knowledge of ML was limited before you studied the ACEML. 1 2 3 4 5

Thank you for your participation in the study

APPENDIX B: INTERVIEW SCHEDULE

QUESTIONS:

1. Which grade and subject are you currently teaching?

2. What is your mathematics literacy teaching experience?

3. What was the reason for you studying the ACE? What was the motive behind?

4. Were you involved in teaching ML before you enrolled in the programme? If yes, what were the challenges of teaching ML prior to training?

5. How do you view yourself in terms of development and effective teaching before or after training?

6. Among the ML modules which one do you think was useful in contributing to successful professional development?

7. Do you think the content of ML is relevant to the department of education's needs or expectations?

8. How would you rate learners' performance with regards to ML after enrolling with the programme?

9. Comment on the short falls of the programme that could have been included in the programme to enhance your professional development.

10. If you were the minister of education what would you do to develop teachers in ML?

APPENDIX C: INFORMED CONSENT FORM

Dear Participant

REQUEST FOR PARTICIPATION IN RESEARCH PROJECT

My name is Thandazile Annamaria Mkhize (Student Number: 984212090 a Master of Education (MEd) student in the School of Education at the University of KwaZulu-Natal (Pietermaritzburg campus). As part of the requirement for this degree, I am required to conducting a research project. I request your assistance in this research project and request your participation in this research study. The title of my study is: "Exploring the role of the Advanced Certificate in Education Mathematical Literacy Programme in developing teacher knowledge of Mathematical Literacy teachers in Umgungundlovu District".

The aim and purpose of this research study is to explore the role of the Advanced Certificate in Education Mathematical Literacy Programme in developing teacher knowledge of Mathematical Literacy teachers in Umgungundlovu District. As a participant, you will be required to complete questionnaires and participate in semi- structured interviews that are expected to last between 30 to 40 minutes at a time suitable to you which will not disturb teaching and learning. Follow-up interviews may be conducted if necessary. Each interview will be voice-recorded. The duration of your participation if you choose to participate and remain in the study is expected to be 4-6 weeks.

This study will not involve any risks and/or discomfort to participants. Also, the study will not provide direct benefits for participants.

In the event of any problems or concerns/questions you may contact me, my supervisor or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

My contact number

Email: mkhizethandazile72@gmail.com Cell: 0762267077

Supervisor

My supervisor is Dr J. Naidoo who is located at the School of Education, Pietermaritzburg campus of University of KwaZulu-Natal.

Telephone 033 260 5867, Email address: naidooj@ukzn.ac.za

UKZN Research Office

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Participation in this research study is voluntary and participants may withdraw participation at any point. In the event of refusal/withdrawal of participation participants will not be penalised. There are no consequences for participants if they withdraw from the study.

No costs will be incurred by participants as a result of participation in the study and there are no incentives or reimbursements for participation in the study.

All names of schools and participants will be changed and pseudonyms will be used so that schools and participants remain anonymous. Information provided by participants will remain confidential and will not be shared with anyone else. Data generated through questionnaires and semi-structured interviews will be stored in my supervisor's office, at the School of Education, Pietermaritzburg campus for five years, and thereafter be destroyed.

Thank you for your cooperation.

Yours in Education

Ms. Thandazile Mkhize

DECLARATION OF CONSENT

I, ____ (Name of participant) have been informed about the study entitled: "Exploring the role of the Advanced Certificate in Education Mathematical Literacy Programme in developing teacher knowledge of Mathematical Literacy teachers in Umgungundlovu District" by Ms. Thandazile Annamaria Mkhize.

I understand the purpose and procedures of the study.

I have been given an opportunity to ask questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at mkhizethandazile72@gmail.com or Cell: 0762267077.

If I have any questions or concerns about my rights as a participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Additional consent, where applicable

I hereby provide consent to: (Please circle response)

Audio-record my semi-structured interview	YES / NO
Complete questionnaires	YES / NO

______________________ ______________________

Signature of Participant **Date**

APPENDIX D: LETTER TO PRINCIPALS

University of KwaZulu-Natal
School of Education
Telephone: +27 (0) 33 260 6189
Facsimile: +27 (0) 33 260 5900

Letter to School Principal

Dear Sir/Madam

My name is Thandazile Annamaria Mkhize (Student Number: 984212090) a Master of Education (MEd) student in the School of Education at the University of KwaZulu-Natal (Pietermaritzburg campus). As part of the requirement for this degree, I am required to conducting a research project. I request your assistance in this research project and request your participation in this research study. The title of my study is: "Exploring the role of the Advanced Certificate in Education Mathematical Literacy Programme in developing teacher knowledge of Mathematical Literacy teachers in Umgungundlovu District".

The aim and purpose of this research study is to explore the role of the Advanced Certificate in Education Mathematical Literacy Programme in developing teacher knowledge of Mathematical Literacy teachers in Umgungundlovu District. I request your assistance in this research project by being granted permission to conduct my study with a teacher at your school. Participants will be required to complete questionnaires and participate in semi- structured interviews that are expected to last between 30 to 40 minutes, which will not disturb teaching and learning. Follow-up interviews may be conducted if necessary. Each interview will be voice-recorded. The duration of their participation if they choose to participate and remain in the study is expected to be 4-6 weeks.

This study will not involve any risks and/or discomfort for the school and participants. Also, the study will not provide direct benefits for the school or participants.

In the event of any problems or concerns/questions you may contact me, my supervisor or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

My contact details

Ms. T.A. Mkhize

Email: mkhizethandazile72@gmail.com Cell: 0762267077

Supervisor

Dr J. Naidoo (School of Education, Pietermaritzburg campus of University of KwaZulu-Natal)

Telephone 033 260 5867, Email address: naidooj@ukzn.ac.za

UKZN Research Office

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000 KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Participation in this research study is voluntary and participants may withdraw participation at any point. In the event of refusal/withdrawal of participation the participants will not be penalised. There are no consequences for participants who withdraw from the study.

No costs will be incurred by participants as a result of participation in the study and there are no incentives or reimbursements for participation in the study.

All names of schools and participants will be changed and pseudonyms will be used so that schools and participants remain anonymous. Information provided by participants will remain confidential and will not be shared with anyone else. Data generated through questionnaires and semi-structured interviews will be stored in my supervisor's office, at the School of Education, Pietermaritzburg campus for five years, and thereafter be destroyed.

Thank you for your cooperation.

Yours in Education

Ms. Thandazile Mkhize

DECLARATION OF CONSENT

I____ (Full names of the school principal) have been informed about the study entitled: "Exploring the role of the Advanced Certificate in Education Mathematical Literacy Programme in developing teacher knowledge of Mathematical Literacy teachers in Umgungundlovu District" by Ms. Thandazile Annamaria Mkhize .

I understand the purpose and procedures of the study.

________________________ __________

SIGNATURE OF PRINCIPAL DATE

APPENDIX E: ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

27 August 2013

Mrs Thandazile Annamaria Mkhize 984212090
School of Education
Pietermaritzburg Campus

Protocol reference number: HSS/0686/013M
Project title: An exploration of the role of Advanced Certificate in Education in Mathematical Literacy programme in developing teacher knowledge of mathematical literacy teachers in Umgungundlovu district.

Dear Mrs Mkhize

Full Approval – Expedited

This letter serves to notify you that your application in connection with the above **has** now been granted full approval.

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach/Methods must be reviewed and approved through an amendment /modification prior to its implementation. Please quote the above reference number for all queries relating to this study. Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

Best wishes for the successful completion of your research protocol.

Yours faithfully

....
Dr Shenuka Singh (Acting Chair)

/px

cc Supervisor: J Naidoo
cc Co-supervisor: Dr S Bansilal
cc Academic Leader Research: Dr MN Davids
cc School Administrator: Ms B Bhengu and Mr T Mthembu

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Acting Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 3587/8350/4557 **Facsimile:** +27 (0)31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukn.ac.za
Website: www.ukzn.ac.za

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

INSPIRING GREATNESS

APPENDIX F: GATE KEEPER PERMISSION LETTER

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Sibusiso Alwar Tel: 033 341 8610 Ref.:2/4/8/443

Mrs Thandazile Annamaria Mkhize
P. O. Box 05
Glenside
3247

Dear Mrs Mkhize

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct a pilot and research entitled: **An Exploration of the Advanced Certificate in Education in Mathematical Literacy Programme in Developing Teacher Knowledge of Mathematical Literacy Teachers in Umgungundlovu District**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 01 July 2013 to 31 July 2015.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Mr. Alwar at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Director-Resources Planning, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to Educators in the Umgungundlovu District of the KwaZulu Natal Department of Education:

Nkosinathi S.P. Sishi, PhD
Head of Department: Education
22 July 2013

KWAZULU-NATAL DEPARTMENT OF EDUCATION
POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa
PHYSICAL: Office G25, 188 Pietermaritz Street, Pietermaritzburg, 3201. Tel. 033 3418610 Fax : 033 341 8612
EMAIL ADDRESS: sibusiso.alwar@kzndoe.gov.za; CALL CENTRE: 0860 596 363;
WEBSITE: www.kzneducation.gov.za

...dedicated to service and performance
beyond the call of duty

APPENDIX G: CERTIFICATE FROM LANGUAGE EDITOR

Proofwrite Solutions

WRITE - EDIT - RESEARCH - DESIGN

28th of April 2019

To whom it may concern

EDITING OF DISSERTATION FOR MRS THANDAZILE ANNAMARIA MKHIZE

I have a master's degree in Social Science, Research Psychology and a TEFL qualification from UKZN. I also have an undergraduate and honour's degree Bachelor of Arts in Health Sciences and Social Services from UNISA.

I have 15 years of teaching experience and have been editing academic theses for students from UKZN, UNISA, the University of Fort Hare, and DUT for the past seven years. I have further done editing, transcribing and other research work for private individuals and businesses.

I hereby confirm that I have edited Thandazile Annamaria Mkhize's dissertation titled **"AN EXPLORATION OF THE ROLE OF THE ADVANCED CERTIFICATE IN EDUCATION MATHEMATICAL LITERACY PROGRAMME IN DEVELOPING PROFESSIONAL DEVELOPMENT OF MATHEMATICAL LITERACY TEACHERS IN UMGUNGUNDLOVU DISTRICT"** for submission of her master's dissertation in education at the University of Kwa-Zulu-Natal. Corrections were made in respect of grammar, tenses, spelling and language usage using track changes in MS Word 2010. Once corrections have been attended to, the dissertation should be correct.

PLEASE NOTE: Should the student add content to their dissertation after my editing and suggested corrections, I cannot in anyway guarantee their work is correct in respect of grammar, tenses, spelling and language usage.

Yours sincerely

Shuttleworth

Terry Shuttleworth (Tefl, UKZN, MSocSc, Res Psych, UKZN).

APPENDIX H: TURNITIN ORIGINALITY REPORT

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Thandazile Annamaria
Assignment title:	Postgrad chapters
Submission title:	An exploration of the role of the A...
File name:	EDITED_FINAL_STUDY.docx
File size:	701.19K
Page count:	106
Word count:	35,042
Character count:	187,447
Submission date:	24-Apr-2019 07:58PM (UTC+0200)
Submission ID:	1078852922


CHAPTER 1

1.1 INTRODUCTION

1.2 BACKGROUND TO THE STUDY

An exploration of the role of the ACEML programme in developing professional development of ML teachers in Umgungundlovu district.

ORIGINALITY REPORT

9%	6%	3%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	James, Angela, Sarah Bansilal, Lyn Webb, Busisiwe Goba, and Herbert Khuzwayo. "Teacher professional development programmes in MST for developing contexts", Africa Education Review, 2015. Publication	1%
2	Submitted to University of KwaZulu-Natal Student Paper	1%
3	www.pythagoras.org.za Internet Source	<1%
4	researchspace.ukzn.ac.za Internet Source	<1%
5	files.eric.ed.gov Internet Source	<1%
6	sajournalofeducation.co.za Internet Source	<1%
7	uir.unisa.ac.za	