AN EXPLORATION OF THE CONTRIBUTIONS OF THE ADVANCED CERTIFICATE IN EDUCATION IN MATHEMATICAL LITERACY PROGRAMME TOWARDS THE PROFESSIONAL DEVELOPMENT OF TEACHERS IN KWAZULU-NATAL.

By

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A Dissertation submitted to the School of Education, University of KwaZulu-Natal, in fulfilment of the requirements for the degree of Master of Education (Mathematics Education).

Supervisor: Professor Sarah Bansilal

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DECLARATION

I, Priscilla Brijlal, declare that the research reported in this dissertation is my original work submitted in fulfilment of the requirements for the degree of Master of Education (Mathematics Education)

This dissertation has not been submitted for any degree or examination at any tertiary institution/university.

Where use has been made of the work of other people, such work has been duly acknowledged in the text and referenced

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ABSTRACT

This study explores some of the contributions made by the Advanced Certificate of Education in Mathematical Literacy (ACEML) program towards the participating teachers' professional development. The teachers' professional development was explored by looking at the development of content knowledge, pedagogical content knowledge, the changes in their beliefs and identity and the attainment of self- confidence. The study uses a mixed method approach where data was collected by means of a questionnaire using a survey of thirty one teachers. Six of the teachers from this sample were then interviewed. An analysis of the questionnaires and the interviews was done together with some of the tasks done by the participants. This entailed using at first a quantitative analysis and then a qualitative analysis.

The findings revealed that the teachers had learnt new content knowledge since mathematical literacy was a new subject. Many of the teachers also felt that they had improved on their existing knowledge by using context to make them real life problems. The teachers reported that they gained pedagogic content knowledge and confidence both in and out of the classroom and saw themselves participating as a professionals. The beliefs of the teachers in Mathematical Literacy (ML) changed as they identified with the content and the pedagogic content knowledge of ML. They experienced learning through their tutors, peers and resource materials. Since mathematical literacy was a new subject with a discipline requiring different pedagogical content knowledge from the subjects that they previously taught. The teachers explained that the program also assisted them in becoming reflective teachers. Completion of the qualification opened up access to membership of professional bodies such as AMESA which is a mathematics educator organisation, as well as opportunities for promotion as leaders and senior officials in the department of education. The results also has implications for the teacher, department of education and the universities. An ongoing teacher development is necessary to maintain a high standard of professionalism.

PREFACE

This dissertation comprises of the field work carried out at the Nelson Mandela Metropolitan University and the Universityof KwaZulu-Natal, and the dissertation studied and written through the School of Education, University of KwaZulu-Natal, from **January 2011 to December 2013** under the supervision of **Professor Sarah Bansilal** (Supervisor)

This study represents an authentic and original study by the author and has not been submitted in any form for any degree or diploma to any tertiary institution. Any use of information that has been used from other sources and work of other authors has been duly acknowledged in the text.

Priscilla Brijlal

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Acronyms

ACEML - Advance Certificate in Education in Mathematical Literacy

ACE - Advance Certificate in Education

AMESA - Association for Mathematics Educators of South Africa

CCK - Common Content Knowledge

DoE - Department of Education

DoBE - Department of Basic Education

EMS - Economic and Management Sciences

INSET - In-service Education and Training Project

KCS - Knowledge of Content and Students

KCT - Knowledge of Content and Teaching

KZN - Province of KwaZulu-Natal

LO - Learning Outcomes

LPG - Learning Programme Guidelines

ML - Mathematical Literacy

NMMU - Nelson Mandela Metropolitan University

PCK - Pedagogic Content Knowledge

PLESME -Program for leader Educators in Senior Phase Mathematics Education

SCK - Specific Content Knowledge

SMK - Subject Matter Knowledge

UKZN - University of KwaZulu-Natal

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- Thanks to God for giving me the strength and courage to complete this study

DEDICATION

To my loving husband, Rogers, I thank you for your love, patience, dedication, limitless support and motivation that you have given me over the years. You have been an integral part of my success and I am eternally grateful to you for your sacrifices.

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CHAPTER ONE

OVERVIEW AND FOCUS OF THE STUDY

1.1 Introduction and the Background to the Study

South Africa saw an emergence of a new curriculum in 1988, the outcomes-based education known as, Curriculum 2005. According to the Department of Education (DoE), outcomes-based education, "when practised well, allows all learners, irrespective of their background, abilities or personality, the space for, reasoning and critical thinking, problem solving, retrieval, understanding and use of information, relating learning to existing knowledge and experience, thoughtful reflection on experience. (DoE, 2006, p.26)

This significant change heralded various other changes over a period of time and in 2006 Mathematical Literacy (ML) was introduced. Mathematical Literacy (ML) was very different from Mathematics. This subject was introduced at the grade 10 level in 2006, and was compulsory for a learner who did not study mathematics in order to ensure that their numerical literacy levels are enhanced and prepare them for the real world. The reality was that the subject was taken mainly by the weaker learner with low mathematics marks in Grade 9.

ML is seen as a subject driven by "life related applications of mathematics." (DoE, 2003, p.9).There were global concerns about the low levels of mathematical literacy in all spheres of life especially in the workplace. Previously mathematics was offered on the higher grade or standard grade and was not a compulsory subject. So many learners opted not to study mathematics since they considered it to be difficult subject. The mathematics that was studied was more of an abstract nature. Hence school leavers were inadequately prepared and lacked "fundamental numerical and spatial skills with understanding," (DoE, 2008, p.7) for the workplace. The education department introduced ML at the grade ten, eleven and twelve levels of the National Senior Certificate (NSC), especially for the learners who had no intention of studying mathematics, providing them with an alternative and an opportunity to develop numerical and spatial skills and make them more competent in the workplace.

According to the NSC for Mathematical Literacy (DoE, 2003, p.9):

> Mathematical Literacy provides learners with an awareness and understanding of the role that Mathematics plays in the world. ML is a subject driven by life-related applications of Mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse and solve problems.

The above definition emphasises that ML competence involves the ability to understand, judge, do and use mathematics in a variety of intra and extra mathematical contexts. Consequently ML as a school subject can be seen as shaping and maintaining democracy by equipping the individual with the prerequisites needed to involve themselves in the issues of immediate societal significance. Bowie and Frith (2006) indicated that the above definition specifies three elements of ML, namely the content, the contexts and the abilities and behaviours that a mathematically literate person displays.

The main aims of the ML school curriculum were to broaden the education of the teacher and the learner by making them 'self-managing', 'contributing workers' and 'participating citizens.' (DoE, 2005, p.7).

According to Bansilal and Debba (2011)

> "…contexts in ML demand a greater real life authenticity because of its emphasis as a subject driven by life-related applications of mathematics. So the purpose is for learners to use mathematics in order to make informed decisions in everyday life." (Bansilal and Debba, 2011, p.1)

The evolution of a new democratic South Africa in 1994 led to major changes in education – which were intended to eradicate the imbalances of the past due to racial inequality and apartheid. The apartheid policies were clearly evident in the training of mathematics educators. In the past mathematics teachers were trained in separate colleges or universities according to their race. The majority of the teachers in South Africa belong to the disadvantaged community. The Colleges they attended were poorly resourced and equipped since money was allocated according to race, hence the system was "ineffective in the provision of quality teacher education." (Adler, 2000, p.103). With the new curriculum, mathematics teachers were involved in the process of the development of the curriculum, which was a change from the past practices. Previously teachers were considered as "knowledge users and mere technicians implementing someone else's ideas." (Adler, 2000, p.94).

The National Teachers Education Audit of 1995 and the survey of the Mathematics and Science Teachers of 1997 found that there was a lack of professionalism in most teacher educational institutions, especially in previously disadvantaged colleges of education. (Mkhize, 1999). A contrast in teacher qualification can be observed, with those being advantaged having a degree in mathematics while the disadvantaged left college with just a 3 year diploma.

With the introduction of ML, there was a need to train teachers to teach the subject, since there were no trained ML teachers who could teach this new subject. (Goba, James, Bansilal, Webb & Khuzwayo, 2011). Teachers were drawn from a variety of subjects, especially from the 'scarce' subjects, for example, Afrikaans and History. Teachers had be trained with the subject matter as well as the skills of teaching the new subject, because unlike Mathematics, it was context driven. The DoE arranged training for the teachers in the different districts for a week where the aims and objectives of the curriculum were merely cascaded upon the teachers and insufficient time was spent on the content and the pedagogic content knowledge. Hence this week proved to be inadequate in terms of any professional development taking place. 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 a group of academics, namely Chisholm, Volmink, Ndhlovu, Potenza, Mahomed, Lubisi, Vinjevold, Ngozi, Malan & Mphahlele, in their report

as a review committee, and presented to the minister of education in 2005. They stated that the model

> "…failed to prepare either officials or school based educators for the complexity of C2005 implementation … resulted in the 'watering down' and/or misunderstanding of crucial information. …trainers that lacked understanding to manage confidence, knowledge and understanding to manage the training process."
>
> (Chisholm et al, 2000, p55)

The participants in this survey also indicated that these cascading workshops had little or no effect in ML since they were still confused with content knowledge and contexts.

There was a further need for development and growth of teacher capacity. Teachers needed more training on content, contexts as well as methodology because new content, such as data handling, probability and transformation geometry was added. Mathematical Literacy being a new subject, having content taught within a context required that the different learning outcomes (LO's) had to be approached within a given context. The method of teaching also had to change, with a move from teacher centred to learner centred 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.

Even before the advent of ML, there were shortages of skilled and qualified mathematics teachers. Many qualified mathematics teachers had exited the profession after they had taken the severance packages offered by the DoE. According to (Parker, 2006) many teachers are either unqualified or under qualified to teach mathematics. The data below relates to the need for training of ML teachers:

- learner –teacher ratio in South Africa is 30,6 : 1 (Goba et al ,2011).
- 61 591 learners wrote ML in 2011 (DoE, 2011, p58) in Kwa -Zulu Natal
- 3 013 teachers were required to teach these learners. However if the grade ten and eleven learners were also doing ML then at least 6 039 teachers would be required. (Goba et al 2011)
- In 2008, the number of learners writing ML at grade twelve level 8, 263 464 learners, in 2009, 277677 learners and in 2010, 29341 learners. (DoE, 2011, p.58)

Thus the number of teachers required would increase to 8 610 for the grade twelve level only. An estimated 25 830 ML teachers were required nationally. The demand for trained ML teachers grew. The DoE, together with the universities, had to step in to provide qualified ML teachers. Some universities such as the University of KwaZulu-Natal (UKZN) and Nelson Mandela Metropolitan University (NMMU) developed programs called the Advanced Certification in Education (ACE) in Mathematics, Mathematical Literacy, and Science to assist the practising teachers in developing their skills and knowledge; to ensure more confident and effective teachers in the classroom. Such courses focussed on developing the teachers' skills and strategies in planning, teaching and assessing as well as contributing to their professionalism. In 2006 the first lot of teachers enrolled at the NMMU at a campus in Durban. The tutors were mainly teachers from KwaZulu-Natal and were trained by the staff of NMMU. NMMU was unique in the implementation of the curriculum in that the content was made up all the learning outcomes (LO) of grades ten, eleven and twelve. The textbook

that was used was also the textbook that teachers used in their classroom at school. The curriculum consisted of a skills and strategy module each year which was intended to develop the teachers' pedagogic content knowledge.

1.2 The Advanced Certificate in Education in Mathematical Literacy Curriculum

The NMMU curriculum in the ACEML program consisted basically of the four learning outcomes as outlined in the ML school curriculum, with the intention of helping the teachers become familiar and confident with the outcomes. In addition there were other modules that focussed on the pedagogic content knowledge. These modules were intended to help the teachers to integrate the content, contexts and the pedagogic content knowledge across the three grades through a process of exploration of the ML content, how it should be taught, designing and displaying tasks and assessments for the learners and identifying misconceptions that arise.
The curriculum of the ACEML program at UKZN was made up of eight modules of which four modules were closely linked to the content knowledge as outlined by the DoE in the Learning Programme Guidelines (LPG). The modules were Pedagogic Content Knowledge (PCK), and focussed on the following: examining the curriculum of ML, exploring how the content will be taught, designing tasks and assessments strategies appropriate for their classrooms and identifying misconceptions that arise. The next two modules were generic modules, namely *Learning and Teaching* and *Educational Policy and Professionalism.* These modules focused on improving the knowledge of teachers of the school, the profession, learning, context, resources etc. The following two modules, *Teaching and learning Mathematics in FET, and Professional Practice in ML*, dealt with the philosophy behind ML and practical applications within the subject.

According to the Learning Programme Guidelines (2005), the ML curriculum was made up of four learning outcomes as described below.

- "LO 1 : Number and Operations applied in context
  Ability to use numbers and their relationships to estimate and calculate, investigate and monitor the financial aspects of personal, business and national issues and to investigate and solve problems in other contexts.
- LO 2 : Functional Relationships
  Ability to recognise, analyse, interpret, describe and represent various functional relationships in order to solve problems in real and simulated contexts
- LO 3 : Shape, Space and Measurement
  Ability to measure using appropriate instruments, to estimate and calculate physical quantities and to describe and represent properties of, and relationships between 2D-shapes and 3D-objects in a variety of orientations and positions.
- LO 4 : Data Handling
  Ability to collect, summarise, display and analyse data and apply knowledge of statistics and probability to communicate, justify, predict and critically interrogate findings and draw conclusions." (DoE, 2005, p.11)

1.3 Purpose of the ACEML

The DoE spent a large sum of money in training teachers experienced in teaching other subjects in the school curriculum, in a new subject ML.
The universities also developed the training program in line with the MLschool curriculum and one of the determinants of whether the program was successful or not was to research whether the teachers who studied the program had developed professionally in terms of content knowledge, pedagogic content knowledge, confidence as ML teachers, and whether there were changes in their beliefs and identity as ML teachers. The majority of the teachers that were identified by the DoE to study the ACEML programme consisted of mostly non-mathematics teachers and it was intended that the knowledge that they had gained would transform them into professional ML teachers. These teachers had previously belonged to a community of practice centred round the subjects that they had trained for and taught for a number of years with their own beliefs and structures. Teachers had entered the program for various reasons namely for re-skilling and upgrading their qualification which resulted in monetary gains, a desire to learn some mathematics, the sense of belonging and taking charge of a new subject and saw it as an opening to "higher education." (Goba et al, 2011, p1).

Another pupose of this program was to help the teachers develop professionally. Teacher professionalism is about the 'quality of practice' that a teacher demonstrates. (Sockett, 1993, p9). According to Kriek and Grayson (2009), professional development is the "integration" of content knowledge, pedagogic content knowledge and professional attitudes. (Kriek and Grayson, 2009, p187). Hence there was need to see to what extent this professionalism was achieved.

1.4 My Personal Reason for the Research

While South Africa was in a the period of transformation in education, I was part of the team of facilitators chosen by the DoE to go around the Province of KwaZulu-Natal and train teachers in the new curriculum of mathematics in 2006. The mathematics team and the ML teams trained at the same venue and I eventually facilitated in both subjects (mathematics and ML). I also served as a tutor in the NMMU ACEML programme in the Durban area. The tutors were trained each semester by academics from NMMU on the ACEML program. I found that the tutor training that I had as a ML facilitator for the province and as a tutor for NMMU in the ACEML program qualified me to teach grades ten, eleven and twelve classes at my school. During this time there were other teachers at my school who had very little knowledge of mathematics studying the ACEML certificate and teaching ML simultaneously. At the beginning I found that many teachers were finding teaching the context and the content a challenge. Drawing up assessment tasks was an even bigger challenge for them. However it seemed that as time went on, they found it easier. I noticed that the teachers' content knowledge and their pedagogic content knowledge as well as their confidence levels and their beliefs in the subject ML changed. Initially the teachers struggled to cope with the pressure of teaching a new subject, new content knowledge and new skills and strategies in teaching the context specific knowledge, but these tasks became more manageable in time. These factors led to my research into the professional development of the teachers.

From my observation while tutoring the participants I found that the teachers at NMMU also found it hard to adjust to a new subject with very little resource material available except that which the university had provided. Many teachers studying the ACEML program were

teachers specialized in teaching subjects like Afrikaans, IsiZulu, Life Science, Geography and many other subjects. Some were even primary school teachers who were looking for either a higher qualification or a change in their professional direction of teaching. Some of the teachers dropped out of the program since they could not deal with the pressure of learning a new subject or the pressure of school overpowered the pressure of studying or for personal reasons. Some teachers even found that the pace of the program was too fast and also the content was too rigorous and sometimes difficult to understand, but many persevered and completed the program.

Another significant fact was that teachers of other specialisations with a limited background and understanding of mathematics were teaching ML after having received one week of training by the DOE. Some teachers went on to study the ACEML program. Furthermore, the teachers were also being supported at school by the Head of Department, which involved meetings and classroom visits. As the Head of Department at my school, I was also responsible for supporting and mentoring the teachers, and I became interested in trying find out how the different models of professional development could work together to improve the teachers' practices. Hence I decided to embark on this research to first observe in depth how the model of ACEML program at both NMMU and UKZN had contributed to the professional development of the teachers. At schools many mathematics teachers were also involved with the teaching of ML since schools that had no trained ML teachers had to use the resources that they had and many schools felt that mathematics teachers were the most suitable. The impression of teachers who were in the ACEML program was that the mathematics teachers did not have adequate training to teach the ML and lacked the skills to teach the subject in the manner envisaged by the curriculum. Mathematics teachers were trained to teach mathematics and both the subjects were different in terms of the content and the pedagogical content knowledge. There was constant debate between the mathematics and the ML teachers, since the mathematics teachers also felt that they had more content knowledge and skills to teach ML and misinterpreted that ML and mathematics were similar. There were many such debates which spurred me on to find out more about the demands of teaching ML as well as what teachers felt about the value of the training they received from the ACEML. Another aspect that I wanted to investigate was whether a person who has had a strong affiliation and an identity with a subject like mathematics could now form beliefs and a strong identify with ML. Another avenue that I also wanted to explore was whether learning ML through the ACEML programme and the knowledge that they gained, gave the teachers a clear perspective about ML and the new direction that they were moving in, and whether this new direction gave them the confidence to teach ML and move ahead in their career.
After facilitating in the ACEML program worked as a part time lecturer in the B.Ed. (Honours) program at the Durban campus of NMMU. I had lectured to many of the teachers in the ACEML program. I approached these teachers to take part in my research. These teachers were easily accessible to me since I had come into contact with them nearly every week for almost two years. According to Cohen (2007) this type of sampling is occasionally called opportunity sampling and "involves choosing the nearest individuals to serve as respondents and." (Cohen et al, 2007, p.113-114).

Hence this study will explore teachers' perceptions of how the ACEML programme contributed to the professional development of the participant teachers by focussing on aspects such as content knowledge, pedagogic content knowledge and changing the beliefs, identity and the confidence level of the teachers.

1.5 Objectives of the Research

This research is an exploration of how the ACEML program impacted on the professional development of the teachers who had studied, in terms of their content knowledge, pedagogic content knowledge and the changes in their beliefs and identity as well as confidence levels of the ML teachers. Another objective of this research is to assist the DoE and the universities to develop the areas in which teachers require assistance in ML and then develop workshops, programmes, in-service trainings and professional development for teachers of ML with accreditation and develop formal professional development, which would serve as an incentive for teachers to participate in.

The following two questions enabled me to find explanations in my exploration of the dilemma above:

1 **What are some contributions made by the Advanced Certificate of Education in Mathematical Literacy program towards the participating teachers' professional development?**

2 **How was the professional development of the teachers who studied the Advanced Certificate of Education in Mathematical Literacy enhanced**?

The following information assisted in exploring the statements above.

- Whether the teachers saw an improvement in their existing content knowledge or did they learn new content knowledge and were they able to learn new content within the given contexts.
- Whether their pedagogic content knowledge improved or changed as they learnt new content and a new subject. Did it affect their development of assessment, tasks, work plans and ethics?
- Were the teachers able to identify with the new subject ML and did their beliefs about the new subject ML develop to such an extent that they saw a change in their perspectives and identity in relation to ML?
- What were the changes in their confidence level with respect to the teaching and learning in the classroom?
- How the ACEML programme as a whole affected their professional development and their careers as teachers?

This research has great significance in terms of the planning and preparation for the DoE as well as the universities nationally. By exploring what the teachers have learnt in the ACEML programme and exploring what the shortfalls are in the teachers' content knowledge and pedagogic content knowledge the DoE and universities can either review the existing program, add or delete what is crucial for the overall requests of those who have gone through the programme. The teachers in the program were seasoned teachers who were specialists in other subjects. However they are now classified as novices in the new subject ML. Hence the content and skills learnt in ML were new to them. They had to now apply this new knowledge and skills in their classrooms. By doing so they would be able to determine exactly how much they have learnt and what gaps there are in their content knowledge and how much of skills they still require. This knowledge also makes curriculum developers examine the usefulness of what exists in the program. Especially problem areas that needs to be rectified or sections that need to be improved on and what new ideas that can be included or excluded. According to Hobden (1999) "curriculum innovators should seek ways that

make it possible for people to accommodate new ideas within the constraints of their personal belief system." (Hobden, 1999, p.11).

1.6 Limitations of the research

The research that was conducted was restricted by the following determinants namely, the type of sampling that was done, lack of classroom observations, lack of data verification, time span of collecting data and completion of the ACEML program was not immediate. Of the thirty one teachers selected for this research, 28 of them were studying towards the B.Ed honours degree. Although the sample consisted of rural and urban teachers the results would have been more accurate if all the teachers who completed the ACEML program, were included in the research. There would have been a more substantial amount of data that would have been available especially in relation to those teachers who had struggled with the curriculum. This sample consisted only of Black and Indian teachers. The study may have been broader if teachers of all races were included. The research consisted of surveys and interviews. The surveys and interviews are feelings and opinions that were reported by the individuals themselves. There were no classroom observations, where the researcher could observe the teachers first hand and verify the extent to which the teachers' knowledge and professional development had been enhanced or improved. If the research had been done immediately after the ACEML program was completed, teachers could have commented on the professional development gained from the program itself. On the other hand with a lapse in time, teachers would have also gained further content knowledge from their classroom experiences and this may have been reflected as contributions from the programme.

1. 7 Organisation of the Study

The study comprises of five chapters followed by the references and the appendices.

- Chapter one comprises of an overview and the focus of this study. The background of the study and the reasons why ML was introduced in the country, the ACEML curriculum and its purpose, my personal reason for the research, the objectives and significance of the research and the limitations of the research.
- Chapter two consists of the literature review and the theoretical framework. The literature review consists of definitions of mathematical literacy, the challenges faced in preparing the teachers to teach mathematical literacy and the need for teacher training colleges. In the theoretical framework the professional development, the teachers' content knowledge, pedagogic content knowledge and the teachers' professional identity and beliefs were discussed.
- Chapter three consists of the research methodology used. A mixed method approach consisting of a quatitative method, during which 31 teachers were surveyed and a qualitative method, where 6 of the participants were interviewed, was used . samples of the participants tasks were also analysed .
- Chapter four gives a detailed analysis and report of the surveys and the interviews that were conducted.

- Chapter five is the concluding chapter that highlights a summary of the research findings and answers the critical questions of the research as well as states the limitations and recommendations of the research.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

I first present a discussion on the introduction of mathematical literacy and an explanation of what mathematical literacy is. This is then followed by an extensive literature review and a theoretical discussion using literature readings in relation to professional development, content and context, competency and confidence, and classroom methodology of teachers in the study of Mathematical Literacy.

2.1.1 What is Mathematical Literacy?

This is a phrase that is widely used throughout the world and denotes a skill or competence. In order for one to be able to be mathematically competent one has to be mathematically proficient. In this thesis, the term mathematical literacy, or ml, refers to the skill or competence. Mathematical Literacy, or ML, is a reference to the subject that was introduced as part of the curriculum in 2006.

A study committee comprising of experts in the field of classroom practice, mathematical sciences, cognitive sciences, business and mathematics education, from the United States was formed to conduct a study about mathematics teaching and learning and to make suggestions as to the most effective practices in early school development from 1998 to 2001. They also had to define and describe the context of their study in relation to "successful mathematics learning." (Kilpatrick, 2001). Through this exploration of the terminology "successful mathematics learning", the committee recognized the fact that they had to characterize the learning and hence considered words like "mathematical literacy, mastery of mathematics and mathematical competence." (Kilpatrick, 2002). The National Research Council (Kilpatrick, Swafford & Findell, 2001) agreed on the use of the term "mathematical proficiency", which they described in terms of the five strands. They described mathematical proficiency as the integrated attainment of "conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition." (Kilpatrick, Swafford & Findell, 2001, p.6) asserts that proficiency in mathematics will enable learners to cope with and meet with the challenges of their daily lives thus continuing with mathematics in high school and thereafter.

Mathematical Literacy is also referred to by terms such as numeracy, mathematical proficiency, quantitative literacy, mathemacy, or critical mathematics education. This in turn gives rise to various definitions and interpretations which subsequently leads to particular interpretations and debates. The following are some of the definitions.

- According to the Programme for International Student Assessment (PISA 2000) "Mathematical Literacy is the capacity to identify, to understand and to engage in mathematics and to make well founded judgements about the role that mathematics plays, as needed for an individual's current and future life, occupational life, social

life with peers and relatives, and life as a constructive, concerned and reflective citizen" and they went on in 2006 to say that "Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well founded judgement and to use and engage with mathematics in ways that meet the needs of that individuals life as a constructive, concerned and reflective citizen" (PISA, 2006, p.187). Mathematical literacy (ml) also enables an individual to know and experience at first hand the crucial parts of elementary mathematics, hence giving one the ability to solve simple multi-step problems.

- In 1993 the National Adult Literacy Survey used the term Quantitative Literacy and defined the term as "the knowledge and skills required to apply arithmetic operations, either alone or sequentially, using numbers embedded in printed materials (e.g. balancing books, completing an order form)" and in1995 the International Adult Literacy Survey redefined the term quantitative literacy as "The knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations".

- In 2000 Evans: defined the term Numeracy as "the ability to process, interpret and communicate numerical, quantitative, spatial, statistical, even mathematical information, in ways that are appropriate for a variety of contexts, and will enable a typical member of the culture or subculture to participate effectively in activities that they value."

- Gellert et al. (2001) and Jablonka (2003) perceive ml in terms of higher order mathematical skills. Jablonka (2003, p.78) feels that any attempt to define ml "faces the problem that it cannot be conceptualised exclusively in terms of mathematical knowledge, because it is about an individual's capacity to use and apply knowledge. Her definition of ml is "a bundle of knowledge, skills and values that transcend the difficulties arising from cultural differences and economic inequalities because mathematics and mathematics education are not seen as culture bound and value driven." (Jablonka, 2003, p.81)

Sfard and Cole (2003) discussed the meaning of the concept mathematical literacy by considering two ideas separately: 'mathematical discourse' and 'literacy'. They define 'literacy' as "the ability to use secondary discourses" and secondly, that within the communicational framework there are two types of discourses: 'everyday or colloquial mathematical discourses' and 'literate mathematical discourses' and "mathematics is seen as a special type of discourse" ... and that…"unlike spontaneously acquired everyday discourses, secondary discourses require deliberate teaching." (Sfard and Cole, 2003, p.3). These authors specified some differences between the two types of discourses:

- unlike everyday(colloquial) mathematical discourses, literate mathematical discourse does not develop spontaneously.

- literate mathematical discourse is taught, whereas everyday mathematical discourse is not.
- literate mathematical discourse is visually/symbolically mediated, whereas everyday mathematical discourse is predominantly physical.
- literate mathematical discourse is characterized by the distinctive use of words and their unique routines which derive from and build on, the symbolic and recordable nature of the discourses.
- literate mathematical discourses are general-purpose, whereas everyday mathematical discourses are specialized and highly limited in their applicability. Sfard & Cole, 2003, p.7).

Sfard & Cole (2003) defined mathematical literacy as follows from their discussion above;

> "...being mathematically literate means to be a skilful and proactive participant of literate mathematical discourse. The term proactive means that the mathematically literate person has a general disposition toward using the literate mathematical discourse in a broad range of situations, including situations much different from the one in which this discourse was originally learned." (Sfard & Cole, 2003, p.5)

De Lange's description of mathematical literacy encompasses these preceding descriptions and he defines ml as

> "an individual's capacity to identify and understand the role that mathematics plays in the world, to make well founded judgements, and to engage in mathematics in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen." (OECD, 1999). He also stated "mathematical literacy will lead to different curricula in different cultures." (De Lange, 2006, p.88).

These various conceptions of mathematical literacy has tremendous influence on the professional development of the participants in this study. By using these theories I was able to reflect on the participants professional development in trems of the content , pedagogic content knowledge and their identity and beliefs.

ML links mathematical content, real life contexts and the skills attained. According to Jan de Lange (2006, p.81) the interplay between content, context and solving problems is illustrated in the following figure.

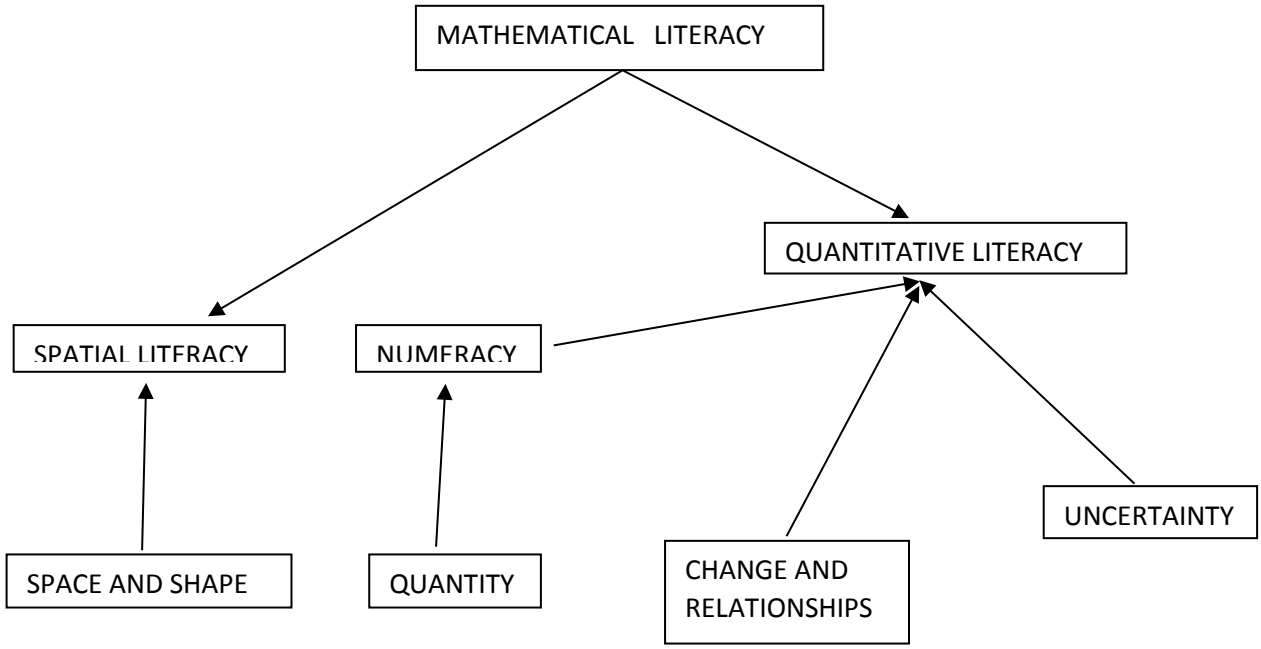


Figure 2.1 de Lange's understanding of mathematical literacy

De Lange cites Neubrand et al (2001) when he describes the following competencies needed for mathematical literacy

- Mathematical thinking and reasoning
- Mathematical argumentation
- Mathematical communication
- Modelling
- Problem posing and solving
- Representation
- Symbols
- Tools and technology

"To be mathematically literate, individuals need all these components to varying degrees, but they also need the confidence in their own ability to use mathematics and comfort with quantitative ideas." (De Lange, 2006, p.78).

2.1.2 Introduction of the subject Mathematical Literacy in South Africa

In South Africa educational authorities went a step further than other countries and introduced a school subject Mathematical Literacy (ML) which was designed to address the mathematical literacy demands described in the preceding paragraphs. “Literacy” refers to mathematically related functions of a person and is implied in the name, “mathematical literacy”. It can be seen as a pure application of a once abstract subject, mathematics.

However, ML is very different from Mathematics. AMESA (2003) a mathematical association for educators in South Africa suggests that ML is related to but is not the same as mathematics and implies that ML is a competency in the following statement

> “If literacy is the ability to read, write, then mathematical literacy should be the ability to read, write and engage with information and situations that are numerical in nature and mathematical in structure. While the mathematically literate person may draw on mathematical algorithms or knowledge, their mathematical literacy is reflected in habits and ways of engaging with problems and situations.” (AMESA, 2003, p.2).

These comments emphasise that 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.

This subject was introduced at the grade 10 level in 2006, and was compulsory for any learner who did not study mathematics in order to ensure that their levels in numerical literacy are enhanced and prepare them for the real world. This introduction of the subject was due to the concern that many learners have not been involved in learning and applying mathematical skills beyond grade 9 level. In 2000 to 2005 at least 40% of the learners writing the matric examination did not take mathematics as a subject. (Brombacher 2010). The subject ML was seen as one way of addressing the problems of low levels of numeracy in the adult population. Learners can choose mathematics or ML at grades 10 to 12 levels. In 2009, 277677 learners wrote mathematics and 290407 learners wrote ML at grade 12 level. In 2012 the corresponding figures were 225874 and 291342 for ML and mathematics respectively. (DoBE, 2013). These figures illustrate an increase of learners studying ML.

The introduction of Mathematical Literacy was also as a response to the challenges faced by industry and the workplace, tertiary institutions and the communities when dealing with the products of the South African schools. The problems have been compounded by outdated teaching methods, rote learning, learning and teaching without conceptual understanding, mainly through abstract rules and procedures. (Graven, 2004) There has been a growing concern about the fact that the formal mathematics curriculum does not prepare and equip the 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 etc.

According to the National Senior Certificate for Mathematical Literacy (DoE, 2003, p.9):

> "Mathematical Literacy provides learners with an awareness and understanding of the role that Mathematics plays in the world. ML is a subject driven by life-related applications of Mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse and solve problems ... Mathematical Literacy, should enable the learner to become ... a contributing worker and a participating citizen in ... a democracy." (DoE, 2003, p.10)

The definition emphasises that ML competence involves the ability to understand, judge, do and use mathematics in a variety of intra and extra mathematical contexts. It also encourages liberty for individuals and society in a democracy.

Bansilal (2012) stated that ML is a subject that will assist learners in the real world by introducing them to various presentations of data so that they are comfortable when confronted with this as well as that they will be able to make informed decisions if and when a problem arises. According to (Bansilal, 2012, p.2) "the subject ML is not about learning more mathematics, but about developing skills that will enable them to participate (and not to be excluded) in situations which use numerically based arguments." Similarly Venkat (2010) states "the emphasis in ML is on developing the skills needed for a range of adult life roles – becoming a self-managing person, a productive worker and a contributing citizen." (Venkat, 2010, p.54). Consequently ML as a school subject can be seen as shaping and maintaining democracy by equipping the individual with the prerequisites needed to involve themselves in the issues of immediate societal significance.

According to Brombacher (2011) "to be mathematically literate means, Being able to make sense of expressions of likelihood, understanding that such expressions cannot predict when the event will happen - only that it will, understanding that the quality of the prediction is a function of the process that led to its development, understanding that there are no "free lunches" and having the capacity to ask the questions that will reveal the "catches." (Brombacher, 2012, p.3 study guide PHML402)

Debba (2011), stated that within the South African context ML "must provide learners with the opportunity to demonstrate both competence with mathematical content and making sense of the world."

According to Steen "many educated adults remain functionally innumerate." (Steen, 2001, p.1) He also states that citizens need to know more than formulas and equations, that they need to see the world mathematically, and to "see the benefits of thinking mathematically about commonplace issues." (Steen, 2001, p.2). Ellis (2001) also argues that "the nation requires that citizens and workers have the ability to reason in a common sense way in situations involving numbers, graphs, and symbols." Citizens need to be mathematically equipped in order to approach real-life problems with confidence. Steen (2001), Pugalee (1999) and Ellis (2001) argue that citizens need access to mathematics and they must be able to apply it to real-life situations. Pugalee (1999) describes the aim of mathematical literacy in terms of obtaining full access to the school curriculum and to participate fully in the adult world. Steen also emphasizes that mathematical literacy "empowers people by giving them tools to think for themselves, to ask intelligent questions of experts, and to confront authority confidently." (Steen, 2001, p.2). Hence the subject ML will empower an individual to be

more knowledgeable and have the confidence to ask questions and make well-informed decisions. Ellis claims that "in education community needs to find an appropriate balance between teaching rules of thumb that can get the job done quickly and intellectual abstractions." (Ellis, 2001, p.62).

The Livingstone and Washtenaw Mathematics Steering Committee (2008) stated that "ML is the inclination to see mathematics as accessible, sensible, useful and worthwhile to meet a person's life needs. It should be demonstrated by communicating, reasoning, analysing and formulating and solving problems." (Livingstone and Washtenaw, 2008, p.3)
They found that an ongoing, continuous and sustained professional development of the teacher, addressing areas of teaching that had an impact on student achievement is necessary. This would in fact help to affect change in the learning process, since the teacher is directly in control of his classroom and the teacher is the only person in the classroom that can have a direct effect on the students learning. (Livingstone and Washtenaw, 2008). This research resonates the need to investigate what impact the ACEML program had on the professional development of the participants who were surveyed.

2.1.3 The need for training ML teachers and the challenges faced

With the introduction of ML in the school curriculum there arose a need for qualified ML teachers. However the universities and the DoE were faced with many challenges arising from this situation. There was a need to train teachers to teach the subject with the introduction of ML. Teachers were drawn from a variety of subjects, especially from the 'scarce' subjects, such as Afrikaans, History and other subjects and teachers had to be trained with the subject matter as well as the skills of teaching the new subject, because unlike Mathematics, it was context driven. The DoE arranged training of the teachers in the different districts for a week but this proved to be inadequate in terms of quality and time. (DoE, 2005) There was a further need for development and growth of teacher capacity. Many universities, in conjunction with the DoE offered the ACE programmes that were focussed on providing upgrading and re-training teachers to teach ML. (Goba et al., 2011).

Teachers needed more training on content, contexts as well as methodology because:

- new content, such as data handling, probability and transformation geometry was added.
- Mathematical Literacy being a new subject, having content taught within a context required that the different learning outcomes (LOs) had to be approached within a given context.
- since ML was part of the new OBE curriculum, it also had to have shifts in the philosophy of teaching.
- 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.

According to Nel (2012)

> "ACEML was designed to expose participants to knowledge and understanding of the ML curriculum (meaning), development of an integrated approach to teaching and learning, classroom didactics, lesson plans (practice), and group work activities where

> active participation and dialogue in lectures were encouraged (community)." Nel (2012, p.144).

When ML was introduced as a new subject, short two day or three day workshops had been scheduled for teachers by the DoE.

Hence, Nel (2012) found in her research that

> "… although valuable time and effort are spent on re-skilling of teachers into a new learning area, this seldom leads to a change in teacher identity to become custodians of the new learning area. Merely feeding teachers with content knowledge and/or best practices does not necessarily lead to the development of these teachers."

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. The ACEML was devised exactly for this implementation.

Teachers of ML need to know more than just the mathematics that is embedded in the ML curriculum. They need to understand the difference between mathematics and ML and to be clear about the purpose of ML in the learner's life. ML has a different philosophy, a different purpose and a different content. ML is a subject that contains some form of elementary mathematics and is described as "those elementary mathematical concepts and skills that are relevant to making sense of numerically and statistically based scenarios faced in everyday lives of individuals." (DoBE, 2011, p.8). ML also consists of exploring real life problems that are contextually based, unlike mathematics where problems have to be solved using procedures and rules. Duranti and Goodwin (1992) comment that the function of the context is "to describe such circumstances that give meaning to words, phrases and sentences." (Duranti and Goodwin, 1992, p.2).

A further demand on ML teachers is to help learners to become skilled in recognising numbers in real life and to be able to apply what they have learnt at school in everyday life.

Even before the advent of ML, there were shortages of skilled and qualified mathematics teachers. Many qualified mathematics teachers had exited the profession after they had taken the severance packages offered by the department. According to (Parker, 2006) many teachers are either unqualified or under qualified to teach mathematics. Also within the South African context is the language barrier since the majority of the teachers as well as the learners use/study English as their second language. ML is taught in English and examined in English. Code switching to their mother tongue is permitted, however all teachers are unable to code switch. Learning and teaching mathematics in multilingual classrooms where the medium of instruction is not the learners' home language is a complicated matter. Learners have to deal with the new terminology of ML as well as the new language of instruction, English, in which mathematics is taught in South African schools. (Botes and Mji, 2010, p.1). 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 is necessary. This theory of code switching is widely supported by Setati. In support of this view it has been stated Mathematics teachers face various challenges in their multilingual classrooms from Language teachers. English language teachers have as

their goal, fluency and accuracy in English. Mathematics teachers however have a dual task. They face the challenge of continuously needing to teach both mathematics and English at the same time (Adler, 1997). 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.

A further challenge for the training of competent ML teachers was the effect of the apartheid policies which have led to many imbalances in education. The apartheid policies were clearly evident in the training of mathematics educators. In the past mathematics educators were trained in separate colleges or universities according to their race. Most of the teachers in South Africa were trained at teacher training colleges. These colleges were poorly resourced and equipped since money was allocated according to race, hence the system was "ineffective in the provision of quality teacher education." (Adler, 2000, p.94). With the new curriculum, mathematics teachers were involved in the process of the development of the curriculum, which was a change from the past practices. Previously teachers were considered as "knowledge users and mere technicians implementing someone else's ideas." (Adler, 2000, p. 95).

The National Teachers Education Audit of 1995 and the survey of the Mathematics and Science Teachers of 1997 found that there was a lack of professionalism in most teacher educational institutions, especially in previously disadvantaged colleges of education. (Mkhize, 1999). A contrast in teacher qualification can be observed, with the previously advantaged having a degree in mathematics while most previously disadvantaged teachers left college with just a 3 year diploma.(Adler, 2000). Teachers with only a three year diploma were not as fully prepared as those who were fully qualified and this affects the teaching of ML. The fact that teachers were fully qualified mathematics teachers also did not necessarily mean that they were competent enough to teach ML.

2.1.4 Professional development of teachers

This study is focused on the professional development of mathematical literacy teachers and it is therefore important to survey some studies that have been conducted in the area of professional development.

Wilson & Berne's research entailed finding out more about teachers professional development and focussed on the practicing teacher, and how the teacher learnt in terms of the curriculum and the pedagogy. In their investigation they found that after the teachers were given the new curriculum, and were trained at a workshop and the "teachers did not enact the curriculum in the ways intended." (Wilson & Berne, 1999, p.177). But immediately after the teachers had met again and had "shared meetings", (Wilson & Berne, 1999, p.178) there seemed to be changes in their pedagogy. This study shows that teachers do not immediately take up reform ideas, but need some more encouragement and support before they try to implement new ideas. Professional development of teachers "is the only ticket to reform" (Wilson & Berne, 1999, p.173) and is one of the statements that many educationists agree on.

In addition to preparing teachers for curriculum reforms, professional development is an important aspect of teacher learning. Kelly (2006) argues that teacher learning is the process by which teachers move towards expertise (Kelly, 2006, p.514). Graven (2004) states that

"the notion of confidence is pivotal in understanding and explaining mathematics teacher learning." (Graven, 2004, p.177).

Features of professional development which includes changes in content knowledge and teaching practices should eventually lead to improvements in student achievement. This contributes to effective professional development. Desimone (2009) proposes a basic model which represents interactive, non-recursive relationship between the critical features of professional development, teacher knowledge and beliefs, classroom practice and student outcomes. She also discusses that "being a professional" teacher of mathematics involves the ability to be adaptable to changing circumstances, new information and to be a continuous learner. (Desimone, 2009)

Kelly (2006) also alludes to the need to changing circumstance. According to Kelly (2006) "individuals acquire skills, knowledge and understanding in one setting often specifically designed for that purpose, and subsequently able to use these skills, knowledge and understanding elsewhere." (Kelly, 2006, p.506).

The setting in which a teacher works is an essential aspect that must be considered in the development of professional development programs. 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. According to Peressini et al (2004), it is just as important to consider the context in the study of teacher learning, as learning is to be done in terms of a context. The authors further imply that that there are two parts to learning, namely what a person learns as a set of knowledge and the situation in which the person learns and experiences cultures and problems.

Hindle(1997) asserted that what the country desperately needs is professionalism in which each individual takes responsibility for their own personal development, a critical practitioner who takes a lead in a particular field, in this case, mathematics education. However not all teachers are at the stage where they can take responsibility for their own growth. In fact, some researchers felt that not all teachers are ready for taking such responsibility, and that different teachers are at different stages of their development and consequently require different interventions (Hugo et al, 2010; Rogan, 2007). Hugo et al. (2010) wrote that "professional development for teachers must be based on principles which allow teachers to move their levels of education and training in small jumps." This comment infers that the need for capacity building amongst practising teachers is essential. The term teacher capacity is used to consider the teacher's development and what it is that the teacher brings to teaching. This term has two meanings namely, the phase to absorb or retain knowledge and the inner potential for growth development or accomplishment. (McDiarmid & Bright, 2008 p.135).

In a bid to foreground the important issue of teacher's contexts, Rogan (2007) developed the Zone of Feasible Innovation (ZFI) theory which prescribes the extent of change that is feasible for a teacher during the process of learning and professional development. Rogan (2007) used the concept of the Zone of Proximal Development (ZPD) as outlined by Vygotsky to develop his concept of the ZFI. Vygotsky's theory of ZPD describes the levels at which new concepts are learnt. The ZFI is defined by its boundaries with the teacher's current practice at one end and the upper end occupied by the desired curriculum standards as set out by the DoE. Since the ZFI forces the researcher to take into consideration the context in

which the teacher is working, it is therefore important that the current practices are researched in order to support innovation and with ZPD it is the socialization of the learner with the knowledgable others. Researching teachers within the South African context presents particular challenges especially since the teachers themselves come from different socio economic backgrounds and hence bring with them a variety of different cultures and ideas.

With the myriad changes made to the curriculum and the introduction of ML most practising teachers need extensive re-training and re-skilling. With respect to the new subject ML, there was an additional demand of ensuring that teachers understand the philosophy and purposes of ML and how it was different from mathematics. There is a widespread misconception that ML is a simpler or "watered down" version of mathematics and that it caters for the learners who were weak in mathematics. (Bansilal, 2012). Thus ML teachers have the additional task of influencing their colleagues, learners and parents to change their mind set about ML. It is therefore incumbent upon any professional development authority in ML to prepare teachers to meet this challenge. There is also little agreement about who would make a more effective ML teacher; a mathematics teacher or a teacher from another specialization who had to be trained in a new subject. Thus some universities, in joint initiatives with the DoE, introduced the 2 year ACEML program. One route taken by the department of education was that of recruiting teachers from subjects that were 'dying' off or 'scarce subjects' and re-training them to teach ML. According to Goba et al (2011) "some mathematics teachers and HODs or principals believed that a mathematics specialist teacher was better qualified to teach ML", while some teachers who were retrained from other subjects are adamant that this was not the case. A study by Thembela (2012) revealed that most of the participants agreed that a mathematics teacher had to undergo training in the ACEML program to successfully teach ML. The author also stated that teachers who had taught mathematics previously had problems even after consulting with resources. ML required specific skills and strategies to teach the contextual content oriented subject. Debba (2011) expressed concern about mathematics teachers teaching ML. He wrote that a challenge faced was "whether teachers would be able to shift from teaching mathematics to teaching ML and whether the training will be successful to take on the challenges of teaching a new subject." (Debba, 2011, p.9).

2.2 THEORETICAL FRAMEWORK

Reflecting on the data collected during my research led me to view professional development as a form of teacher learning. To better understand professional development in terms of teacher learning I draw on the work of Lave & Wenger (1991) and Wenger (1998), which helped focus my attention to a situative cognition perspective. The situative cognition perspective provides a bridge between the cognitivist perspective and a sociological perspective.

According to Lave & Wenger (1991)

> " … the notion of situative learning now appears to be a transitory concept, a bridge between a view according to which cognitive processes are primary and a view to

> which social practice is the primary, generative phenomenon, and learning is one of its characteristics." (Lave & Wenger, 1991, p.34).

Adler (2000) stated that Lave's model does not necessarily relate to student learning but in fact strongly relates to teacher learning in a mathematics class, hence I find it applicable to understanding teacher development in my study of the ACEML teachers.

It is clearly visible within this situative learning perspective the focus is on the broader community rather than individual learners. Hence there is no guarantee in the situative learning perspective that success in a particular situation means success in another. Lave and Wenger (1991) prioritises the importance of participation in the practices of a community and identity as primary features of learning by stating:

> "Learning involves the whole person: it implies not only a relation to specific activities but a relation to social communities … learning thus implies becoming a different person with respect to the possibilities enabled by these systems of relations … learning is not merely a condition for membership, but is itself an evolving form of membership." (Lave and Wenger, 1991, p.53).

We can conclude that learning and identifying with the learning is therefore synonymous. Since the development of the identity is dependent on the participation in a community of practice, Lave and Wenger state that:

> "…a community of practice is a set of relations among persons, activity and world over time and in relation with other tangential and overlapping communities of practice. A community of practice is an intrinsic condition for the existence of knowledge, not least because it provides the interpretive support necessary for making sense of its heritage." (Lave and Wenger, 1991, p.98)

Lave & Wenger (1991) stated that professional development of teachers involved teachers learning through a process of co-participation, in an interactive manner and not as individuals. They prioritise the importance of participation in practices of a community and identity as a primary feature of learning. They also went on to say that "school teaching is a special kind of learning practice that must become part of the identity changing communities of children's practice if it is to have a relationship with their learning." (Lave & Wenger, 1996, p.161). ML was introduced for this reason. To enable the learners to:

> "…recognise that the world is a set of related systems, understand cause and effect, that small numbers sometimes have a big impact and large numbers can sometimes have no impact at all and understanding one's role in the cycle and/or how the cycle impacts on one." (Brombacher, 2012, p.3).

Wenger's later work in 1998 focuses on the concept of community of practice and identity and this has implications for this study that is based on teacher learning. His focus is to relate these communities of practice to the four learning **components** of meaning, practice, community and identity. Furthermore he based his work on the following four **premises** which is closely aligned to the assumptions underpinning the subject ML:

- that people are social beings in a central aspect of learning.
- knowledge is about competence with respect to valued enterprises.

- knowing is about active engagement in the world.
- meaning is ultimately what learning is about. (Wenger, 1998, p. 4)

These four premises resonate strongly with the purposes of ML.

Firstly, the idea that learners are social beings who are part of a broader society is a theme that underpins the introduction of ML which seeks to prepare learners to participate in society. It emphasises that ML teachers should provide learners with opportunities to develop and practise communication skills which will help them interact with others and share their understandings.
Secondly, ML is very clear about its purpose being different from that of mathematics, because "the purpose of this subject is to equip learners with the necessary knowledge and skills to be able to solve problems in any context that they may encounter in daily life and in the workplace." (DoBE, 2011, p.9). Thus its purpose is not to learn more mathematics but to be able to apply basic mathematics to better understand the contexts they encounter which is aligned to Wenger's second premise about competence being related to valued enterprises. Here the valued enterprises are the actual contexts that the learners may encounter.

Thirdly, the DoE (2011, p.8) writes that:

> "The competencies developed through Mathematical Literacy allow individuals to make sense of, participate in and contribute to the twenty-first century world — a world characterised by numbers, numerically based arguments and data represented and misrepresented in a number of different ways."

This description of the purposes of ML is reflected in Wenger's third premise above of knowing is about active engagement in the world.

Furthermore, in order to engage in real life contexts in ML, it is essential to make meaning of the contexts they encounter, and they cannot apply the mathematics without understanding the contextual significance, and this aspect of learning is reflected in Wenger's fourth premise above. This discussion on Wenger further reinforces the situative perspective where there has to be understanding of "how practice learnt at the universities and colleges courses can be re-contextualised in elementary and secondary schools." (Peressini et al, 2004, p.70)

ML was a new subject taught by teachers who had been previously trained to teach other subjects, such as history, mathematics, life science, Afrikaans etc. One therefore is unable to imagine that the new subject would involve replacing "old" practices with "new" practices. In the teachers previous situation success would have been defined in terms of facilitating knowledge of the previous subject. With the advent of their new specialization of ML, success will be defined differently.

According to (Graven, 2002)

> "… implementing the new curriculum would involve a process of fashioning the curriculum in such a way that it becomes part of the teachers' 'way of being'. This would be enabled through providing teachers access to a range of resources including opportunities to participate in a community engaged with new information, mathematics content, methodological ideas, new discourses, materials, curriculum documents etc." (Graven, 2002, p.142)

According to the study by Graven (2002), there is connection between Lave & Wenger's perspective of "learning as becoming" to the context of teacher learning in South Africa. ML a subject, unlike mathematics, requires "the need to work collaboratively in teams and groups to enhance mathematical understanding." (DoE, 2002, p.10). Graven's (2004) work encompasses Wenger's (1998) four learning components namely meaning, community, practice and identity and found that confidence was actually the fifth resultant component of her community of practice, PLESME (INSET project researching mathematics).

She stated that:

> "…confidence was clearly foregrounded by teachers in terms of their descriptions and explanations of learning ……. It is therefore analysed separately but considered in relation to the components: meaning, identity, practice and community." (Graven, 2002, p.129)

The following figure shows Wenger's theory of learning including his four components as explained by Graven (2002, p.153), namely meaning (our ability to experience the world as being meaningful), practice (our ability to share historical and social resources, frameworks and perspectives that sustain mutual engagement in action), community (ability to talk about the social configurations in which our enterprise is defined and our participation is recognisable as competence) and identity (a way of talking about how learning has changed who we are) and fuses his four premises on which his work is based on;

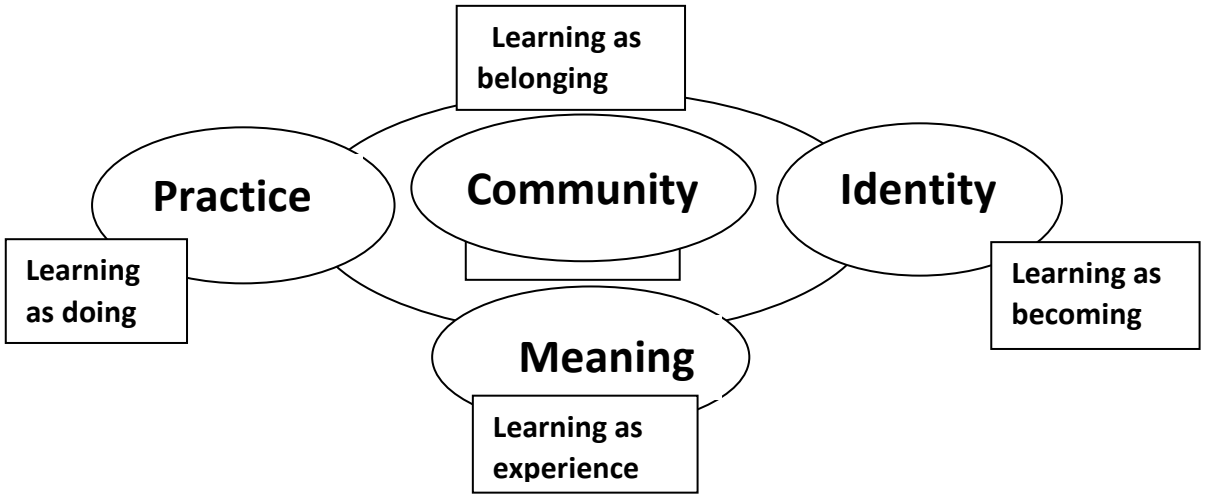


Figure 2.2.1 (Wenger, 1998, p.5)

Hechter's study (2011) focussed on Wenger's (1998) four learning components. On researching the ACEML teachers she found that "teachers shared a general understanding of the nature and purpose of ML and how it should be taught" (Hechter, 2011, p.143). She goes on to say that

> "the teachers own ML class was seen as a community of practice where the teachers learning of his /her acquired meaning of ML translated into his/her own individual teaching practice during lesson preparation and presentation." (Hechter, 2011, p.144).

This study also focuses on the my own community of teachers that I had tutored and hence relevant to my research.

2.3 Dimensions of teacher knowledge

Having outlined the theoretical perspective of teacher learning that underpins this study I will go into more specific details about specific elements of professional development that are linked to teacher learning. The perspective taken in this study is that there are three main dimensions to teacher knowledge, namely content knowledge, pedagogic content knowledge and teacher identity and beliefs. However, ML is always taught within a context, hence 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. Hence it is rather difficult to separate the content knowledge from the pedagogic content knowledge.

Teacher professionalism is about the 'quality of practice' that a teacher demonstrates (Sockett, 1993, p. 9). Peressini, D., Borko, H., Knuth and Willis & Romagnano, L. (2004) makes inferences about the complex relationships that exist between teaching practices and teachers' developing knowledge and beliefs about mathematics, mathematical pedagogy and professional identity. In Peressini et al's model, professional knowledge is seen in terms of subject matter knowledge, knowledge of content- specific pedagogy and the development of professional identity as used by Peressini et al (2004). Madongo (2007) researched the teachers who had just begun the ACEML program in 2006 and highlighted a number of reasons why teachers had problems in teaching ML and one of the main reason was "lack of confidence due to their insufficient pedagogical content knowledge and their conceptions and beliefs about the nature of mathematics." (Madongo, 2007, p.122). The participants of this research were teachers who had taught other subjects and hence had no skills and knowledge of the new subject ML. They therefore lacked this confidence and beliefs about the subject matter knowledge and themselves.

Kriek and Grayson (2009, p.187) in their attempts to design a Holistic Development Model (HDM) took cognisance of the fact that their model "explicitly integrates the development of teachers along three dimensions ....namely content knowledge, teaching approaches and professional attitudes." (Kriek and Grayson, 2009, p.187) Kriek and Grayson asserts that it is the 'integration' of the above three dimensions of professional development that makes their model holistic.

In this study, the model of teacher knowledge that is assumed, encompasses three domains of content knowledge, pedagogic content knowledge and teacher beliefs or identities as used by other studies. (Bansilal and Rosenberg, 2011; Peressini, 2002; Kriek &Grayson; Thembela, 2012) In this section I will now elaborate and motivate the importance of these domains as an organising principle of the study.

2.3.1 Subject Matter Content Knowledge

Sullivan (2008) identifies three perspectives of knowledge and states that "the complexity and challenges of identifying expected knowledge for the teaching of mathematics is:

- knowledge of mathematics which deals with learners methods of finding answers through algorithms and intuitive reasoning.
- knowledge for teaching mathematics deals with the teacher's ability to identify and link specific concepts within a question and link them to concepts in the curriculum.
- knowledge of the pedagogy, where the teacher faces the challenge of "converting the question to a learning experience" (Sullivan, 2008, p.6).

Ball, Thames & Phelps (2008) identified four domains of mathematical knowledge, some of which overlap with Sullivan's ideas. However the domains of Ball et al are more specifically outlined as different areas of knowledge.

- Common Content knowledge (CCK), which they defined as "the mathematical knowledge and skills used in settings other than teaching." (Ball et al, 2008, p.399)
- Specialised Content Knowledge (SCK) refers to content specific knowledge and "… making features of a particular content visible to and learnable by students." (Ball et al, 2008, p.400)
- Knowledge of content and Students (KCS) refers to the teachers' knowledge, their learners and their ability to choose contexts and topics that their students will be familiar with and also ones that they will find interesting and familiar.
- Knowledge of Content and Teaching (KCT) where teachers need to know the sequence of the topics and "the knowledge at the intersection of content and teaching." (Ball et al, 2008, p.401)

The importance of a teacher having a sound knowledge base cannot be over-emphasised as Kahle (1999, p.2) stated "schools are only as good as their teachers, regardless of how high their standards, how up to date their technology or how innovative their programs." His comments underscore the need for teacher strengthening and development in order for there to be an improvement in the subject itself. It is therefore important that professional development initiative should focus on improving teacher's content knowledge. Taylor and Vinjevold (1999, p.139) writes that "teachers poor grasp of the knowledge structure of mathematics .....acts as a major inhibition to teaching and learning."

Thembela (2012) reported in his study that the teachers reported:

> " … on their improved content knowledge, on new content knowledge that was acquired as well as on some misconceptions previously held that was corrected through their involvement in the program." (Thembela, 2012, p.113).

Sullivan (2008) defines knowledge of mathematics as that which deals with learner's methods of finding answers through algorithms and intuitive reasoning. It can also be described as the ability to know what is within the subject structures and solve problems by using appropriate rules and formulas in the subject, as well as work with two and three dimensional shapes. ML includes elementary content as well as many contextual domains, and hence in this study content knowledge in ML will be taken as and include the mathematical knowledge as described by Sullivan as well as knowledge of the various contexts utilised in ML.

2.3.2 Pedagogic Content Knowledge (PCK)

Shulman (1986) stated that subject knowledge and the actual skill of teaching are dependent on each other which he called 'pedagogical content knowledge'. The diagram in figure 2.3.2 illustrates the relationship between PCK, content knowledge and curricular knowledge as exemplified by Shulman (1986).

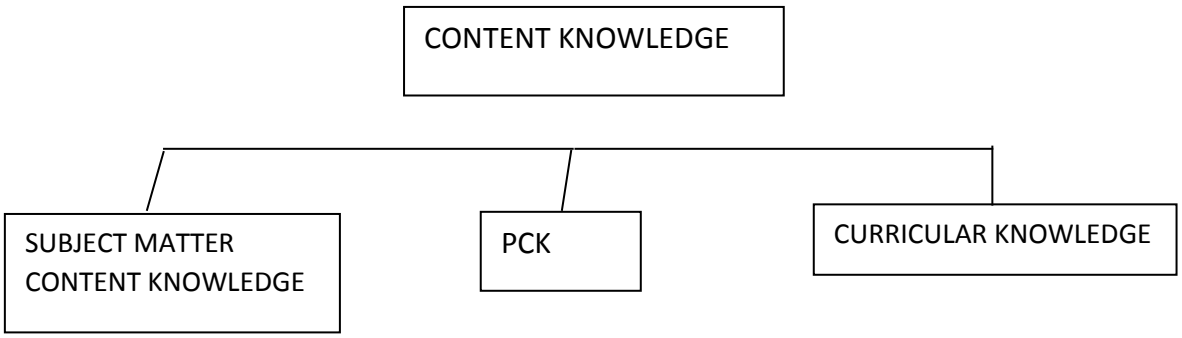


Figure 2.3.2 Shulman's component of knowledge

As expected content knowledge is very closely linked to PCK and it is inevitable that a discussion of one aspect, will entail a discussion of the other, which is the case in the description of PCK that is presented. The subject matter content knowledge involves knowing more than knowledge of the facts, but also to understand the structure of the subject matter. Subject matter knowledge also refers to the teacher's professional knowledge. Similarly, PCK refers to an in depth understanding of how the subject matter 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,1986b, p.7).

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 come 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. Shulman (1986, p.15) describes “PCK as the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by students.” In relation to curricular knowledge teachers must be able to teach the content at different levels and be able to build up the content from the preceding year to the next according to the level of difficulty that is required at that level. Shulman (1986, p.9) also emphasises the importance of knowing the content but then making it comprehensible to others.

In the following year Shulman (1987) characterized professional knowledge into the following categories:

- general pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organisation that appear to transcend subject matter.
- knowledge of learners and their characteristics.
- knowledge of educational contexts, ranging workings of the group or classroom, the governance and financing of school districts, to the character of communities and culture.
- knowledge of educational ends, purposes, and values and their philosophical and historical grounds.
- content knowledge.
- curriculum knowledge, with particular grasp of the materials and programs that serve as ‘tools of the trade’ for teachers.
- pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their special form of Professional development. (Shulman, 1987, p.8)

These categories emphasise the importance of content knowledge and situates it in terms of all the knowledge that a teacher needs to know for effective teaching in the classroom. Shulman also made it clear that all categories could not exist without each other, they were interdependent when he said “mere content knowledge is likely to be useless pedagogically as content free skill.” (Shulman, 1987, p.8). Content knowledge consists of knowledge of the subject and its organising structures (Grossman, Wilson, & Shulman, 1986b, 1987). Curricular knowledge is “represented by the full range of 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 particular curriculum or program materials in particular circumstances.” (Shulman, 1986, p.10). “A teacher requires proper subject matter knowledge and a high level of pedagogic content knowledge to assure effective teaching.” (Shulman,1986, Ma,1999). This theory is also supported by (Kilpatrick, 2001; Taylor, 2008)

when they say that “the most fundamental aspect in effective and proficient teaching of mathematics is a high level of knowledge.”

Ball (1991) states that 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. Therefore one can see the relevance of pedagogic content knowledge and its importance for quality education in the classroom. This can only be achieved when the teacher has mastered the art of knowing the subject content, and the manner in which the students can learn the subject content.This implies that the teacher must use strategies that are applicable to that particular content and that particular group of community of students or class. Hill, Rowan and Ball (2005) investigated both specialized content knowledge and skills used in teaching and found that “teachers’ mathematical knowledge was significantly related to student achievement gains in both first and third grades.” (Hill, Rowan and Ball, 2005, p.1). Given the extensive research supporting the importance of instructor knowledge, it is clear that the professional development plan must address the issue of content and pedagogical knowledge for all mathematics teachers.
Shulman (1986, p.9) describes Pedagogical content knowledge as “.....subject matter knowledge for teaching.....the ways of representing and formulating the subject that makes it comprehensible to others.” This theory is also reinforced by Johnson & Hodges and Monks (2000, p.185-186) who says “the actual classroom practice the teacher uses for a particular group of students on a particular day with a topic can only be selected from the teachers stock of pedagogical content knowledge.”

Grossman (1990) classifies PCK into four components as depicted in figure 2.3.3 by the diagram below

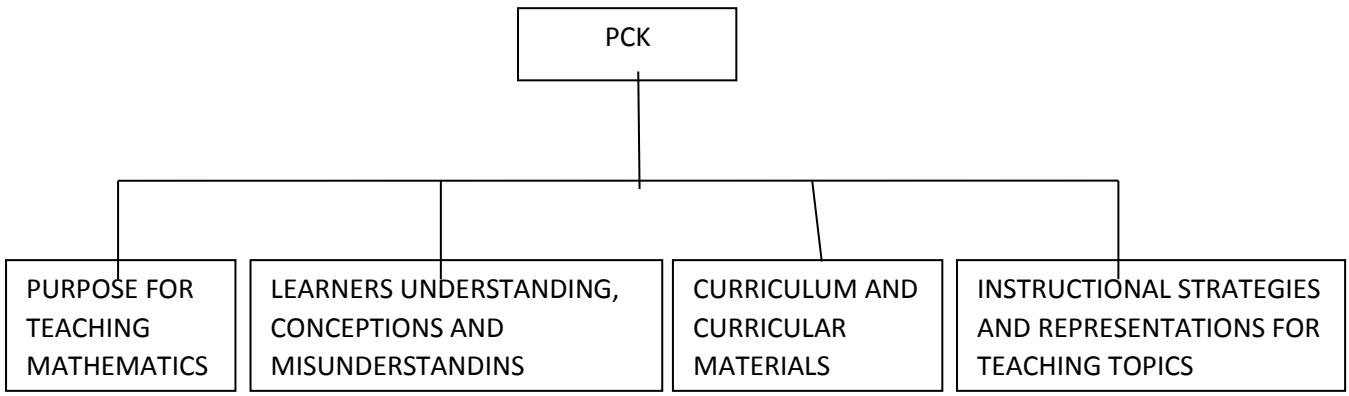


Figure 2.3.3 Grossmans classification of PCK

In the first component the teacher has to map ideas that will enable him to make decisions with regards to classroom objectives, the strategies he is going to use, assignments /work that is going to be given to the learners, curricular materials and assessment of learners. This comprises the teacher’s professional knowledge base, since it comprises the knowledge about the subject as well as what is important and necessary for the learners. The second component concerns the teachers’ ability and knowledge about what mathematics the learners will understand, how he will teach it in order for them to understand and through his expertise, what misconceptions the learners would have. Like Grossman, Leach & Moon (2008) stated

that pedagogy encompasses many facets namely strategies of teaching, arrangement of classrooms, formulating questions and developing schemes of work. These authors mention that content [i]specific pedagogy does not mean that teachers acquire a possession that they keep forever. It is ever changing. Leach & Moon (2008) argue that a pedagogic setting has a past, a present and a future.

This knowledge is clearly evident in the research by Sowder, (2007, p.165) "... plan more effectively because they can anticipate learners difficulties. They know what prior knowledge must be present to understand... how to scaffold knowledge to assist learners in developing understanding....how to listen to students. Much of this knowledge comes from practice..." In the third component teachers are expected to use all resources according to their strengths and weaknesses. They need to be able to integrate the knowledge of what they have to teach across the grades as well as within a grade and also be able to link the subject matter to other subjects. In the subject ML the issue of designing activities that are linked to the curriculum is important. Contexts which help learners develop decision skills in real life, are crucial tools in trying to achieve complexities in ML. Thus a key competence of an ML teacher is the ability to design suitable, relevant and meaningful tasks which can contribute to this end. Hence ML teachers need to be able to produce clear and unambiguous tasks which allow learners to investigate issues that they encounter. Lastly the fourth component consists of the teacher's ability to adapt representations according to the specific needs and goals of individual learners.

Teacher content knowledge and pedagogical knowledge have also been shown to have a profound effect on the manner in which teaching and learning takes place. Not only is a teacher's deep understanding of mathematical content important, but his/her pedagogical knowledge also plays a key role in student learning. Koency and Swanson (2000) found that studies in classrooms with high expectations and challenging mathematics suggest that "teacher knowledge of mathematical content is a key factor that underlies the quality of classroom instruction." (Koency and Swanson, 2000, p.3).

Adler and Reed (2002, p.25) indicate that subject knowledge on its own is insufficient but "the issue is how to integrate further learning of the subject with learning about how students in school acquire subject teaching." A teacher must be able to take the knowledge he or she has learnt and be able to deliver that content to the type of community of learners he teaches. Benita Nel's theory is closely allied to Wenger's belief that "knowledge is about competencies related to valued enterprises is reflected in the inclusion of knowledge that is considered to be essential in a mathematics community." In her explanation of this statement she goes onto say that teachers are able to take what they have learnt in the four modules of ML and are able to integrate the content within a context that pertains to a community of participants and thus engaging them in real life activities. Similarly Graven wrote that "mastery of the profession of mathematics teaching involves mastery of particular epistemic demands relating to mathematics and pedagogy." (Graven, 2002, p.165)

Sfard and Cole(2003) also asserts that in order for a teacher to be regarded as being mathematically literate, the teacher has to be able to use the two types of mathematical discourses both when the initiative comes from others or from their own accord in any situation in which the discourse can be helpful. This describes the 'how' and then 'when' of

literate mathematical discourse. They assert that ".... when it comes to poor results in developing mathematical literacy, the school is found to be the culprit." (Sfard and Cole, 2003, p.10). They also stated that successful teaching and learning of mathematics for the purpose of promoting literate discourses can best be achieved by changing school practices such as "discontinuing the practice of using mathematics as a tool for measuring human potential." (Sfard and Cole, 2003, p.10). Hence the development of the competency mathematical literacy is dependent on the teachers' skill and practices and this requires sound content knowledge and PCK.

Taylors (2008) through his research found that most teachers in literacy and mathematics did not have the knowledge that the curricula demanded to teach the learners proficiently. Hence there was a need to emphasise expert knowledge as the teaching of mathematics requires content knowledge, knowledge of the curriculum and the methodology in terms of how learners learn.

Ball, Thames & Phelps (2008) also emphasise the fact that pedagogical content knowledge bridges "content knowledge with the practice of teaching ,assuring that discussions of content are relevant to teaching and that discussion of teaching retain attention to content." (Ball, Thames, Phelps, 2008, p.3).

A fundamental difference between the teaching of mathematics and the teaching of ML is the role of the context. In ML, engagement with one context, requires the application of more than one type of subject matter content for example area of a rectangle and costing. An activity set around finding the cost to tile a rectangular surface would involve knowledge of area of a rectangle, as well as working out conversions based on units of measurements. Context forms an important part of ML. From a South African context, in a recent study by Thembela T.E. (2012), found that "teachers noted the difference between teaching and learning of mathematics and ML with regards to their teaching practice … context form a huge part of ML problems, and therefore teachers need to be creative and spontaneous in designing problems whose context fits with their respective learners." (Thembela T.E., 2012, p.103). Venkat (2010) remarks that "a life-preparation orientation, in which contextualisation in everyday life situations is central is a prevalent feature of the ML curriculum." (Venkat, 2010, p.55). Similarly Christiansen (2006) critiques the tension between the contextual teaching approach and the mathematically organized Mathematical Literacy curriculum in the following quote: By claiming that it is about life-related topics, the curriculum renders the underlying organizing principles of the content invisible to the learners (and possibly to some teachers, too), who therefore will not learn mathematics, unless the teacher is in a position to ensure coherence and progression of mathematical concepts. The learner who thinks that AIDS is the topic, when generally it is about reading graphs, will get it wrong, yet the curriculum does not encourage that the learner is given the necessary guidance to develop the mathematical concept of graphs. (Christiansen, 2006)

Hence, a curriculum based on these objectives and competencies would assist in developing the learner's skills in interpreting, assessing, using and applying numerical information in real life contexts. Hector (2011) also stated that "the training with respect to teaching practice needs to include training with respect to curriculum implementation, lesson planning, lesson presentation and the setting of assessment tasks". (Hector, 2011, p.149). Nel (2009) also noted in her study that "a definite shift took place from being unable to introduce a concept to a more definite approach" (Nel, 2009, p.51).

Content knowledge and PCK are dependent on each other and are very closely linked. ML is a complex subject which deals with the real world. Hence teachers, with the knowledge that they possess, have to develop contexts and have the capacity to transform the content knowledge and present it to the learners. Innovative teaching, keeping in mind the multicultural and diverse society within which teachers' work, the language barriers faced by teachers and learners and the misconceptions that occur while reading a context is a challenge for the teacher within the South African context. These are some of the aspects researched. The formation of tasks for class based exercises and assessments are all part of PCK that a teacher needs to know and the task is to find how the teacher has developed professionally in terms of PCK.

2.3.3 Teacher's Professional Identity and Beliefs

The third domain of professional development is that of a teacher's professional identity and beliefs. Teachers by developing their own professional identities view themselves as belonging to a particular community

Wenger (1998) states that learning through participation in a community of practice involves four components namely practice, meaning, identity and community. Identity and community of practice is "the main entry points into a social theory of learning." (Wenger, 1998, p12). He goes on to state that as teachers learning changes who he/she is, their identity changes in many ways. He characterises identity as

- Negotiated experiences. We define who we are through participation and by the way we and others reify ourselves.
- Community membership
- Learning trajectory
- Nexus of multi membership
- A relation between the local and the global. (Wenger,1998,p 149)

Wenger 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 then only can one say that the "notion of identity related to being a professional has taken place." (Benita Nel, 2012, p145). Dall' Alba (2009, p37) states that the identities of teachers changes when teachers learn to become professionals through a process of transformation. Jansen (2001, p. 242) defines teacher identity as "their sense of self as well as their knowledge and beliefs, dispositions, interests, and orientation towards work and change." So in terms of a ML teacher one 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. Wenger (1998, p.4) argues that active participation "shapes not only what we do, but also who we are and how we interpret what we do".

Jansen (2012) looked at ML as a subject that is taken by the weaker learners since it is considered easier than mathematics, however teachers who trained as Ml teachers were able to highlight exactly what the differences are between the two subjects, since they are able to identify with the subject according to Thembela's (2012) study. The study by Thembela

(2012) also revealed that the participants who studied the ACEML certificate changed in terms of their identity and were able to validate the usefulness of ML in real life situations.

Each teacher's professional identity is "emphasised by his sense of belonging and participating in a group by sharing ideas, knowledge and expertise" according to (Wenger, 2000, p.239). By being active participants in the ACEML program Wenger goes on further to state that "as trajectories, our identities incorporate the past and the future in the very process of negotiating the present….. Learning events and forms of participation are thus defined by the current engagement they afford as well as by their location on a trajectory." (Wenger, 1998, p.155). This was clearly evident in their activities involving task based assessment and lesson presentations (Nel, 2012) The author also states that as the person talks about their experiences in terms of what they have learnt, reflects changes in their identity, since all this meaning that is attached to the experiences forms identity. The research on professional development is underpinned by a situated learning perspective, since learning is meant for participating, sharing community building, belonging and communicating (Sfard, 2008). The teachers professional development encompasses the knowledge that he has gained through studies and the ability to recognise, find and use these resources productively in any given environment, 'creating a situation where learning to teach will take place. It can also be observed that teachers teach according to the manner in which they understand and perceive their subject and this means that to improve teaching and learning in the classroom teacher's content knowledge and competence must be improved and developed. A teacher's professional identity is inclusive of both cognitive and socio-cultural aspects of identity and identity construction. It is an aspect that the teacher uses to make sense of oneself and not something that one has. This cognitive and socio cultural aspect of identity is what makes every educator unique in the classroom (Peressini, Borko, Romagnano, Knuth & Willis; 2004). (Kriek, J.,Grayson,D., 2009, p.187) stated that teacher professionalism 'is about the quality of practice that a teacher demonstrates, and it is the integration of the content knowledge teaching approaches and the professional attitudes of the teacher that makes professional development holistic.

Thus mastery of the profession of mathematics teaching involves a dynamic process of becoming a confident mathematics teacher in relation to the components of meaning, practice identity and community. (Graven, 2002, p165). Nel (2012) asserts that "teachers who learn to become professionals through a process of transformation, during which their identity changes." (Nel, 2012, p145) Like Graven (2006), Thembela (2012) stated that the development of self-confidence is one of the main emerging themes of his study. Thembela (2012) identified three categories of identity that emerged from his study which was similar to Nel (2009):

"(i) teachers foregrounded the new ML identity and back grounded their previous identity;

(ii) teachers who had a dual identity – the one they had before and a new ML identity;

(iii) those whose ML identity was less strong, with their previous identity remaining strong."

Teachers' beliefs according to Dilts (1999) is defined as "as judgements and evaluations that teachers make about themselves and their teachings." Dilts (1999). Sidiropoulos (2008) also stated that "beliefs are wide-ranging based on personal and societal constructs…….. like

attitudes they are difficult to measure and ascertain." (Sidiropoulos, 2008, p27). A teachers identity and confidence levels also changes when their beliefs in the subject changes.

According to Thembela (2012) "some teachers emerged from the study as reflective practitioners who were able to look into their own teaching. They were able to point to specific changes and improvements which they saw themselves and in teaching as a result of participating in the ACEML program." (Thembela, 2012, p101). Some teachers had not studied at all after they had qualified as teachers according to Thembela (2012) "teachers who had not been studying at all for very long periods were revived in seeking professional development through the ACEML program …… some teachers are currently furthering their studies …….two are engaged in their masters studies." (Thembela, 2012, p110).

Learner achievement and teacher attitudes and beliefs about mathematics have been found to affect the way teachers interpret and teach curriculum. According to Barlow and Reddish, "Beliefs impact practices because beliefs affect how teachers see their students, how they view the practices of other teachers, and how they accept the ideas given to them to develop their practice – whether those ideas are introduced through staff development, content courses, or pedagogy courses." (Barlow and Reddish, 2006, p 145). These beliefs must be addressed with all teachers before we can expect improvement in learner achievement.

Due to the changes that have taken place in education, in South Africa, came the birth of a new subject ML, which was taught by many non-mathematics teachers. The study researches the teachers' beliefs in themselves as well as the subject ML and investigates to what extent, and if there has been any changes in the identities of the teachers by comparing Nels (2012) studies to this research.

2.4 Summary

There are several theories that have been discussed following a time span from Shulman (1986) to Thembela (2012). However the work of Lave and Wenger (1991), Wenger (1998) and subsequently the work of Graven (2002) and Benita Nel (2012) influenced my study immensely. There was a strong emergence of Lave and Wenger (1991) and Wenger's work based on the four components of learning: meaning, practice, community and identity that arose out of the data and findings in my research. Like Graven (2002) and Nel (2012) I used this theory as a frame of my analysis.

The aim of my research is to explore the ways in which the ACEML program at the NMMU influenced the professional development of the participant teachers. The questions that I used to guide me through this research involved finding out what were some of the contributions made by the ACEML programme towards the professional development of the teachers and how was the professional development enhanced. Since these teachers belonged to and participated within a community of NMMU and UKZN and within a brand new subject, they learnt new content knowledge, new pedagogic content knowledge, a change in knowledge and beliefs and identity was expected. A synopsis of Shulmans (1986), Ball et al (2008), Sullivan (2009), Grossman (1990) and Peressini et al (2004) theory on content knowledge, and pedagogic content knowledge is described so that the link is visible during the analysis of the data and the resultant theory. Attention is also given to Nel's (2012) theory where learner assessments and tasks that have been prepared by the parpants influence the teacher's identity

and beliefs. Using Lave and Wenger's (1991) and Wenger's (1998), community of practice, Graven (2002), Nel (2012) and Thembela (2012) found that "confidence" was another component that highlights itself through the acquisition of content knowledge and PCK. Graven (2002) community of practice involving PLESME is a clear indication of how the participants in her research were able to work with each other and were able to emulate the tutors, share knowledge, ideas and teaching skills and strategies with their peers especially in task designs, assessments, lesson presentations and group discussion and learning by different methods as well as learning by engaging with different resources.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter I elaborate on the research design and methodology that was used in my study. My discussion begins with the approaches that was used, namely the mixed method approach comprising the qualitative and the quantitative approaches. Thereafter an explanation of the selection of the participants will be presented, and then a description of the data collection process follows. Finally there is a discussion of the validity and trustworthiness issues associated with the study, followed by a report of how the ethical considerations and challenges were addressed in the study.

3.2 Purpose Of The Research

The purpose of this study was to explore the ways in which the ACEML Program at the (NMMU) and the UKZN influenced the professional development of the participant teachers. In this study the term teachers' professional development encompasses content knowledge, pedagogical content knowledge and the changes in their beliefs and identities of the teachers. The study takes the form of an in depth case study of successful teachers who participated in the ACEML in NMMU and UKZN. It can be seen as "an investigation into a specific instance or phenomenon in its real –life context". (Cohen, Manion & Morrison, 2007, p170). These teachers will in fact form the unit of analysis (Yin, 1984, p.30) of this "exploratory study" (Yin, 1984, p.28), which sought to explore and analyse the teacher's perceptions of their professional development that was enabled by their participation in the ACEML program. Although this is a case study, the participants making up the case, came from different races, different backgrounds, different types of schools and different regions both urban and rural.

The research questions which guided the study are as follows:

Question 1

What are some contributions made by the Advanced Certificate of Education in Mathematical Literacy program towards the participating teacher's professional development?

Question 2

How was the professional development of the teachers who studied the Advanced Certificate of Education in Mathematical Literacy enhanced?

I now describe the research approach taken on in this study.

3.3 Research Approach

In trying to design the study, I was well aware of the need for a nuanced and in depth look at the phenomenon, which is ML teachers' professional development. I had to choose a design that would allow me to capture some of the complexities of the issue. In this regard, I was guided by Tellis's (1997) recommendation that the design of case study research should be done in such a way that that it brings out detailed experiences and viewpoints of the participants by using multiple sources of data already been researched previously. According to Soy (1997) case study research conveys an understanding of complex issues or objects and can add strength or extend experience. He also suggests that case studies places emphasis on detailed contextual analysis of a limited number of events or conditions and their relationships. In this study the research is aimed at identifying some of the contributions of the ACEML towards the participating teacher's professional development, as well as exploring how the professional development of the teachers was influenced. A mixed approach was used in the research which consisted of a quantitative and a qualitative approach. "The combination of both the quantitative and the qualitative data provides a better understanding of the research problem." (Cresswell, 2000, p.5). The research is also in line with Lave & Wengers' (1991) theory of learning in communities of practice.

Hitchcock and Hughes (1995) suggests that a case study approach is invaluable, especially when the researcher has no control over events. He highlights the following features of case studies:

- It is concerned with a rich and vivid description of events relevant to the case study.
- It blends a description of events with the analysis of them.
- It focuses on individual actors or group of actors, and seeks to understand their perceptions of events.
- It highlights specific events that are relevant to the case.
- The researcher is integrally involved in the case.
- An attempt is made to portray the richness of the case in writing up a report.

(Hitchcock and Hughes, 1995, p.317).

Although the research takes on a mixed methods approach, there is nonetheless a strong emphasis of the interpretive paradigm as stated by Keys' (1997), as conveyed by the purpose, reality, viewpoint, values, focus, orientation, data, instrumentation, conditions and results. (Keys, 1997, p2). The linkage of my research to Key's qualitative research constructs are elaborated below:

Purpose: My aim is identify some contributions of the ACEML towards the participating teacher's professional development as well as to explore how the professional development of the teachers was enhanced or limited by this intervention.

Reality: I was mindful that **c**hanges occur, as I explored the teachers' perception of their study

Viewpoint: In this study, the teachers' perceptions are crucial because reality is what each teacher perceives it to be.

Values: In researching this study, I will have to understand and take into account the impact of values.

Focus: The emphasis of this study was to try and generate a complete holistic picture.

Orientation: As the data is collected and analysed theories evolve, are strengthened and sometimes rejected

Data: The data collected can be subjective since the data in this study are perceptions of the teachers' about how their studies influence their professional development.

Instrumentation: The researcher is the primary collection instrument, in this study.

Conditions: The surveys and the interviews were taken under natural conditions.

Results: The results are more trustworthy in this study because the focus is to gain "real', 'rich' and 'deep' data. (Key,1997, p.2)

The following characteristics of a typical case as stated by Merriam (1988), are also pertinent to my study because the study was designed around these ideas.

TABLE 3.1 Characteristics of a Case Study(Merriam, 1988, p.18).

Point of Comparison	**Qualitative Research**
Focus of Research	Quality (nature, essence)
Philosophical roots	Phenomenology, symbolic interaction
Associated phrases	Fieldwork, ethnographic, naturalistic, grounded, subjective
Goal of investigation	Understanding, description, discovery, hypothesis testing
Design characteristics	Flexible, evolving, emergent
Setting	Natural, familiar
Sample	Small, non-random, theoretical
Data collection	Researcher as primary instrument, interviews, observation
Mode of analysis	Inductive (by researcher)
Findings	Comprehensive, holistic, expansive

The focus of this study is the teacher's participation in the ACEML program and how it has contributed to their professional development. A detailed contextual analysis needs to be provided, since each teacher is unique and according to Cohen et al (2007) "contexts are unique and dynamic , hence case studies investigate and report the complex dynamic and unfolding of events, human relationships and other factors in a unique instance." (Cohen et al 2007, p.181).

The research design utilised aspects of quantitative and qualitative approaches, and is referred to as a mixed method approach. A combination of both the qualitative and quantitative data provides a better understanding of the research problem than either approach on its own (Cresswell, 2000). The author elaborates further:

> "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 in the research phases. As a method it focuses on collecting mixing both, analysing and mixing both quantitative data in the study. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone." (Cresswell, 2000, p.5).

Within a mixed methods approach, the data could be collected concurrently or sequentially as was the case in this study. The options for implementation of the data collection consists of gathering the information in phases as indicated below in figure 3.2. In this study the quantitative data was collected first and then the qualitative approaches are followed. Closed ended questions are asked included for accumulation of the quantitative data, in contrast open ended questions are asked to gather information for the qualitative data. The information drawn will depict the participants own ideas and views. According to Creswell & Miller (2000), it can be observed that when the quantitative data precedes qualitative data, the intent is to explore the design with a large sample first, to test variables and then to explore in more depth with a few cases during the qualitative phase. He also goes on to say that when the two phases of data collection exists, the researcher typically reports the data collection in the two phases. The analysis can take place in each of the phases separately in the report and the information can be integrated as a discussion in the form of a conclusion (Creswell et al, 2000, p. 218).

However in this study the research process was delineated into five distinct phases as represented in Table 1, and which are described in more detail below the table

TABLE 3.2 Phases of Research

PHASE	TASK/ACTIVITY
1	Design and administration of questionnaire
2	Quantitative analysis of data generated from the questionnaire and the task designs of the participants
3	Interview process-
4	Qualitative analysis of interviews
5	Synthesis of the two methods involving triangulation

The first phase comprised the design, and administration of questionnaires to a sample of thirty one teachers. This was a convenience sample made up of teachers who teach in two main districts and who have completed the NMMU ACEML and UKZN ACEML programme. The second phase entailed the quantitative analysis of the questionnaire, which guided the direction and focus of the next phase and an analysis of the tasks that was obtained from some of the participants. Most of the participants were unable to find their tasks since they had discarded them. The third phase included interviews with a selection of six teachers, chosen from the original sample, so that they were broadly representative of the bigger group in terms of gender, race and performance in the programme. This was to allow for an in depth analysis of trends and patterns across the sample.

The fourth phase was the qualitative analysis. Qualitative research is characterised by "detailed descriptions of situations, events, people and interaction.....from people about their experiences, attitudes, beliefs and thoughts" (Patton, 1990, p.22). Qualitative research is synonymous with exploratory methodologies and is described as ethnographic, naturalistic, anthropological, field or participant observer research.

The fifth and final phase involved synthesising the two methods. In this stage, I assimilated all the data using triangulation procedures in order to make well-informed and supported claims. Thereafter the data generated from the two instruments were examined and used to provide answers to the research questions. The mixed methods approach allowed me to use triangulation devices to confirm the interpretations and inferences made from the data.

Creswell recommends the:

> "…merging or converging the two dataset 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". (Creswell, 2000, p.7)

This supports my approach to “mixing the qualitative data with the quantitative data, so they together form a more complete picture of the problem.” (Cresswell, 2000, p.7).

Figure 3.1 below depicts the manner in which I utilised the mixed method approach

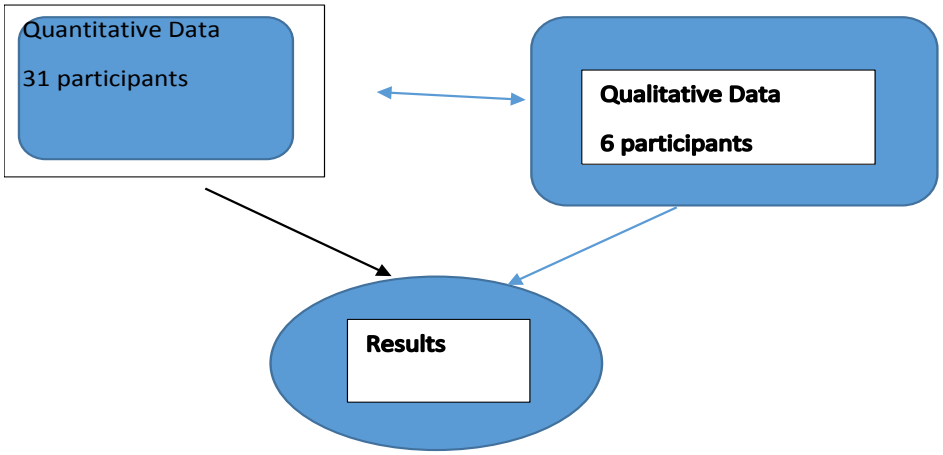


Figure 3.1 Mixed Method Approach

After the completion of the survey, some of the participants from the same survey were interviewed. The two dataset were connected having one build and support the other. There will be more comprehensive evidence provided in the research if the two approaches are connected.

3. 4 Context Of The Study

One of the major challenges faced by education authorities with the introduction of the subject ML in the Grades 10-12 band, was the scarcity of trained ML teachers. There were many efforts made by universities and departments of education to design professional development programmes suitable for practising teachers. One such initiative was the introduction of an ACEML that was developed to retrain teachers to teach the new subject of Mathematical Literacy in ways which promote the values and philosophy of the democratic South Africa. The institutions that offered this programme were the NMMU and UKZN.

There was one large cohort of ACEML program run by NMMU, in 2006, of which eight hundred and seventy teachers graduated. The class that started at UKZN in 2006 consisted of approximately 35 teachers, of which only 13 graduated. However UKZN enrolled a large number of teachers to study the ACEML in 2007, of which many graduated in 2009. The modules had a focus on the teaching and learning Mathematical Literacy and include generic aspects such as assessment and skills development. The teaching was carried out using a two-tier model of development. Part time lecturers were trained by module coordinators who designed the assessment tasks and summative assessments. I was one of the part-time lecturers who lectured on the program at NMMU.

This study was designed to follow up on successful participants in the programme to find out if the programme contributed to their own professional development and if so, what was the nature of the contribution. Accordingly the study took the form of a case study looking at successful participants in the programme

3.5 Participants in the study

The participants of the study were drawn from the graduates of the ACEML and all (except one) of the participants were teachers enrolled for the B.Ed. Honours in mathematics and mathematical literacy with NMMU. Their ages ranged between thirty nine years to forty nine years. The teachers came from the deep rural areas of KwaZulu- Natal to the urban areas and consists of a multiracial group. The campus is based in the central parts of Durban. Some of the teachers travelled a distance of 500km to attend lectures on a Saturday morning since this is the only venue that NMMU uses for the B.Ed. Honours program. The class consisted of approximately forty one students.

As a part time lecturer in the B.Ed. (Honours) program, I lectured to many of the teachers in the ACEML program. I approached these teachers to take part in my research through convenience sampling which is in fact a method of non-probability sampling appropriate to qualitative research. These teachers were easily accessible to me since I had come into contact with them nearly every week for almost two years. According to Cohen (2007) 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, 2007, p.113-114). This was reaffirmed by Neuman who stated that convenience sampling entails "select anyone who is convenient." (Neuman 1997, p.205).

There was a larger sample of teachers who completed the questionnaire; from this a smaller sub-sample were approached for interviews. Forty teachers were originally invited to complete the questionnaire (see Appendix A). However, some of the participants did not want to participate. My sample eventually consisted of thirty one participants, all (except three) had continued their studies in the B.Ed. (Honours) program offered by NMMU. The reason I was interested in these teachers was to investigate how the ACEML program enhanced their progress and knowledge required in their new studies. I also found the relationship that I forged with the participants during my lectures assisted me immensely during the research. This was evident by the willingness of the teachers to respond so eagerly and enthusiastically to the research questions and also sacrifice their spare time in order to do this. Lave and Wenger, (1991) "way of being" describes this relationship between the participants and myself in my research.

From the thirty one participants who had completed the questionnaires, interviews were conducted with six of the participants. This smaller sample was chosen so that it was broadly representative of the different races, gender and different areas that the teachers taught.

The first participant whom I interviewed was a 43 year old Black male who teaches in a rural area. Learners at his school take IsiZulu as their home language and English is their second additional language. The school is located in an impoverished area. His reason for enrolling for the ACEML was that he was qualified to teach another subject but wanted to retrain to teach mathematical literacy.

My second interviewee was with a 49 year old Indian male teaching in an urban area. Most of the learners came from the townships and spoke IsiZulu at home but did English as their home language at school. He was previously qualified to teach history and geography and

taught these subjects for twenty nine years. He still teaches his core subject history and one class of ML per year up to grade 12. He wanted to upgrade himself in terms of having enough knowledge in mathematics since he had only studied mathematics up to grade 9 level. He also felt that he is qualified in some subjects and had a fear for mathematics that he wanted to overcome. He was the only participant who had not continued with the B.Ed. (Honours) program

My third interviewee was a 45 year old Black male teaching in a township school. He currently teaches accounting and mathematical literacy from grade 10 to grade 12. He stated that he was qualified to teach another subject and did the ACEML so that he could retrain. He had taught accounting for a number of years and he felt that he needed a change and since mathematical literacy was interesting and dealt with figures he decided to study it.

My fourth interviewee was a 41 year old Black female teaching in a rural school with most learners coming from disadvantaged homes. She is currently teaching grade 10 to 12. She enrolled for the program because she knew that mathematical literacy was a new subject and wanted to know what it was all about. She also wanted to learn it well before she taught it to the learners.

The fifth person interviewed was a 44 year old Indian female. She teaches at school located in a semi-urban area. However the learners who attend the school live in the townships and other informal settlements. She taught Afrikaans for fifteen years. She was a teacher of languages for a very long time and she felt that she needed a change and also wanted to upgrade and do something new.

The sixth participant interviewed was a 44 year old Black female. She teaches at a school which is situated in a suburban multicultural area. She taught commerce and science. She wanted to gain new knowledge and wanted to know what was happening in this new subject. She also enrolled for the B.Ed. (Honours) in mathematical literacy but dropped out in the second semester of the course because of personal problems.

3.6 Data collection

My first data collection instrument was a questionnaire that consisted of thirteen closed questions and six open ended items was given to students who had completed or dropped out of the ACEML with NMMU or UKZN. The questionnaire appears in Appendix 4. The purpose of the questionnaire was to gather data on the teacher's perception of the effectiveness of the teaching strategies, modes of delivery, learning materials and training guides used by tutors in the program and **what** contribution the above has made to their professional development both positively and negatively. The questionnaire was also designed to investigate the teacher's perceptions about their experiences in the course and **how** they were relating it in their classrooms as well as to the development of their professionalism. It was expected that these questions enabled me to gather information on the effectiveness and relevance of the ACEML programme as well as that of the knowledge and content gained in the programme and finally details of the ways in which the teachers attribute their professional growth to the programme.

The teachers were informed about the reason for their participation in completing the questionnaires, what would be done with the information that they have completed and how it would enhance the study which is consistent with Bell's (1991) view. The teachers were given a week to complete the questionnaire, thus allowing them time to think very clearly about their experiences and how they had benefited from the program and what it lacked.

However it took me almost a month before I had managed to collect all 40 of the questionnaires as a result of disruptions and strikes at schools. However only 31 questionairres were analysed since the 9 others were not completed properly. Much research in South Africa is affected by disruptions that makes it difficult to answer the research questions one sets out to study. (Vithal, 1998 ; Adler & Lerman, 2003;Nyabanyaba,2001). According to Graven (2006), "these disruptions can possibly include strikes, teacher absenteeism, funerals, sports arrangements, timetable rescheduling etcetera." (Graven, 2006, p.104).

The second data collection technique that I utilised was the semi-structured interview. According to Cohen, Manion & Morrison (2007, p. 357) "semi-structured interviews allow the 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".

Semi-structured interviews allowed me to the probe the educator's thoughts and perceptions and to thereby get a detailed description of their experiences in the course as well as in their classrooms.

According to Cohen, Manion & Morrison (2007)

> "…the interpretive paradigm is characterised by a concern for the individual, to understand the subjective world of human experience, to retain the integrity of the phenomenon being investigated, efforts are made to get inside the person and to understand from within." (Cohen, Manion & Morrison, 2007, p.22)

During the interview the teachers' views on the curriculum were elicited, as well, their views on the content offered in the course. The interviews also probed the teachers about the extent to which the ACEML program helped them in teaching the content at grades 10/11/12 level at school, and how they had developed professionally. According to Merriam (2000) "learning how individuals experience and interact with their social world, the meaning it has for them, is considered an interpretive qualitative approach" (Merriam, 2000, p.4). It is important to note that an individual socially constructs meaning as he or she interacts with the world. There are various constructions and interpretations of reality, hence we can see that reality changes according to different situations, it is not permanent. We see this very clearly in the different teacher's experience of the ACEML program and what they have learnt from the program. Johnson & Onwuegbuzie (2004) stated that "an understanding and description of peoples experiences of phenomena" (Johnson & Onwuegbuzie, 2004, p.20) is apt for the type of methodology that is being used. In this case study teachers are being interviewed and as such the data is presented as that which has been spoken by the participants.

Cohen & Manion (2007), states the research interviews can be understood as "a two person conversation initiated by the interviewer for the specific purpose of obtaining research relevant information. (Cohen & Manion, 2007, p.269, Cannell and Kahn, 1968, p527). Graven (2006) stated that interviews serve as a dual purpose, namely to gather data for

research purpose as well as enabling teachers to reflect individually on various issues. Cohen et al (2007) elaborates further by saying that an "interview is not simply concerned with collecting data about life: it is part of life itself, its human embeddedness is inescapable." (Cohen et al, 2007, p. 267). It was quite evident that the participants were able to discuss their interpretations of their studies in terms of their own experiences and were able to express how they observed situations from their own point of view. The interviews started off as more structured question –response interviews and gradually became more semi-structured as the interview became conversational through the stimulation of a set of probing questions. "Interviews also allows for greater depth than is the case with other methods of data collection." (Cohen et al, 2007, p. 269)

From the thirty one participants who had completed the questionnaires, interviews were conducted with six of the participants. The interview participants were selected based on the responses to the questionnaire and according to the different races, different gender and different areas that they resided in. In this way I figured that I would be able to gather data rich in information about different experiences. Semi-structured interviews were conducted with each of the six participants at different times.

The interviews were video recorded. According to Atkinson and Delamont (2006), an interview in a qualitative research is usually recorded and translated. He gave the following reason why interviews should be done in this manner namely, it helps to correct the natural limitations of our memories and allows more thorough examination of what people say. It permits repeated examinations of the interviewees' answers and it opens up the data to public scrutiny by other researchers who can evaluate the analysis that is carried out and it therefore helps to counter accusations that an analysis might have been influenced by a researcher's values or biases. Finally it allows the data to be reused in other ways from those intended by the original researcher. (Atkinson and Delamont ,2006, p.321)

3.7 Data Analysis

This study, on the ACEML teachers begins with essentially a quantitative orientation focusing on the identification of variables that could be linked to the specific research questions. A sequential explanatory design is employed by first carrying out a substantive interrogation of the quantitative data followed by an extensive analysis of the qualitative data. Creswell et al (2000, p.225) describes its (sequential exploratory design) characteristics by the collection and analysis of quantitative data followed by the collection and analysis of the qualitative data. The two methods are integrated during the interpretative phase. In a sequential exploratory design, with a lead taken by the qualitative research, the paradigm may be more interpretive or participatory. The data was analysed according to the two different methods of research, from the questionnaire and from the interviews.

Data analysis is an important aspect of organising and explaining the information that has been collected. Once the questionnaires were collected, the data was read, collated and summarised into a document and analysed. This allowed me to look at the evidence that enabled me to proceed to the next phase of data capture since according to Adler (2000) the data collection process is mutually developmental. Each question in the questionnaire enabled me to "establish units of analysis of the data", which in turn enabled me to "indicate how

these units are similar to and different from each other."(Cohen et al., 2007, p184). A spread sheet was compiled for all the sections in the questionnaire. The data was analysed and reported statistically. However Section A dealt with personal questions and they differed from individual to individual. Section B consisted of Likert-scale type questions. The participants had to give their impressions about the ACEML program. Data reduction was also used where the responses were counted and the data was represented with two compound bar graphs. Tables and graphs allow the reader "to see at a glance where differences and similarities lie between individuals." (Cohen et al, 2007, p. 266).One can see clearly a display of frequencies of occurrences and responses at a glance. Section C consisted of narrative type question were the participants had to explain or give reasons. These responses were also tabulated on the excel spread sheet and were summarised provided a background of the teacher and gave a basic understanding of how the participants perceived the ACEML program. It also gave a broad outline of what gaps they had of understanding and practising the curriculum. They also gave an indication of which parts of the curriculum they enjoyed and had a good understanding of. The tasks of the participants were then analysed.

The interviews which involved close interaction with my participants, allowed me to gain a deeper insight of the individuals as experienced by Graven (2006, p.101): "Data collection would need to include teachers talking about their practice…..to access such data would involve close interaction between the teacher and myself (as researcher)." (Graven, 2006, p.101).

Analysis of the data generated from the interviews comprised of numerous steps, which involved a lot of "moving back and forth between steps." (Taylor-Powell & Renner, 2003, p.2). This was clearly evident in the interviews that were videotaped. The transcripts had to be listened to a number of times in order to fully understand what was really been told and then make sense and create and impression of the data that was collected. (Cohen et al. 2007, Taylor-Powell & Renner, 2003). The interviews were transcribed into written format and I was then able to examine more clearly the perceptions of the six participants of the ACEML program.

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. They identified a vast number of changes taking place in their participation, practices and their identities. Most important of all was their growth in their professional development, pedagogical content knowledge and their identity. Participants also indicated that learning also boosted their confidence and they related this concept of confidence to engaging in NMMU community of practices. Hence we once again note Wenger's (1998) learning components namely practice, identity, meaning and communities.

In line with Lave & Wenger (1991), Wenger (1998) and Graven (2006) which concerned learning in communities of practice, in my research all the participants were part of a community that studied the ACEML either at UKZN or at NMMU. Hence it was necessary to see the individual teacher in relation to NMMU or UKZN and to see NMMU or ULZN in relation to the individual teachers who constitute it. As a researcher I explored each individual case to determine the commonalities, differences and the similarities. (Cohen et al, 2007). The information was put into categories. This was done by a process of identifying themes and patterns and then into sorting and organising into coherent categories". (Taylor-

Powell & Renner, 2003, p. 2). The data sources also reflected exactly what the participants said and did in both the questionnaires and the interviews and this according to Lave and Wenger (1991) indicates that the data includes teachers 'talking within practice.'

A further layer in the data analysis process involved using the emerging themes to provide answers to the research questions. The figure below depicts how the data from the two data sources contributed to answering the research question:

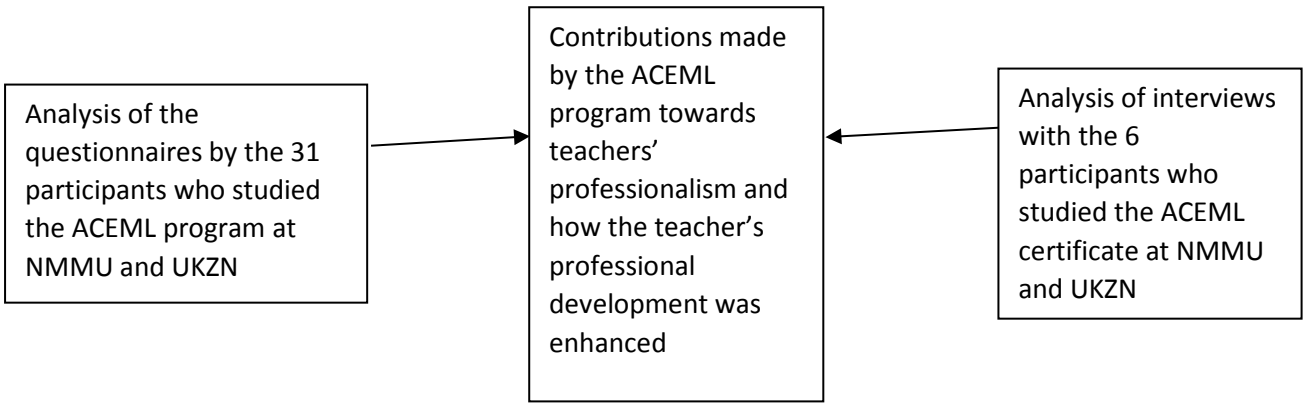


Figure 3.2 Process of Data Analysis

3.8 Issues of Validity and Trustworthiness

In this research data was collected in different phases. The questionnaires were given to the participants and collected a few weeks later. These questionnaires were completed in the absence of the researcher.

According to Cohen et al. (2007):

> "…it enables the respondent to complete the questionnaire in private, to devote as much time as they wish to completion…and to avoid the potential threat or pressure to participate caused by the researcher's presence." (Cohen et al. 2007, p.344).

He goes on further to states that in doing this the researcher allows the participants to reveal sensitive matter and to give more real and valid information. According to Merriam (1998) "reliability is problematic in the social sciences simply because human behaviour is never static." (Merriem, 1998, p.145). Reliability in certain studies refers to the degree of consistency with which different observers assign the same category to data (Hammersley, 1992 in Silverman, 1993, p.145). This research contains data that is available to the readers in terms of video recordings and transcriptions so that categories and themes can be seen and recognised. The quantitative data obtained from the questionnaires is also supported by the qualitative data obtained from the interviews. This research was not compromised although I lectured to the participants. Reliability of data is significant in that the data was captured on video as well as the questionnaire.

According to Golafshani,2003; Stenbacka,2001; Lincoln & Guba, 1985 researchers state that the concept of validity is more applicable when conducting quantitative studies than qualitative studies, and in order to ensure that the research is rigorous and valid, appropriate

criteria must be used. Hence we note that reliability and validity are the focal point in any discussion of rigor in the research (Silverman, 1993) and validity is the key issue in qualitative research (Maxwell, 1992). Adler (1996) notes that in the use of qualitative research validity lies in the relationship between interpretation and evidence. This involves two types of validity namely, descriptive and interpretive validity and theoretical and explanatory validity (Maxwell, 1992). Nyabanyaba (2002) also asserts that validity concerns transparency.

This is reiterated by Graven (2006) that

> "…it is important that researchers supply as far as possible the data from which various assertions are made. More importantly…must make available as far as possible, information relating to the context of the research and the nature of the relationship between the researcher and the researched." (Graven 2006, p. 134).

Graven 2006, argues that issues related to concepts reliability a validity differ according to the

> "…nature of the research conducted and the philosophical and ontological assumptions of the researcher. In some research, traditions achieving objectivity is crucial in judging the reliability or validity of the study. This assumes, firstly that objectivity is possible, and that secondly, that there is an empirical reality out there that can be objectively represented." (Graven, 2006, p.133).

Adler states conversely that objectivity is a myth, and that research is infused with values, positions, choices and power relations. The interviews in this research, which formed a part of the qualitative phase was conducted personally by the researcher. This allowed for a "free and relaxed atmosphere for the interviewees." (Thembela, 2012, p48). The venues used was familiar to the participants and the researcher. It can be seen that the researcher was the key instrument of the research and just not a tool. This relationship that existed between the researcher and the participant over the years reflects the community of practice according to Lave & Wenger (1991) and Wenger (1998). Cohen et al. (2007) stated that "the involvement and in-depth responses of individuals secure a sufficient level of validity and reliability." (Cohen et al., 2007 p.134).

Cresswell and Miller (2000) input on the data is as follows "data are saturated to establish good themes or categories, and how the analysis of the data evolves into a persuasive narrative." (Cresswell and Miller, 2000, p .125). However crucial information can be lost during the analysis phase through at different times, for example when the interviews are being transcribed. Hence we see a need for more than one method of data collection. Researchers can choose the option of using the process of corroboration, which will in turn enhance the likelihood of others finding the research "credible and worthy of consideration." (Khan.M.B, 2008, p.40). According to Keys (1997) the process that is involved in corroboration is triangulation (mixing the methods). Cresswell and Miller (2000), define triangulation as "a validity procedure where researchers search for the convergence among multiple and different sources of information to form themes or categories in a study." (Cresswell and Miller, 2000, p.126). Cohen et al, (2007) describes triangulation "as the use of two or more methods of data collection in the study of some aspect of human behaviour." Hence a greater degree of confidence in the validity of the data can be observed, especially when multiple methods are being used and similar results are being yielded. Through a

process of triangulation one can check and verify data that is collected and also at the same time find trends that are followed as well as trends that do not exist, using theories of absurdum. Cohen et al. (2007**)** also states that "exclusive reliance on one method may bias or distort researcher's views." Golafstan (2003) emphasises that the method of triangulation of data "will lead to more valid, reliable and diverse construction of reality." (Golafstan, 2003, p. 604).

Krefting (1991) spoke about the naturalistic criteria appropriate for judging the overall trustworthiness of qualitative study which are credibility, transferability, dependability and confirmability. The table below summarises the components with which to establish trustworthiness to research.

Table 3.3 Components of Trustworthiness

COMPONENT	CRITERIA	APPLICATION
1 Credibility	Prolonged and varied field experiences. Interview techniques	Participants completing questionnaires as written responses Participants completing interviews through audio visual-DVD Data analysis of questionnaires and interviews
2 Transferability	Dense description	Quotations from interviews. Excell spreadsheets from questionnaire
3 Dependability	Dependability audit Triangulation	Questionnaires Transcripts from interviews DVD of interviews
4 Confirmability	Confirmability audit Triangulation	Questionnaires and transcripts to be checked with cross reference to interviews on DVD

(**Krefting, 1991, p.219)**

The information in the table above assures reliability in this mixed methods research and indicates the essential component of trustworthiness.

Merriam (2000) talks about the importance of reliability when she says "reliability lies in others concurring that given the data collected the results make sense, they are consistent and dependable." (Merriam, 2000, p .27). The research contains a rich detailed description of the participant's background. This is important to the reader to "make decisions about the applicability of the findings to other settings or similar contexts" (Cresswell and Miller, 2000, p.129). Guba (1981) also supports this idea of a 'thick description' by saying that this

information is “reasonable to suppose that tentative findings of Context A are also likely to hold to Context B” (Guba, 1981, p.81).

3.9 Ethical Considerations

Cohen & Manion1994 and Merriam1998 are some of the writers advising researchers on how to proceed ethically ensuring the validity of the research, namely by providing tips on acquiring informed consents, access and acceptance, privacy, anonymity and confidentiality. Although this research is conducted within a South African context, the issues raised are not limited to South Africa. The issue about race and gender in particular is addressed in South Africa because South Africa is a country that is emerging from a period of apartheid and male dominance. According to Graven (2006), “Research conducted in South Africa is not ‘exotic’ and should not be ‘othered’. Rather these contexts should be seen as opportunities for illuminating research issues that might be taken for granted in other countries.” (Graven, 2006, p.119).

Although most of the participants in this research are familiar to me, since they are students of mine, the validity of their comments and the reality of the situation was not compromised. Another issue that had to be considered with the participants in my lectures was not to compromise the ‘good relationship’ that I had formed with the participants. Hence a sense of confidentiality had to be forged and this had to be through some kind of anonymity. However many participants were vociferous and wanted their input sent to the department of education. Setati (2000) and Graven (2006) stated that it was problematic to pay teachers for their participation in the research. I also agree with their statement since it may impact on the research in ‘unpredictable ways’. Setati (2000) explains the concept of reciprocity and explains that reciprocity should enable teachers to ‘pursue their own agendas while fulfilling the researchers agenda.” (Setati, 2000, p.519).

Vithal (2000) includes in her argument that choice negotiation and reciprocity are important in a democratic relationship and elaborates on what reciprocity really entails namely,

> “…ensures that the goals and outcomes of the research process will meet the needs of both the researcher and the research participants … keeps at bay the possibility for the research process to collapse by helping to secure the commitment and participation of the research participants.” (Vithal, 2000, p.572).

3.10 Limitations of the Study

The choice of participants in my study was a bit of a challenge at the beginning, since I was aware that mathematical literacy was a fairly new subject and that many teachers who were teaching the subject were not even qualified to teach the subject. There was also the rumour that the subject itself was very easy to teach, however the teachers who had studied the ACEML program felt that the unqualified teachers were not doing good job as they mainly consisted of mathematics teachers who were using methodology used to teach mathematics. They were mere teaching rules and not teaching within a context. Although I had lectured to the teachers in the ACEML program it was difficult to reach all of them since they had come from all parts of KwaZulu-Natal. The teachers from the B.Ed. honours class that I was

lecturing in at that time consisted of students, who had qualified at UKZN and NMMU. Some of the teachers whom I approached were not teaching ML at that time as well. It also took a long time retrieving the questionnaires from the participants, since I was only seeing them once or twice a month. The choice of participants for the interview also posed a problem. For analysis of the questionnaires I chose a few participants for the interview. However a few of them could not be accommodated in the times that was available. Hence new participants had to be chosen. Managing time was a bit of an issue since many travelled from a distance to the lectures. I had also selected participants according to race, gender, rural and urban.

I used a convenient sample, comprising of the teachers that were available. Hence it does not permit any form of generalisation and this is so apt in the following statement that is made by Cohen, Manion and Morrison (2000) "as it does not represent any group apart from itself, it does not seek to generalise about the wider population." (Cohen, Manion and Morrison, 2000, p.103).

Merriam (2000) also has this view that:

> "…since small, non-random samples are selected purposefully in qualitative research, it is not possible to generalise …the general lies in the particular; what we learn in a particular situation we can transfer to similar situations subsequently encountered." (Merriam, 2000, p.28).

Only three of the teacher surveyed were teachers' who were had not progressed to the next level of their studies while twenty eight of the teachers were successfully completing their B.Ed. honours in ML. The lapse in time from the time the teachers had completed the ACEML programme to the time the research was done was 3years hence the teachers had gained more knowledge in terms of content and PCK.

3.11 Summary

A mixed method approach as defined by Cresswell (2006) was used. This mixed method approach comprised of a quantitative and a qualitative approach. Key's qualitative research constructs of purpose, reality, viewpoint, values, focus, orientation, data, instrumentation, conditions and results form a strong link in this research. A convenience sample of 31 participants was drawn from graduates of the ACEML program from the NMMU and UKZN. Six of these participants were chosen from this sample and interviewed. 28 of these participants were completing the B.Ed. honours. Tasks of the participants were also analysed

CHAPTER FOUR

RESULTS

In this chapter the questionnaires, the tasks designed by the participants and the interviews with the teachers who have studied the ACEML program will be critically analysed. By doing this analysis I will report on what the teachers learnt and experienced whilst on the ACEML program. To fully understand the context of this study, analysis was done in terms of a survey of thirty one teachers who had studied the ACEML program for two years. From this group, three teachers have already completed their honours degree in ML, one did not study further for personal reasons while one had enrolled but dropped out in the first semester and the other twenty six teachers are currently in their final semester of their honours degree. Furthermore, a sample of six teachers from the above survey was interviewed and an analysis of these interviews will be presented. The questions in the quetionnaires were designed in such a way that the participants had to relate specifically to the ACEML program. Interview questions also related specifically to the ACEML program. Note that each of the teachers were assigned a code so that they can be identified while remaining anonymous.

SECTION A

ANALYSIS OF THE SELECTED SURVEYS

Under this subsection an analysis of the thirty one surveys was done. The survey was done with the thirty one teachers and comprised of nineteen questions. Section A, that is, Questions 1,2,3 and 4 dealt with the teachers personal particulars namely their teaching experience in the last few years, subjects and grades they are teaching at school, current post level and qualifications and reasons for enrolling for the ACEML program, and whether they are currently teaching ML at school. Section B namely questions 5 to 14 consisted of questions dealing with the teachers impressions of the program. Question 5, 6, and 7 dealt with the following issues namely, the tutors, the centre and communication with the university. Questions 8, 9, 10, 11, 12, 13, 14 and 15 dealt with the program itself and section C which consisted of questions 16, 17, 18, and 19 were questions in general on what impact the program had on them.

4.1 Background

In this part of the survey I presented an analysis of the background to the study of the teachers themselves, namely the schools they teach at, their formal tertiary qualifications, their rank at school and the reasons for enrolling in the ACEML program. Question 1, 2, and 3 formed this part of the analysis. The 31 teachers come from and live in both rural and urban areas. The towns include Durban, Umlazi, Ladysmith, Vryheid, Drakensberg, Pietermaritzburg, Pinetown, Port Shepstone, Harding, Greytown and Kwamashu. Question 1 dealt with the teachers experience in the subject in the last few years. Only one teacher indicated that she had not taught ML up to the FET phase since the school she teaches at goes up to grade 9, while another teacher only taught up to 2008 since she is now office based. The rest of the twenty nine teachers who had done the ACEML program are currently teaching

ML. Question 2 dealt with the teacher's current post level and the teaching qualifications they had prior to enrolling for the ACEML program. Six of the teachers were level 2, one was at level 3 and twenty four of them were level 1. All of them had a qualification of a three year teacher's diploma and twenty eight of them were currently studying towards their honours degree in ML. All teachers agreed that the main reason for enrolling in the ACEML program was to retrain, and were teaching other subjects. Six teachers indicated that they taught mathematics previously and that they had a mathematics qualification while the rest of the teachers taught one of the following subjects namely biology, physical science, accounting, agricultural studies, English, history, geography, IsiZulu, economics and business studies. They also indicated that they were the only teachers who were either chosen by the principal or opted to do the course on their own.

4.2 Impressions About The Program

4.2.1 Impressions Of The Tutors and the Centres

Question 5 dealt with the teachers' impressions of the tutors with respect to their knowledge of the content, their explanations, preparedness and attitudes of the adult. Most of them agreed or strongly agreed on all five points, while five were neutral on tutors being fully prepared and three were neutral on whether they considered the tutors considerate and empathetic. Question 6 dealt with the centre that the teachers attended. Twenty four teachers indicated that they agreed or strongly agreed conditions were good while twenty two agreed or strongly agreed that there were sufficient resources, the university appointed manager was available and useful and that they as teachers felt welcome at the centre. Nine teachers were neutral in each of the above. The majority of the responses for question seven was positive, at least twenty three teachers agreed or agreed strongly on all of the communication with the university namely, process of the calculation of the Duly Performance (DP), DP appeal process, special requests, timetables, feedback on tests, registration details and examination results. In each category there were two teachers who disagreed or totally disagreed.

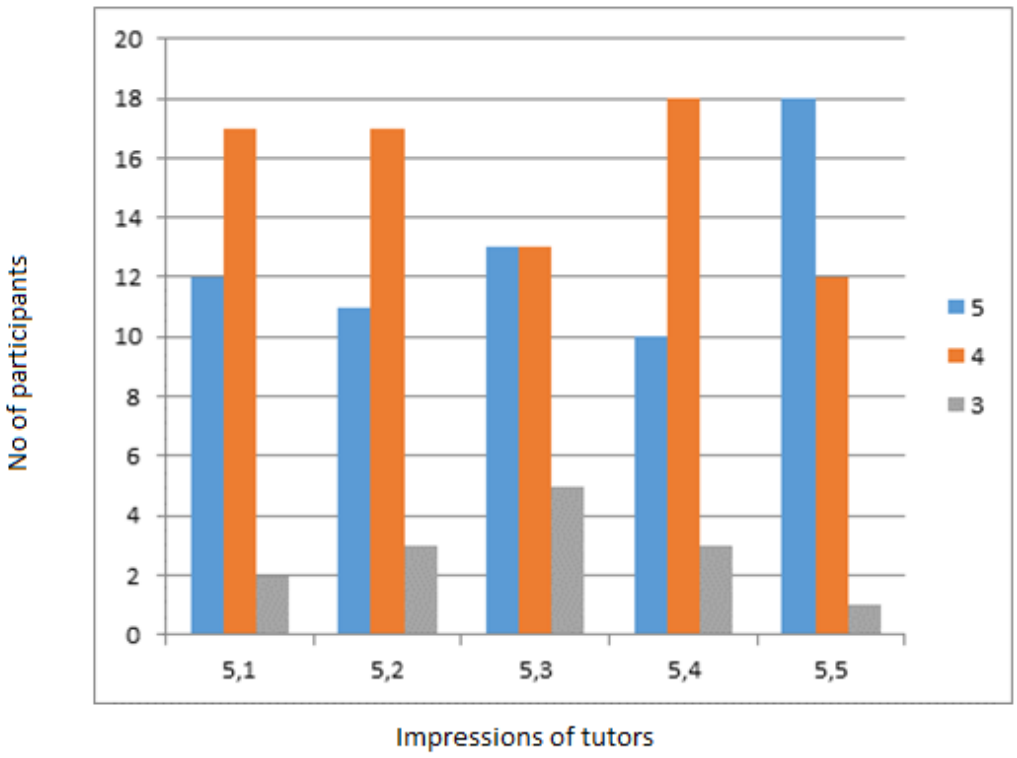


Figure 4.1 Impressions of the tutors and the centres

Code 5 strongly agreed

4 agreed

3 neutral

In figure 4.1 seventeen teachers strongly agreed that the tutors knew and were able to explain the content well and eighteen of them felt that the tutors were empathetic and considerate to their situation and treated them as adults. The same number of teachers either strongly agreed or just agreed that that the tutors were well prepared. Only a small number of teachers, on an average of three remained neutral. This indicates that the teachers had good impression of the program.

4.2.2 Results Of The Teachers' Participation

The teachers indicated they were overwhelmed by the results of their participation in the ACEML program. Of the twenty nine teachers seven agreed and twenty two agreed strongly that their content knowledge and their teaching strategies improved while two of them remained neutral. Twenty eight teachers agreed or agreed strongly that their assessment skills improved tremendously. All the teachers admitted that their confidence in the classroom as Mathematical Literacy teachers increased and hence they strongly agreed or agreed. Only one teacher wished to be neutral about the results of the learners while thirty of them agreed or strongly agreed that the Mathematical Literacy results have improved.

Since Mathematical Literacy is a new subject and noting that that only six of the teachers have a mathematical background, it was of importance to look in detail at the responses about the content knowledge. Many of the teachers who completed the course were teaching Afrikaans, IsiZulu, history, biology, physical science and subjects not related to mathematics. Hence they found the content knowledge fairly new. **HDJ** a teacher who previously taught history commented that ML was a 'hands on' approach to the environment outside the classroom. Even those who previously taught mathematics (**MS, NSD, JBD, TERM, SSG, TM**) in a formalized way found that using a context brought reality to the subject and the learners in the classroom. It increased their awareness of what they were doing and therefore found that their teaching strategies were improving each day. Another teacher **NCBH** commented that some content can be improved on, meaning that that program should incorporate more examples and more contexts in order to expand the teachers' knowledge.

The teachers felt that their studies were made easier for the following reasons: twenty five teachers agreed or strongly agreed that the materials were readable, clear and useful while five were neutral and only one teacher disagreed. Twenty seven teachers felt strongly that the tutors were supportive while four of them were neutral. Thirty strongly agreed or agreed that the tutors were knowledgeable. All the teachers either agreed or strongly disagreed that there was a good link between what they learnt in the sessions and what they were assessed on. Twenty four of them agreed that the students in their class were supportive and helpful, while the others did not agree. All of this was addressed in question 9. **HDJ** commented that he had a good rapport with the tutor and his peers, and he was the student representative in the class. Question 10 looked at other means of support that the teachers received. Twenty two teachers agreed or strongly agreed that their studies were made easier because they had a supportive family network, seven were neutral and two disagreed with this. Only seventeen teachers felt that they received support from the school management and colleagues, eleven were neutral and two disagreed and two totally disagreed. Twenty felt that the contact sessions were well paced and not too intensive, eight were neutral and two disagreed while two totally disagreed. Seventeen felt that they had sufficient time to study and that the centre is not very far away hence their studies were made easier. Fourteen felt otherwise.

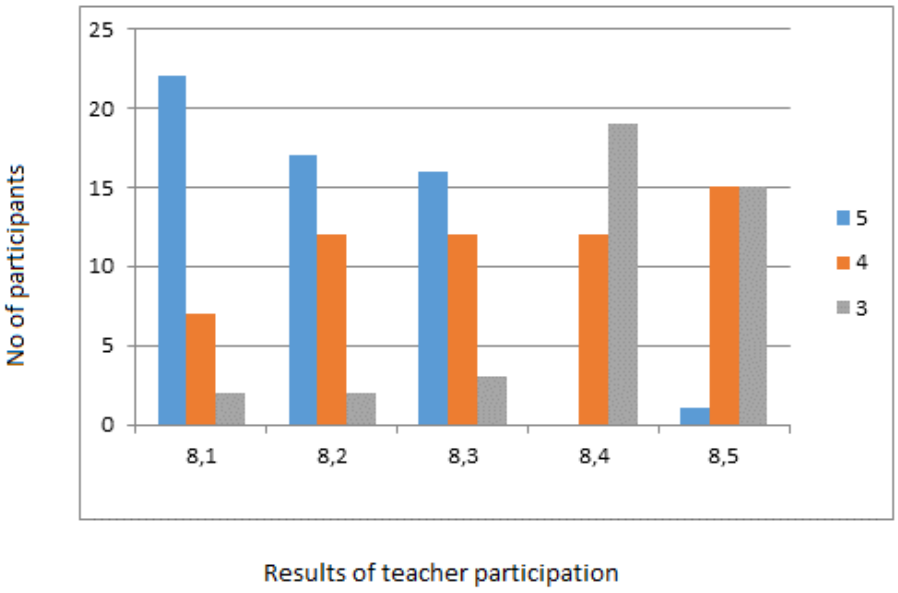


Figure 4.2 Results of the teachers' participation

5 strongly agree

4 agree

3 neutral

The graph in figure 4.2 above shows how the teachers felt as a result of their participation in the ACEML program. Twenty three teachers felt strongly that their content knowledge had improved, mainly through the fact that many had little or no knowledge of mathematics. Through their participation seventeen teachers strongly agreed that the teaching strategies and their assessment skills as well as their confidence as a ML teacher had improved, whereas twelve of them agreed that there had been an improvement. Thirteen teachers agreed that their assessment skills and their confidence as ML teacher had increased. However fifteen teachers agreed and fifteen teachers were neutral about the ML results of their learners showing any improvement.

4.2.3 Factors That Helped Teachers Remain In The Program

Question 12 and 13 dealt with the teachers who dropped out of the ACEML program. The teachers had mixed feelings about why the dropout rate for the ACEML was high. Nine teachers agreed that students did not have a supportive family network while nine disagreed and the rest were neutral. A possible reason for remaining neutral could be due to the fact that the teachers were pursuing with their own goals and the fact that they still had the same responsibilities to do at home and at school. There was a similar attitude towards support from their school management and colleagues. Their workloads at school did not change. Management expected the same output from the teachers and at times there was even envy from colleagues at the school since these teachers who were studying and would get some monetary gain as well as be elevated to another level or grade in their career. Ten of them

agreed that dropping out was also caused by the contact sessions being too intensive since the classes were held on a Saturday and started at 8h00 and ended at 16h00. Classes were held every Saturday in the month hence the teachers felt that they had very little time to do other things. Twelve disagreed on this point and the rest were neutral. An important point to see is that sixteen of them agreed that students dropped out because they did not have sufficient time to study and had too far to travel to the centres. The rest disagreed on this point. Six out of thirty one teachers felt like dropping out of the course while the remaining twenty five had no such feelings showing that this group of teachers were highly focused.

These twenty five teachers were happy because they felt that the course was interesting and contained subject matter that was relevant to what they were teaching in the classroom. The comments by some of the teachers on why they did not drop out of the ACEML program can be categorized into four main groups.

Representing knowledge

Firstly, many teachers made comments related to improving their knowledge in ML or helping ML learners. **JBD** felt that the course was interesting and was eager to help learners who were not capable of doing mathematics. **TCM** stated that she figured out the importance of having mathematical literacy as she did not have mathematics. **SPM** stated that he was passionate about learning that he had a very good tutor in the ACEML program. **SPM** said that the modules were very interesting and relevant to curriculum taught at school. **NMM** stated that she wanted to teach ML and have the knowledge and skill and also that she felt that she had to continue because she was a bursary holder. **BFM** liked to gain knowledge of the new subject and stated that the tutors were delivering the subject content in a very interesting way and were always ready to answer questions that were asked. Since mathematical literacy was life related it also helped them in their own personal lives like working with budgets and finance, doing home improvements using the sections on space, shape and measurements and various other decisions. These sentiments were raised by **TERM. GTN** had the desire to obtain more knowledge.

Representing goals

Secondly, some of the teacher's comments were related to achieving the goals they had set, on how support from other people kept them going on with their studies and not dropping out. **PJM** wanted to achieve her objectives. **SCM** felt that he wanted to achieve his goals and finish what he had started.

Representing empowerment

Thirdly, two teachers commented on how support from other people kept them going on with their studies and not dropping out. **TERM** said that persuasion by fellow students kept him going on. **AN** stated that he continued because he had a supportive spouse

Representing support from others

Fourthly, many teachers felt that this was an opportunity for their empowerment in terms of qualification and greater re-numeration. **SNZ** felt that she was under qualified. **ZPN** and **L** felt that if they dropped out of the program then they would have to pay back the bursary that was given to them by the department. **NCBH** felt the desire to graduate and empower herself in her teaching strategies. **GTN** was hopeful that her salary would increase on completion.

4.2.4 Modules That Were Most/Least Useful To The Teachers

Questions 14 and 15 were based on the modules that were most useful and least useful and which made a huge difference in their teaching of ML. There were many things done in the ACEML program that made a huge difference in their teaching and learning of ML. Some of them, namely, **JBM, SNZ, GTN, GBN and SSG** stated that the modules revived their teaching methods and strategies and teaching of data handling became very good. Learners in their class taught learners in other classes. **TJK** also went on to say that the zone of proximal development that they learnt in methodology helped them to teach the learners in their own classes by taking them through the different stages in their learning. **OBN, SNZ, TPM, AN, HDJ and L** stated that the most important aspect was that what was taught in ML was applicable to the lives of both teachers and learners. **NCBH and SSG** stated that the teachers also emulated the methods used by the tutors in their classrooms. One of the teachers, **SSG,** said that she had always avoided word problems in her teaching. After studying the program she became really good at it and is now able to link the content to the context and solve word problems. Many teachers namely **HDJ, SSG, TM, ZPN, L, GBN** also mentioned that they always avoided teaching problems in space, shape and measurement. Their knowledge on the use of scale was limited since they had not learnt any mathematics since they had finished school. They were now confident in teaching the content in the above sections. Teachers like **OBN, SNZ** and **TERM** also learnt how to budget, read their water meter and tariffs and also learnt about calculating interest rates and saving money. **TERM and SPM** stated that ML was useful in that it allowed learners to make sound financial judgments

4.2.5 General

In question 16 under general 87% of the teachers felt that mathematics teachers could not teach ML confidently without having studied the ACEML program, since mathematics is taught formally with rules and no context while 13% remained neutral. 93% of the teachers disagreed with the fact that their subject matter knowledge in mathematical literacy was adequate before they enrolled in the program and strongly agreed that the program has improved their subject matter knowledge, namely concepts and application. Only 9% indicated that the ACEML program should have been replaced by 2 or 3 weeks departmental workshops and 91% felt that the ACEML program was a necessity. About 7% of the teachers felt that they had some degree of content knowledge as well as teaching strategies of ML from their experiences or from other studies. 98% of the teachers also felt that the program had introduced them to new strategies that they are now implementing in their classrooms. 88% felt more confident in a ML classroom than if they had not studied it, and that a formal ACEML qualification is very necessary for one to teach ML. Their confidence has increased to such an extent that they can participate in any mathematical literacy related debate with

peers and that they can defend the introduction of mathematical literacy as a subject. The participants saw themselves as belonging to a group of professionals after studying the ACEML program. They felt strongly that this study has made them effective teachers in the classroom. All the teachers felt that ML teachers should study this program since it extended their content knowledge as well as their PCK.

The table below shows a breakdown of the data as per each given criteria

TABLE 4.1 Teachers general Impression of the Program

	1 Strongly Disagree	2 Disagree	3 neutral	4 agree	5 Strongly Agree
16.1 Mathematics teachers can confidently teach ML	20	7	2	1	1
16.2 Subject matter knowledge in ML was adequate before they enrolled for ACEML Programme	19	8	1	1	2
16.3 ACEML programme has improved their subject matter knowledge	2	0	0	9	20
16.4 The ACEML programme could have been replaced by 2 weeks to 3 weeks	20	4	1	1	5
16.5 The ACEML programme has introduced them to new teaching strategies that could be used in their classroom teaching	1	0	0	16	14
16.6 A formal ACEML qualification is not necessary for one to teach ML if one has a background of mathematics	18	7	1	4	1
16.7 You feel more confident in a ML class than you would been if you had not studied the ACEML program	3	1	1	10	16
16.8 You can participate in any ML related debate with confidence with peer educators as a result of studying the ACEML program	0	0	0	14	17
16.9 You understand most Government policies in education better after enrolling in the ACEML programme	0	1	6	12	12
16.10 You can defend the introduction of ML in the FET to people who still criticise	0	0	2	7	22

the introduction of the subject after studying the ACEML					
16.11 You see yourself as belonging to a group of professionals after studying the ACEML	0	0	4	5	22
16.12 After completing the ACEML you really feel that you would not have been able to teach ML effectively had you not enrolled for the ACEML programme	0	0	3	8	20
16.13 You would recommend to any ML teacher that they should study this programme	0	1	1	7	22

4.3 SUGGESTIONS MADE TO NMMU AND UKZN FOR THE IMPROVEMENT OF THE PROGRAMME

Question 18, dealt with suggestions that they would give NMMU in order to improve the ACEML program. The teachers who were surveyed were the first lot of teachers in KwaZulu-Natal to which the ACEML program was introduced. This analysis was discussed within this context. One of the teachers, **MS,** felt that the universities should increase the enrolment of teachers doing the course per year, and **PJM** felt that the number of centres should be increased so that students would not have to travel long distances to attend lectures. **TGM** stated that contact sessions should be extended, however the load of work must be reduced, for example, the number of assignments and tasks must be reduced. **GTN** felt that Saturday classes should continue but the frequency of Saturdays should be twice a month. **TJK** felt that in-service courses were necessary. There was also a strong need for checking resource material namely textbooks to ensure that all learning outcomes are catered for. According to **SSG t**utors used mainly chalkboard and textbooks which was available. **HDJ** felt that teachers should use more teaching and learning materials from outside the classroom as well. Universities should have provided more resources for example technology in the form of computers and data projectors which would have made lectures more interesting. **SSG** also indicated that more content for mathematics needs to be added to develop teachers since many of the teachers attending the program had no mathematical background or were not mathematics teachers either. Teachers must be shown how to use teaching and learning knowledge outside the classroom. They must be shown how to use material from outside and integrate it in the classroom. All educators felt that the program was very good and every module done was understandable.

In question 19 the teachers were asked to comment on what issues they would immediately attend to if they were the minister of education, in order to improve the quality of learning and teaching Mathematics, Science and Technology in our schools. M**S** felt that all subjects must be treated equally in terms of ranking especially ML at tertiary level. **NM** stated that every learner should do ML, in other words ML should become a compulsory subject at

school for grade 10, 11 and 12 learners. **JBM** felt that all schools should have proper laboratory equipment and should ensure that teachers can handle the equipment properly. **JBD** stated that he would ensure that the basics are taught thoroughly at the GET level so as not to experience problems. **PJM** felt that he would intensify the in-service training for the teachers. **MCM** stated that she would make the teachers understand that mathematical literacy is as important as mathematics. **SCM** would ensure that teachers receive a thorough training session through support programs at the beginning of each term so that they are well prepared for their lessons. **TGK** would make mathematical literacy compulsory for all learners. **SPM** would ensure that all teachers get special training before they even start teaching the subject since it has helped her a lot in teaching the subject. **ZPN** stated that she would give bursaries to teachers who wanted to enrol in mathematical literacy, hire specialists to assist teachers in schools, arrange workshops for teachers and learners and hire qualified teachers to teach the subject. **SSG** felt strongly about the need to improve methods that teachers used in the classroom and would train them thoroughly in one week. **TM** would ensure that subject advisors are supportive so that they know exactly what to do in the classroom with the aid of prepared work schedules.

SECTION B

4.4 TASK DESIGNS BY THE PARTICIPANTS

Contexts which help learners understand some of the complexities of real life, are important tools in ML. Thus a key competence of an ML teacher is the ability to design suitable, relevant and meaningful tasks which can contribute to this end. Hence ML teachers need to produce clear, unambiguous tasks which allow learners to investigate issues that they encounter. I provide here a selection of tasks that participants designed for assessment purposes in the programme, and which they used in their own classrooms.

4.4.1 This task was designed by PJM

This task was designed for a grade10 assessment on scale drawing.

pg 13/14

13

Instructions and information

1. Answer all questions.
2. You may use calculators, but you must show ALL calculations.
3. Read the questions carefully before you write the answers.
4. Write neatly and legibly using blue or black ink and present your work neatly.
5. Number the answers clearly and in accordance with the numbering system used in this task.

Question 1

1.The scale on a road survey map is 1 cm : 500 m (1 : 50 000). Find the actual length that the following map measurements represent :

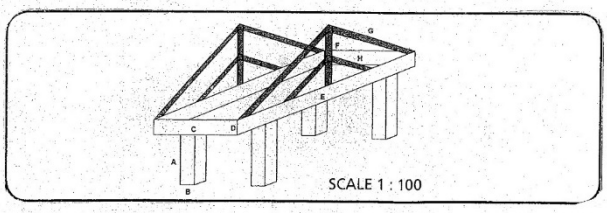
1.1 4 cm 1.2 9 cm 1.3 3,5 cm 1.4 15 cm (1 x 4 = 4)

2.The width of a pavement in a scale drawing is 5 cm. What is the actual width if the scale is 1 : 25? (2)

3.The height of a building is 48 m. What is the height of the building if the scale is 1 : 2000 ? (2)

Question 2

The picture below represents a plan of a bridge that Zizi intends to build in her garden. The picture has been drawn in a scale of 1 : 100. In other words, 1 cm on the plan represents 100 cm in actual size.



The table below contains the measurements of the sides of the bridge. Some of the measurements represent the length of the sides as drawn on the plan, while others represent the actual size of certain sides of the bridge.

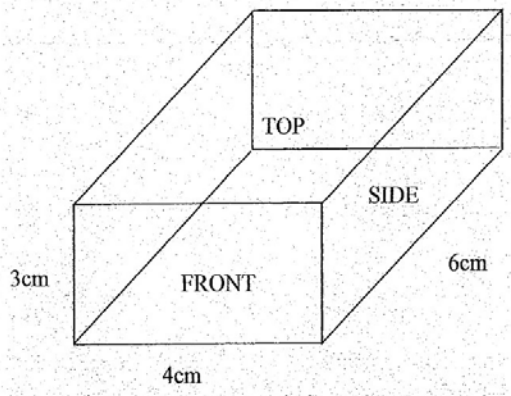
You need to complete the table by filling in the necessary measurements.

Side	Description	Length on plan	Actual size (in metres)
A	Height of leg	1 cm	
B	Width of leg	0,3 cm	
C	Width of beam		1,75 m
D	Height of beam	0,3 cm	
E	Length of beam	40 mm	
F	Height of support	1,2 cm	
G	Length of top strut		2,65 m
H	Length of middle strut	8,5 mm	

(1 x 8 = 8)

Question 3

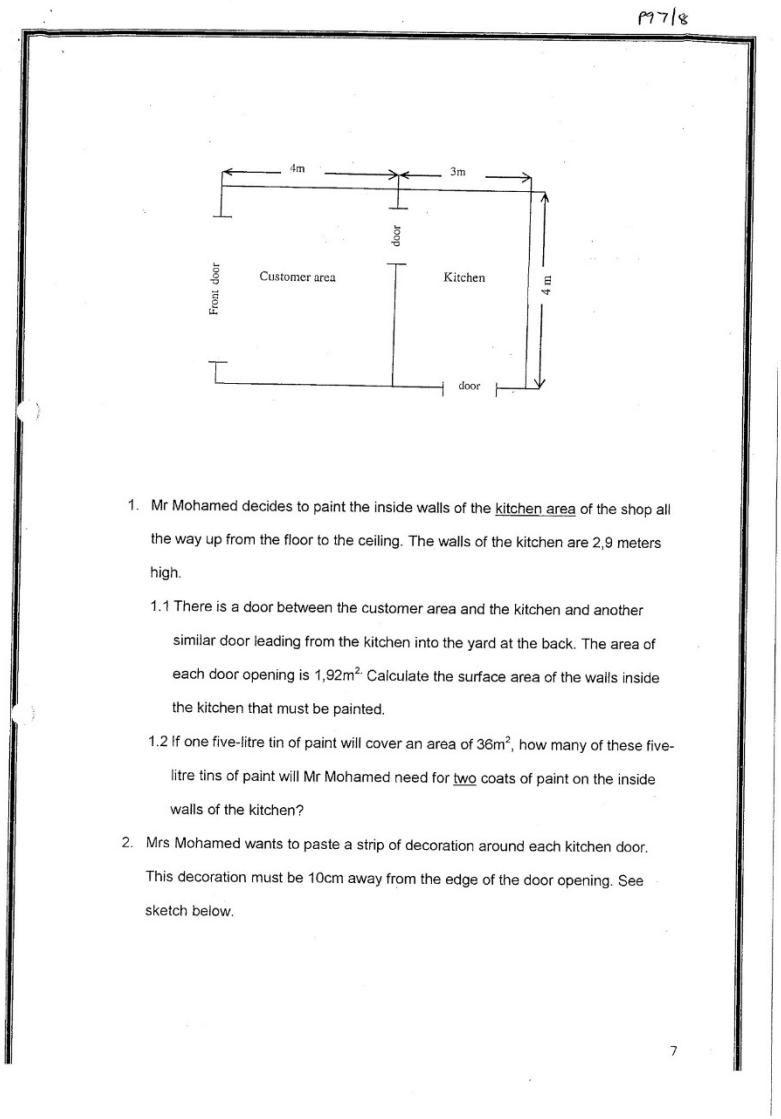
The picture below is a 3-D representation of a box.



3.1 Draw pictures of front, side and top/bottom or the box. (2x 3 = 6)

An analysis of this task raises some concerns. Questions 1 and 2 of the assessment tested only one concept, namely finding either the actual length or scaled length. All the questions are set at level 1 of the assessment taxonomy. Level 2 and level 3 questions could have been included. Question three did not test anything about scale drawing. This would have been a classroom activity rather than a test since the questions were repetitive. Question 3 did not test scale drawing, it merely asked for a copying of the different faces.

4.4.2 This task was designed by GBN



P97/8

1. Mr Mohamed decides to paint the inside walls of the kitchen area of the shop all the way up from the floor to the ceiling. The walls of the kitchen are 2,9 meters high.
   1.1 There is a door between the customer area and the kitchen and another similar door leading from the kitchen into the yard at the back. The area of each door opening is 1,92m^2. Calculate the surface area of the walls inside the kitchen that must be painted.
   1.2 If one five-litre tin of paint will cover an area of 36m^2, how many of these five-litre tins of paint will Mr Mohamed need for two coats of paint on the inside walls of the kitchen?
2. Mrs Mohamed wants to paste a strip of decoration around each kitchen door. This decoration must be 10cm away from the edge of the door opening. See sketch below.

7

This task had questions set at different levels which were an important aspect of assessment. However the mark scheme was missing. The assessment was also very short. Perhaps a time limit should have been given.

4.4.3 This task was designed by HDJ

Figure 2: Grasscutting task (Juganandan)

Benny: The clever grass cutter who makes money while the sun shines !!!

Benny is a grass cutter who charges a fee to cut grass which may be of different heights. He uses his foot, ankle and knee for measurement. This unique and practical method of measurement determines the price you pay for his grass cutting service.

Let us now bring the maths in practice from outside into our classroom.

Lets revise the formulae for area first.

Area of a square = $s \times s$
Area of a rectangle = $L \times B$
Area of a triangle = $\frac{1}{2} b \times h$
Area of a circle = πr^2

Benny uses his "feet a stride place" to measure distance (which could be the length, breadth, diameter or base of a triangle)
He uses his ankle and knee for the height of the grass/shrub. This is how he determines a price for his service:

SQUARE PATCHES OF GRASS

- For square areas, he requires a minimum of 10 stride for each side of the square. (For smaller squares he charges as for a 10-stride square).
- If the grass is ankle high, he charges R50 per square of 10 strides
- If the grass is knee high, he charges R100 per square of 10 strides.
- If the grass is above knee height, he charges R120 per square of 10 strides.

CIRCULAR PATCHES

- He measures the diameter and then charges as he would for a square of 10 strides.

TRIANGULAR PATCHES

- He measures the base of a triangle and charges it at half the price that he would for a square with that length.

Questions:

1.Calculate in cm :
a)the length of your stride
b) the height of your ankle
c) the height of your knee
d) the height of your leg

2. Consider grass that is just ankle high. Investigate which shape of the grass patch is a better deal for Benny.
3. Now investigate which height of the shape you mentioned in Question 2 above, would be a better deal for Benny

This was an excellent task that explored estimation by an employee, who had no mathematical skill in accurate measurement and costs but a good skill in estimation and costs. The task was well planned and well thought off in terms of the context and the questions,

since it explored a real life context and was designed by a teacher who had experienced and recognised this everyday life experience in a mathematical context and **HDJ** was able to incorporate all levels of questioning into the assessment. However if one had to compare the first (**PJM's**) and second task (**GBN's**), with the third (**HDJ's**) task, the third task comprised all levels of questioning, and was linked to a real life context with the second task also linked to real life contexts. The task was carefully planned and each step was clarified. The evidence and the presentation of important and crucial information made solving mathematical literacy problems easier since this information helped to convey meaning to content specific terms, signifiers and

SECTION C

4.5 Interviews

Under this subsection the analysis was presented. This was a qualitative study, and therefore each interview was analysed. An interview with each teacher was presented followed by a summary description of the interview in terms of the teachers' biography, subject matter knowledge and methods of teaching.

4.5.1 TERM

The first teacher whom I interviewed was **TERM**. He was 43 years old, taught in a rural area. Learners who attended this school came from a disadvantaged background and did IsiZulu as their home language and English was their second additional language. He has an ACEML qualification and is presently teaching mathematics and mathematical literacy from grade 10 to grade 12. He is a post level 2 teacher and is currently completing his B.Ed. honours degree in mathematical literacy at the NMMU. His reason for enrolling for the ACEML program was that he was qualified to teach another subject and wanted to retrain to teach mathematical literacy. Furthermore he was the only teacher who could be persuaded to enrol. He also stated that the principal had asked all the teachers to apply since the DoE was paying the fees and he was the one chosen by the department. He stated that he wanted to do the course because he did not know what mathematical literacy was about and was not looking at an opportunity to upgrade since any teacher who already had a B.Ed. honours degree would not qualify for upgrading, only those who have a 3year teacher's diploma would.

When questioned whether it was easy to teach the content and whether it was enjoyable teaching it, he commented, "actually … I enjoyed teaching mathematical literacy more than mathematics after I did the ACEML program." When he was questioned on why he enjoyed teaching mathematical literacy more than mathematics he stated that it was easier to explain since the problem was based on a context, so it was easy to discuss and share with the learners the context and as a result the learners knew what was expected of them and hence knew how to solve the problem, whereas with mathematics it just involved solving for **x.**

On the question on the program's impact on his professional development in terms of the content knowledge, he reacted by saying, "As I have said, the content was clearer, many

things were easy to apply and deliver because it was based on context." His response to the question on how it impacted on his professional development in terms of his teaching methods, he said, "The teaching as well was made easy by the very same fact that it was based on the context, so it was easier to relate to the learners when the problem is based on the context." He also explained that this kind of teaching involved giving the learners the problem and then both the teacher and the learners were involved in a discussion and hence there was greater understanding when the real teaching took place. He was also able to vary his methods of teaching, like group discussions in terms of the contexts, and also other methods that he applied or used during his study of the ACEML.

The programs impact on the professional development in terms of his confidence as a teacher in the classroom was great. He stated, "The confidence was high because it was not like mathematics which I was teaching where some learners feared mathematics. When they do mathematical literacy and you explain to them they enjoy it, they understand it … we and our learners are now moving together." He went on further to discuss that professionally he thought about post student teaching and had learnt how to impart knowledge to the learners and how he approached teaching.

At the time that he was studying the ACEML, NMMU offered the course in terms of grades 10, 11, 12 and a theoretical module. Using the textbook "Mathematical Literacy" by Marc North was sufficient and very good for him at that time. The mathematical literacy content was sufficient and covered all that was taught to the learners. He now has confidence in all the sections of ML being taught at school because he had taught ML since 2006 and has mastered the sections. His experience as a grade 8, 9, 10 mathematics teacher helped him in his studies since he observed that the other students in his ACEML class who did not have a mathematics background struggle a bit with the content. When he was asked about the learner's misconceptions and how he coped with these misconceptions he replied that misconceptions occur in certain areas and that if you as a teacher picked up on these misconceptions then they were easy to deal with it. If you prepared your work you would also know what to expect of them ad it would be easy to find these misconceptions and would hence discuss those with them and show them how to approach these problems with reason.

In conclusion: **TERM** found through his study of the ACEML program that teaching using context helped him professionally in solving many problems in terms of analysing the question so that learners got a better understanding of the problem. The content became more meaningful and relevant through the context and he was able to teach and have discussions with the learners in order to find the solution. Unlike mathematics the question just did not involve solving for the unknown x. His teaching strategies and methods also evolved around the discussions he had with the class itself and within the context he was using in the question. His confidence as a teacher grew enormously because of the learners being involved in solving the problems through participation and discussion again with the context.

4.5.2 HDJ

My second interview was with **HDJ** who taught in a school that catered mostly for a disadvantaged community. These learners spoke IsiZulu at home but did English as their home language at school. **HDJ** was 49 years old. He was previously qualified to teach history and geography and had taught these subjects for the past 29 years and taught one class of

mathematical literacy per year up to grade 12. He still taught his core subject history. He was a level 1 teacher and had a 3year teaching diploma and bachelor's degree. He studied the ACEML two-year program after he had applied for it with other teachers at the school. He was chosen by the DoE. His principal encouraged him to persevere, as well as, the fact that he wanted to upgrade himself in terms of having enough knowledge in mathematics. He also felt that he was qualified in some subjects and had a fear for mathematics that he wanted to overcome.

The next question posed to **HDJ** was on how the ACEML program impacted on his development in terms of his content knowledge. He responded by saying, "It added to my content in terms of mathematics itself. I was able to use that to empower my students to do better in their classroom." He went on to talk about how he was able to estimate and do calculations in his own personal life. He used the example of redesigning his front garden. He had to do some concreting, build a flower garden and layout a grass patch. He was able to draw up a plan, calculate the area of each part and work out the cost of all the materials that was required. He was also able to calculate how much he would pay the labourer for the job done. He thus carried this whole plan to his class and presented a lesson on space, shape and measurement together with a budget, income and expenditure.

In terms of his professional development with the teaching methods he stated the following, "It changed the way I did business with learners in terms of teaching methods, in the classroom itself and in terms of patience…I was able to get into….exploring situations."

When questioned about whether teaching mathematical literacy helped him in teaching his the other subjects and whether he gained more confidence in himself, he replied, "I think in the new curriculum, and the integration of programs, we don't teach a subject in terms of isolation. This subject was able to help me especially in grade 10, 11, 12 geography … use different formulas…scale drawings on maps in the classroom. In terms of history, using space, shape and measurement … shocked to see that the area of the floor space inside of the Taj Mahal measured 56 square metres." He implied that he was very confident in the module on space, shape and measurement. He showed me a model that he made during his second semester in the ACEML program. It was a model of a petrol and service station. He had drawn it to scale before making the model. He had thoroughly enjoyed doing the project. He also indicated the different shapes he used namely a square, rectangle and a semi-circle. He also indicated the measurements. He was sure that had got very good marks. He used this model to demonstrate to his learners problems, encountered on space shape and measurement.

He also indicated that the tutors were like teachers in a classroom. The materials they used were relevant and practical. They had sufficient material which they could use in the classroom. Furthermore he stated that mathematical literacy was a "hands on subject, it's where you take your syllabus and what you do with the grade 11's and 12's. In this classroom we ask the learners to bring their rulers, pencils and tapes and ask them to measure …and when they know the height of the door they know that they cannot have a door more than 2metres high… Here they see the perspective of size." He acknowledged that learners do have misconceptions because they were coming across to mathematical literacy for the first time in grade 10 and it was a new subject although it is an offshoot of mathematics itself, learners think that is very easy.

In conclusion: **HDJ** felt strongly about the content that he had learnt in space, shape and measurement in the ACEML program. He had been able to bring to his classroom the enthusiasm he experienced and the confidence he gained. He enjoyed this module and it had given him the confidence to teach the subject in a practical manner. Their ability to measure and see measurement in the right perspective made the subject a "hands on subject." He also saw the context being integrated across other subjects. Professionally it had helped him to adapt his teaching methods and strategies in bringing reality into the classroom not only in mathematical literacy but also in the other subjects, namely history and geography that he taught.

4.5.3 PJM

My third interview was with **PJM**. He was 45 years old. He also taught in a disadvantaged community. He currently teaches accounting and mathematical literacy from grade 10 to grade 12. He has a three year teaching diploma, the two year ACEML certificate and is in the final year of study in the honours B.Ed. mathematical literacy. He stated that he was qualified to teach another subject and did the ACEML so that he could retrain. He went on to state that he had taught accounting for a number of years and he felt that he needed a change and since mathematical literacy was interesting and dealt with figures he decided to study it. He said that he saw the DoE bursary for the ACEML program as an opportunity to upgrade his qualification.

The program had an impact on his professional development in terms of the content knowledge. He stated, "I think the whole course empowered me as a person because when I started mathematical literacy I did not know exactly what it was about but when I started the course, I realized it was more relevant, so for me it was very empowering. It related to things I would encounter in life." In terms of professional development relating to teaching methods, he considered himself an old teacher who had taught for twenty years hence he was exposed to the new approach of teaching in the ACEML program. He stated, "There was this new approach of teaching in class…for me it did make a difference equipping myself with the new methods of teaching in class." It was difficult for him to say at that time whether the content was good enough or not because he was unable to compare it anything else that he knew. However he was happy with what he was given and he felt that they were in fact useful. The knowledge that he gained in the ACEML program enabled him to stand in front of the class and teach the mathematical literacy confidently. He confessed that he was a product of the old system and used primitive methods but with the ACEML program he was trained with a new approach and his methods changed drastically. "The approach to teaching was totally different from how we were trained before so there is a big difference with the approach." He was also happy with the new approach since it gave learners more time to engage themselves in the classroom. He also felt that it was important to teach grades 8 and 9 learners' mathematics since you get to know your learners better and you are able to prepare them for the next grade. A greater effort was made with emphasis on information that they required in the new grades.

Professionally his confidence levels grew. He stated, "It brought more confidence in me. During the entire duration of the course we were dealing with all sorts of problems and this made me more comfortable in terms of mathematical problems." Hence we saw a boost in

his content knowledge and his confidence increasing through this. As far as the learners were concerned he found that the content was relevant and it was easy to relate the content to the learners since it involved matter that we normally encountered in our real life. He stated, "It was more empowering and it was relevant to the learners and they could relate to the content because it is things that they experience in the real world." He also found that the grade 12 work that they studied involved a lot of mathematics and was very relevant to him. However he also enjoyed the grade 10 and grade 11 content that they had studied. He also never thought of quitting the program at any time because of the kind of support he got from his tutor.

With English as the second language, and ML being context based, the medium of instruction and understanding the context may sometimes become problematic especially for rural learners. He stated the following, " I think that it is the context that is the problem ...the learner from the rural area are not exposed to a lot of things … but in terms of the language itself it becomes a disadvantage even for the learners from the urban areas if they don't understand the language properly." In his particular case he feels that since he had been teaching for a long time he did not really have this problem. There were many learners out there who didn't understand the content and context because they didn't understand the language.

He stated that he was very fortunate that his tutor was able to instil confidence in him in order for him to be able to handle different problems. The tutor was a "good guy" who helped him a great deal, brought a lot of confidence out in him and he was comfortable with that He also felt that that the duration of the course was too short. However he was able to handle a number of issues relating to mathematics and given more time he would have found a bigger difference. The theoretical aspects dealing with the program was complicated for him since the language used was difficult for him to comprehend, after all English is his second medium of communication.

In conclusion I can state that **PJM** has benefited from the ACEML program. It had empowered him in terms of the content knowledge in the classroom since the context within which he was teaching deals with real life problems. He was very confident in the classroom because of the methods that he had used, that is, by involving learner participation and learner involvement. He felt that language barriers may pose a problem for teachers and learner who had English as the second medium of communication.

4.5.4 SPM

My fourth interview was with **SPM** who taught in a rural school and most of the learners came from disadvantaged homes. She is currently teaching grades 10 to 12. She is a level 1 teacher with a three year teaching diploma in mathematics, a two year ACEML program and is currently studying towards a B.Ed. honours degree in mathematical literacy. She enrolled for the program because she knew that mathematical literacy was a new subject and wanted to know what it was all about She also wanted to learn it well before she taught it to the learners. She was also told by her principal that the department was giving a bursary towards this study and she saw this as an opportunity and hence enrolled for the program.

When questioned on the impact the program had on her professional development in terms of the content knowledge, she said that the program really taught her to become a mathematical literacy teacher. All the topics that were covered in the program were what the learners were taught in the classroom. As a mathematics teacher she found that mathematical literacy was difficult at the beginning, but as she got used to the content she was able to teach her learners well. Whatever content she learnt encompassed real life situations which brought reality to the subject.

Professional development in terms of teaching methodology was excellent. She used an example of teaching areas and perimeters. The methods she learnt at the program was exactly what she used in her classroom, unlike the methods that she used when she taught mathematics and she felt the she was teaching herself and not the learners. Prior to doing the ACEML program she used to even shy away from the topics on area and perimeter but now she is called by other teachers to teach this topic in their classes. The impact of the program in terms of her confidence in her classroom was huge. She said, "I am very confident when I am teaching the mathematical literacy because I know the skills of teaching mathematical literacy and I know the learning outcomes and I know what is expected of me to teach each of these learning outcomes." She also stated that she enjoyed the grade 11 module in the program. The module on theory was not enjoyable. She also felt the grade 10 module a bit challenging. The textbook by Marc North which was used extensively throughout the program was extremely useful and good. The books could be used up to grade 12.

She stated that at no time did she feel like dropping out of the course because of the support that she received. She also mentioned that the course was quite relevant and she learnt exactly what was required to be taught in the classroom. She felt that the skills used in teaching the subject in her previous qualification was much different. In mathematical literacy there were a lot of materials that one could use and one got a lot of support in terms of teaching a subject that brought reality in the classroom. She found herself using the PCK in teaching her other subjects as well.

She found that teaching mathematical literacy in a black school had been a challenge since there had been a language barrier. Learners had difficulty in understanding the context and hence did badly in tests because they had difficulty answering the questions. Yet when you taught and explained, the learners said that they understood what was being taught. It boiled down to the fact that the learners had a language problem. There was a lot of reading to be done in mathematical literacy and learners had to follow a story and understand the story before they could answer questions.
In conclusion, **SPM** had become a confident mathematical literacy teacher because she had learnt content in terms of context. The context had brought reality into her classroom and the problems became easier to teach and understand. The program had helped her to become proficient in the new teaching methods. However for her learners language formed a barrier.

4.5.5 NM

The fifth person interviewed was an Indian female **NM**. She taught at a school which was located in a semi urban area. However the learners who attended the school lived in the townships and settlements throughout Durban. She has a three year teacher's diploma and had taught Afrikaans for 15 years. She had studied the ACEML program for two years. She

wanted to study this program because she felt that she was a teacher of languages for a very long time and she felt that she needed a change and also she wanted to upgrade and do something new. She is currently teaching grades 10 to 12 mathematical literacy at school. She also teaches grade 8 mathematics. Another thing that attracted her to the program was the fact that the department of education was offering a bursary to study towards the ACEML certificate.

When questioned about the impact that the program had on her professional development in terms of her content knowledge she replied, "I can say that it helped to a certain extent because mathematical literacy is a diverse subject. The program touched on certain aspects of mathematical literacy that we are doing in school, it did not go into the deeper aspects of it. It gave me a broader knowledge of it. It helped getting me into a new subject." She also felt that the content and the context dealt with real life situations and that was what made the subject so interesting and easy for the learners to comprehend. In terms of content she said, "The content was intense and if you look at the notes they gave you, the source material, and past year examination papers as well, it was very helpful." However she felt that there should be an additional course to update their knowledge as new content was introduced. She felt that she had to deal with new content all the time especially with contexts and questions in past year examination questions in grade 12. The university should therefore assist teachers by not only teaching content from textbooks but teach teachers how to answer past year examination questions. Although she felt that the contact sessions were a lot and occurred during the holidays and weekends. She thoroughly enjoyed it because she said "whatever knowledge we were getting ...was enriching me".

The impact on her professional development in terms of her teaching methods was immense. She stated, "Basically, when we saw how the learners got us to do new stuff and to get children to draw graphs and we introduced them to graphs like things like that. Also the different ways we can use to introduce our lessons." Here she explained the fact that she learnt a lot of different teaching skills and methods from her tutors that she could use in her classroom. She also explained that previously she taught languages and that the strategies she used in teaching were totally different and that there were so many aspects that she learnt that gave her a "lot of confidence to teach" and the training helped.

She also stated that there were many aspects in general that gave her a lot of confidence to teach in the classroom. Some of the aspects included "It broadened my knowledge. There was such a bulk of knowledge that we were given and it did not touch on ML only, it touched on the entire mathematics spectrum. Looking at the content, the content was quite intense and if you look at the notes they gave you, the source material that they gave you and the past year exam papers as well, it was very helpful. We could have had an additional course to update our knowledge as the new work comes in." Her most useful module was data handling since she felt her lecturers were very good and they gave her lots of content to take back to school. She felt very confident in teaching the content on this section and her learners enjoyed it. She also felt that every module was enjoyable because her lecturer taught them well. Whatever knowledge they were given was enjoyable because it was very enriching. The materials that she received were readable and sufficient and exercise and explanations were given and this helped especially when she taught grade 8 and 9 mathematics since all the knowledge she got from mathematical literacy helped in teaching rotations and transformation geometry. Knowledge gained from grade 8 and 9 mathematics is essential for grade 10 to 12 ML.

"There are some basic sections…volume and surface area that I was not aware that learners knew at grade 8 and 9 level…solving for x and transposing values and dividing." She stated that these basic procedures are taught at grade 8 and 9 levels and learners must be reminded of these methods. She also went on to explain that she did not see much difference between things you did in ML and mathematics although mathematical literacy is contextually based and mathematics involves a lot of abstract work.

She, at no point while studying the ACEML course, wanted to drop out because it was so interesting and that every module was informative and at no time did she feel demotivated or anxious, although it was a challenge. For her it was an opportunity that was given to her and she enjoyed it. In conclusion **NM** felt that she had gained content knowledge professionally and had developed into a confident teacher. Her teaching methods have improved. However she felt that the university should hold more classes to develop the teachers further in how to handle context especially in terms of past year examination type questions.

4.5.6 GBN

The sixth teacher interviewed was **GBN**. She previously taught at a rural school in northern KZN which catered for black learners with English as their second language. She is currently teaching at a secondary school which is a suburban multicultural school that has a population of 950 learners consisting of 3% Indians, 4% coloureds, 1% whites and the rest of the learners 92,8% blacks. These learners come from a range of different black townships and rural settlements. Namely Kwa-Mashu, Inanda,Umlazi, Lindaleni, Ntuzuma, Richmond Farm and Newlands East. She has a three year teacher's diploma and is currently a level 1 teacher. At her previous school, she was a level 2 teacher specializing in commerce and science. She accepted a drop in her rank at the new school because she wanted to relocate. She studied the ACEML program because she wanted to retrain and was given a bursary by the DoE to further her studies and improve her qualification and also that she was going to be the first teacher to teach the subject at her school. She also stated that another reason for studying this course was the fact that she wanted to gain new knowledge and wanted to know what was happening in this new subject. She also enrolled for the B.Ed. honours degree in mathematical literacy but dropped out in the second semester of the course because of personal problems. She is currently teaching mathematical literacy, mathematics grade 8 and natural science grade 8/9 and isiZulu grades 9/10.

In terms of the impact of the content training reflected on her professional development she stated, "The content of mathematical literacy is related to our world, it is interesting because we are dealing with things we are doing in our daily life. So I find it interesting and I also gain knowledge …" She commented that she was taught grade 10 content initially and she found it "not simple" and she was also not used to the style in which she was being lectured to but she felt that the content was relevant and eventually grades 11 and 12 content became "simple and easier to understand." The content covered in the modules was sufficient to teach all grades at school and the content was related. She also felt that the tutors were doing more and more content and as a result their knowledge increased tremendously. She also found space shapes and measurement enjoyable. In pure mathematics she found this section to be difficult to understand but in mathematical literacy she found this section to be easy to

understand because of the way she was lectured to. ML “became simpler to do.” In fact she said that she felt comfortable with all the modules that were taught to her. The books and materials used were relevant and the tutors were very good. They taught her everything in a step by step manner.

She has also gained much knowledge with regards to her teaching strategies. She found that with mathematical literacy, which dealt with real life situations learners were better equipped to understand and she could use the same methods that the tutors used in the program. She was also able to use the one on one strategy with her learners and explain to them until they understood all the concepts of mathematical literacy. She used a lot of repetitive and remedial teaching as well so that her learners got a good conceptual understanding. The biggest barrier she found that the learners and she herself had was the language problem especially when relating to the contexts and answering of contexts. She however code switched from English to isiZulu and back if the learners had a problem understanding the concepts. She sometimes taught language skills as well for interpretation. But what she taught her learners was that “what we are dealing with in mathematical literacy, we are coming across it every day and you have to understand everything surrounding you. It gives one ideas on things we need to know.”

As a mathematical literacy teacher she has become confident in terms of the content knowledge that she had gained from the ACEML program and the manner in which she handled the context because the problems all related to real life situations. She was also able to use different teaching strategies with individual learners so that they were able to learn different concepts so that they learnt with meaning and understanding. Although both she and her learners have language barriers she used creative ways in solving the problem by code switching from English to isiZulu and back.

4.6 Summary

This chapter gives a comprehensive analysis of the questionnaires. The following aspects were analysed and included the participants impression about the program, the results of the teacher participation,and factors that helped them remain in the program.Factors relating to them learning new content knowledge and pedagogic content knowledge, changes in their beliefs and Identity as well as suggestions made to the universitys about the program. The tasks of the teachers well also analysed. A discussion of the teachers interviews followed

CHAPTER FIVE

RESULTS AND CONCLUSIONS

5.1 Introduction

This chapter provides a summary of the previous chapters as well as provides answers to the research questions. The study explored the ways in which the ACEML program at the NMMU and UKZN influenced the professional development of particular teachers in KZN. The teacher's professional development encompasses, content knowledge, pedagogical content knowledge and the changes in their beliefs and identities as ML teachers. This study provided a thorough analysis of the context of professional development and the impact it had on the teachers as they navigated through their studies in the ACEML program. It also explored the new pedagogic and mathematical content that the program challenged them with and how these teachers adopted their roles in relation to their community of practice and how their practices and beliefs had changed within this new community of practice.

In chapter one the research study was introduced and contextualized. The research design was that of a case study approach, where teachers were first given a questionnaire and then interviewed in order to determine what contributions were made by the ACEML program towards the professional development of the ML teachers as well as how the professional development of the ML teachers was enhanced.

In chapter two an in-depth analysis of the findings on which the study was based is reflected by the literature review and the theoretical framework. Lave & Wenger (1991) and Wenger (1998) was one of the main components of the theoretical framework from which the data was analysed. Wenger's four components of learning, namely meaning (content knowledge), practice (pedagogic content knowledge), identity (identity and beliefs) and community emerged strongly. Using Graven (2002), Nel (2012) and Thembela (2012) a strong link was also evident with another component "confidence" which emerged through the content knowledge and the PCK through their research as well as this research. The content knowledge, PCK and identity and beliefs were also discussed in terms of Shulman (1986), Grossman (1990), Ball et al (2008), and Sullivan (2008) theories

Chapter three dealt with the methodology that was used namely a mixed method approach comprising the qualitative and the quantitative approaches. Although it was a mixed method approach there was also a presence of the interpretive paradigm as stated by Keys (1997).

Chapter four included an in-depth discussion of the questionnaires and the interviews that were done with the participating teachers. The findings were discussed and they were then categorized into trends which were then reflected on.

5.2 RESEARCH QUESTIONS

My main research question entailed:

1 **What are some contributions made by the Advanced Certificate of Education in Mathematical Literacy program towards the participating teachers' professional development?**

2 **How was the professional development of the teachers' who studied the Advanced Certificate of Education in Mathematical Literacy enhanced?**

In order to answer the above questions which seem very similar in many ways the following criteria was investigated, namely the content knowledge, pedagogical content knowledge and the identity and beliefs of the teacher. The words 'what' and 'how' are closely linked and difficult to separate because they are interdependent on each other since the 'what' helps understand the 'how' and vice versa. Therefore in this chapter the two research questions will be discussed together.

5.3 Improvement of Content Knowledge

I will first consider the domains of content knowledge. ML includes elementary mathematics content as well as contextual domains. Sullivan (2008) defines knowledge of mathematic as that which deals with learners' methods of finding answers through algorithms and intuitive reasoning. It can also be described as the ability to know what is within the subject structures and solve problems by using appropriate rules and formulas in the subject, use the correct skills in answering questions, sketching and interpreting graphs and maps, work with two and three dimensional shapes. Hence content knowledge of ML includes the aspect covered in Sullivan's definition as well as knowledge of the various contexts covered in the subject. The data presented in the previous chapter reveals three ways in which the programme impacted on their content knowledge and these are elaborated below.

5.3.1 The teachers learnt new content knowledge in mathematics

As a result of their participation in the program twenty nine of the thirty one teachers in the questionnaire agreed that their content knowledge had improved tremendously. This was due to the fact that only six of the thirty one of the teachers had a strong mathematics background while the rest were non-mathematics teachers teaching History, IsiZulu, Biology etc. The teachers concluded that they had learnt a lot especially in the section Space, Shape and Measurement. The twenty nine teachers admitted that they had even avoided this section in the lower grades and did not really understand what they were teaching at the grade 10/11 level of mathematical literacy. **TM, NSD, JBD, TERM, SSG** and **TM** who were

mathematics teachers revealed that they were now able to handle problem solving questions or story sums more easily. Although the teachers felt strongly that they acquired new content knowledge, they also wished that they would be provided with regular opportunities in future to build up on their knowledge. Hector (2011) indicated that ML teachers needed to be supplemented with more materials and supported at regular intervals to restore the gaps in knowledge about the content. This was affirmed by the teachers in the questionnaire by **MS, PJM, SCM, SPM, SNZ, HDJ, TM** and **GBN.** These were some of the comments made "intensify the in-service training for ML teachers an on-going process", "make sure that teachers receive a thorough training session to support the program… At the beginning of each term," and "all teachers get special training before they start teaching the section."

According to Ball, Thames & Phelps (2008) the need for Common Content Knowledge (CCK), Specialised Content Knowledge, Knowledge of Content and Students (KCS) and Knowledge of Content and Training (KCT) characterizes professional knowledge and these were needs that the teachers expressed that was satisfied by the program. **HDJ, SCM, TM** and **NJ** felt empowered with the knowledge gained in the different domains. Considering Lave and Wenger's four components of learning, namely **meaning** involving CCK where the participants learnt sections other than what they used in their classrooms for example trigonometry and linear programming. However much of the content learnt also helped them in solving problems in their daily lives as expressed by **TERM** who stated, "I learnt how to budget." **SNZ** stated, "ML is practical." **SSG** stated, "I never knew how to use scale." I also found Wenger's (1998) component of **practice** clearly visible in Ball et all (2008) SCK. Participants were able to take the specified content and contexts making that particular content visible to their students. Fifteen of the participants stated that "space, shape and measurement" became easier to teach. Some of them had even avoided teaching this section previously.

5.3.2 The teachers learnt new knowledge in terms of the context

Many of the teachers who had studied the ACEML program had previously taught subjects from other disciplines. As ML teachers they were expected to facilitate problems that were given in terms of a story or context which required the use of mathematics. These problems were also practical real life problems that required a special type of mathematical skill to solve. This challenge provided excitement and motivation about what and how they were going about the studies and their lessons in the classroom. ML provided the opportunity for them to link to their own experiences. Their prior knowledge became new in terms of the context. **HDJ** was so impressed with the program and commented that ML is a "hands on approach to the environment" and he was amazed that he could now calculate exactly what quantities he had required when he did some construction work at home and he was able to show his learners in the class exactly how to calculate costs using area and volume. He also felt that the content helped him cope with his skills in his personal life, especially in finance and his building and DIY skills. **HDJ** even constructed an assessment task as an activity. Contextual questions became a reality in his classroom. Space, shape and measurement and data handling were the two main sections that the teachers felt confident about applying in ML teaching since they had no basic understanding themselves prior to studying the ACEML. These were the sentiments of **HDJ, SSG, TM, ZPN** and **GBN. HDJ's** and the rest of the participants reflected Lave and Wenger's (1998) theory of learning with meaning and

taking a step forward and putting it into practice within the community of their learners. They could identify themselves as ML teachers with confidence since they could now also identify with the section on space, shape and measurement.

SSG stated that "the square, triangle, rectangle and the circle always fascinated her and before I enrolled for ML I avoided teaching word problems. Now I am very good at it and I also like it." Not only did the completion of the ACEML certificate give the teachers' competence in their professional development in terms of content knowledge, pedagogical content knowledge but also changed their belief in themselves and had given them a new identity, one of confidence and a love for their teaching. **NM** described ML as a "diverse subject" because the course extended her knowledge in a broad outline and felt that maybe more attention to details could have been covered. However she felt that because the content and context dealt with real life situations ML became a subject that was interesting and alive. **GBN** claimed that she had gained a lot of new content knowledge and also her skills and ability to handle the context has been empowered.

5.3.3 The various kinds of learning experiences of the Teachers

The data also revealed that one of the benefits of the ACEML programme was that it provided different learning experiences such as learning from tutors, learning from peers, as well as learning by engaging with different resources.

A Learning from Tutors

Many teachers also felt like they were back at school and found that the tutors explained the content in a manner that was clear precise and easily understandable. **NM** in her interview stated, "I liked data handling a lot because we had very good lecturers/tutors who were of very high quality." **PJM** stated, "The subject is relevant to the learners and they could relate to it because it deals with things in the real world." Everything they learnt could be compared to reality hence learning the content and taking it back to the learners was exciting and easy. Tutors were very hard-working and went beyond their duty and tried to explain each concept within the content in detail, since the majority of the teachers did not have a basic mathematical background. **BFM** stated, "The tutors were delivering the subject content in a very interesting way and were always ready to answer questions asked."

BFM's statement emphasised that the teachers also felt that the tutors went beyond the scope that they were expected to teach, since they expanded on the content knowledge by teaching them basic skills in mathematics, content that teachers had last seen or heard of when they were at school and had forgotten as well as exposed them to topics that helped them to be enriched, like problem solving in mathematics. This formed a solid foundation which they could implement at schools with their learners and a bank of general knowledge that becomes evident in contextual problems that they would find useful in their classroom. This built up capacity within them and hence in their classroom they felt confident and sure of their knowledge when students probed content and contextual problems in ML. **PJM** stated that the tutors instilled confidence in him by exposing him to a lot of different contexts. This in turn empowered him to expose the relevant contexts with his learners, those that he knew

they were comfortable with and was able to expose them to new contexts using the methodology that he felt comfortable with. **HDJ, PJM, SPM** and **NM** confirmed that the tutors taught well and gave them additional notes and resources to take back to their classrooms and this enabled him to teach confidently in their classrooms.

B Learning from Students

Some teachers reported that peer learning and teaching contributed immensely to their understanding of the content as well. They found that the community within which they worked in, namely the community of ACE students, the sharing of ideas, the ability to explain to each other concepts that they did not understand boosted their confidence levels. They also gained a content knowledge through discussions on certain topics. **HDJ** spoke about the support he got from group work and that he was very proud of this. **NM** also stated that through discussion with peers one could get the best knowledge and methods into one's head. Different teachers came from different backgrounds and different levels of thinking and different experiences**. SPM, OBN, TPM** and **GTN** were some of the teachers who explained how effective their discussion, sharing of ideas and experience during the breaks and during classroom activities helped build a tremendous and huge capacity of information that teachers could use in their classrooms with their community of learners. Hence there was a sense teaching and learning that was taking place within the community of NMMU and UKZN students themselves. Lave & Wenger (1991), Wenger's (1998) and Graven (2002) four components of learning, namely meaning, practice, community and identity emerged through the teachers engaging themselves in a community of practice. Their discussions and their sharing of knowledge also reflected strongly this idea of working within a community of practice. Peer discussion on an on-going basis through group and cluster meetings, telephonic conversations on ML is important as it helps in sharing of content knowledge and practices in the classroom thus giving meaning to what they had learnt. The curriculum in ML was new and teachers were expected to teach with only one week of workshop delivered by the Department of Education. Teachers were confused with the content and context and how to teach this together. The ACEML brought together teachers with varying abilities in knowledge and skills. By working together as a community of NMMU and UKZN students and the tutors the teachers gained much knowledge, support, comfort and experience. This enabled the teachers to air their views on the curriculum, discuss their problems relating to the curriculum, their frustrations of teaching the new curriculum with very little or in some cases no help from the department of education, and finding a way forward with the help of other teachers especially when it came to resources in solving the problems.

C Learning by engaging in Resource Materials

I have found that teachers require resources on an on-going process to supplement that which provide all needed resources to schools. After experiencing the resources available on the programme, the teachers were more conscious about the lack of resources and materials at their own schools. **GTN** also expressed the need for the department to "provide learning tools, especially in the form of calculators and other instruments" to the poor communities since ML is a practical subject and the use of a calculator is essential. The teachers at both universities were given study guides and a textbook. The teachers had to find other resources to supplement their work. There is however a need for teachers of ML to be sufficiently

trained to use technology in the form of computers and internet in order to research more content and contexts so that they can expose the learners to a variety of situations and hence become familiar with them as well as broaden their and their learners' content knowledge. There was also a strong indication for the need for resource materials in terms of textbooks, computers, workshops, in-service training and qualified ML teachers to enhance the teaching of ML. In relation to content training workshops the teachers felt that workshops should take place at least once a year or at the beginning of each term so that the can either be updated on new contexts and new content.

SSG and **HDJ** also commented on teachers making contexts practical by taking the learners into the environment and experiencing real life situations, calculating the costs involved when going on a field trip or excursion. Since teachers cannot leave their classrooms and attend workshops and in service training it is absolutely important that the teachers are well resourced in terms of textbooks, technology and internet compliant so that they can update themselves with ML content all the times. **SPM** verified that the ACEML program had made her aware of the numerous resources and materials that were available to make ML a reality in the classroom. There was evidence of teachers from well- resourced schools sharing resources with the poorer schools, in the form of textbooks and worksheets.

Teachers were encouraged to develop their resources as was evident from the task that was presented in chapter four by the following participants, for example, **HDJ'**s task on "grass cutting," **PJM's** task on "scale drawing" and **GBN**'s task on "areas". These examples illustrate that the teachers improved their content knowledge through the use of varied resources.

Lave and Wenger (1991), Wenger's (1998) four components of learning namely meaning, practice, community and identity played a significant role in the various ways that teachers were able to learn the content knowledge. As the teachers learnt new content knowledge they gained meaning. This knowledge they put into practice in their classrooms within a community of their learners. Their learning also consisted of working within the NMMU and UKZN community of peers and tutors, produced their own as well as learnt to use resource materials. On accumulating new content knowledge the teacher's beliefs changed, a boost in their confidence levels in the subject ML was seen and so did their identity change, since they now took ownership of the subject ML.

5.4 Improvement Of The Pedagogic Content Knowledge

In this category I consider that the findings reveal various ways in which the teachers' PCK was enhanced and these are now discussed below. ML is a new subject consisting of a different discipline requiring a different method of teaching. Shulmans' (1986) definition refers to PCK as an in depth understanding of how the subject matter 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, 1986b, p.7). 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. It is clearly visible that all four domains of knowledge,namely CCK, SCK and KCS, of Ball, Thames and Phelps (2008) is evident in the development of content knowledge of the participants as well as their development of tasks, and the contexts.

5.4.1 Integration of contexts and skills different from mathematics.

On completion of the ACEML certificate teachers felt comfortable to go to their classrooms and teach content which now became familiar to them as they had worked through similar examples in their lectures as well as in their own classrooms at school. **TERM** in his interview stated, "The content was clearer, many things were easy to apply and deliver because it was based on context … it was easier to relate to the learners … easy to understand … we were all working together now." **HDJ** stated, "It changed the way I did business with learners in terms of teaching methods, I was able to explore situations." The research has shown that as teachers learnt new content and tried to master this new content they moved towards mastering new methods of practice, finding new ideas in delivering the new content. ML unlike mathematics teaching required teaching from a context. It was clearly evident from the research that learning and knowing the content knowledge is just not sufficient but knowing how to teach that content is just as important. According to Johnson et al (2010) "knowledge is a necessary condition for teachers to change their classroom practice, but it is not sufficient on its own." (Johnson et al, 2010, p.181). Teachers initially taught in the traditional, conservative way by teaching rules, divorcing the context from the content since they felt that their role was to transmit mathematical content by means of algorithms, steps and procedure. **LP** who was previously a mathematics teacher found that when she started teaching ML she found some topics easy and some difficult and most of the time "I did not know where to start and how to teach because I was a maths person and I wanted to treat some questions as maths…when I was doing the ACEML I realized no, I don't need to do…as pure math." **PJM** stated, "... the old system and the way we taught was primitive and when we trained for this course it was drastically changed." However their engagement in the ACEML program developed the insight of formulating and developing rules and algorithms through the contexts, hence solving real life problems.

However with the ACEML program teachers now confronted the context and worked with their teaching from within the context. **PJM** stated that since he had no knowledge of elementary maths he found that he had a problem when he started teaching grade 10 ML since "there were things that were expected to be known by us of which I did not know and it was difficult." **GBN** found teaching shapes and measurement in ML interesting but found that in pure math 'this was very difficult." While many teachers embraced the idea of the new practice, many teachers were challenged in integrating the deeper understanding of the mathematics with the new forms of practice. These teachers were experienced teachers, hence they had some pedagogical content knowledge in the field of teaching other subjects. They had to however learn to teach the ML content to the learners in a way that they would understand it. This meant that the teachers also had to learn pedagogy using context which is what ML requires. **GBN** stated, "I think when we started grade 10 it was not so simple and not used to the style they were teaching us but the content was relevant and grade 11 and 12

was becoming simpler and easier." In my findings teachers were initially overwhelmed by this but through their studies in the ACEML program they have become confident. Shulman (1986) stated that that the knowledge that is required for teaching a particular content included an understanding of what made the learning of that content easy or difficult. According to Artzt (2008), this approach hid the teacher's vision of how much content he should know or how well he should know the learners he was teaching. Shulman (1987) stated that content knowledge and pedagogical content knowledge are dependent on each other. Hence we see that all the teachers in the survey agreed that their levels of confidence increased as they learnt new content and the skill to teach that particular content. **HDJ** was one of the teachers who stated that he had really changed professionally in terms of his teaching methods. He was able to "explore situations in terms of the context" and also developed a sense of patience with the learners.

HDJ found the following in his studies, "I found that in teaching my previous subject, geography, became more meaningful since I was able to integrate the ML studied in the ACEML program with the old subjects especially with maps and scales". According to **HDJ** in his interview, "this subject, ML, was able to help me especially in geography in grade 10, 11, and 12, whereby I was able to use scale drawings on maps that we use in the classroom. In history … I examined the Taj Mahal and was shocked to find that the building inside measured 56 square metres. … Using the globe I was able to use the globe in geography and show the learners how one can calculate time, distance and speed through measurement and mathematical calculation." ML is not taught in isolation but has its bearing in all subjects namely, hospitality studies, consumer studies tourism studies, accounting, business studies, civil technology and even mathematics. Hence teachers felt more confident in teaching and even changed their methodology with their old subjects. **SPM** also felt that the program had a huge impact on her confidence level since she had learnt the skills in the ACEML program. **GBN'**s ability to change her teaching strategies with individual learners, to enable them to learn with understanding and meaning is something that she learnt from the program. This has brought happiness to the eyes of the learners as well as to herself since she saw more learners passing and has given her immense pleasure and job satisfaction. She now finds teaching ML a pleasure and joy.

Multicultural classes meant that the participants brought in their own diversified cultures in the program enabling learning to take place in a broader spectrum. The incorporation of some aspects of their culture within the contexts made learning interesting and innovative especially in the post-apartheid South African context. Also teaching multicultural classes gave participants a greater sense of confidence since teachers besides being better equipped to teach content they were better equipped to teach context in a multicultural class. **HDJ** stated, "teaching my learners context became a joy and easier to explain." **GBN** felt "more confident with teaching within a context" and **NM** was overjoyed. This form of sharing in the learning displayed some form of "Ubuntu". The diversity in culture within the context made teaching and learning real and alive for the teachers at the ACEML program.

According to Venkat and Graven (2008),

> "…We cannot make broader claims therefore about the efficacy, usefulness or success of ML in schools. ML has offered openings for a different kind of engagement with mathematics, and importantly, it has offered these openings to learners who have often entered the FET phase with highly negative prior experiences of learning

mathematics. … Our findings in this school provide evidence that changing learners' perceptions of mathematical working is possible. Learners' comments alerted us to the need to provide clear contrasts with prior experiences in mathematics in order to successfully broaden access to and engagement with mathematical thinking and problem-solving. The implementation of ML in this school appears to have provided fertile ground for the opening of pedagogical and assessment spaces that foster a re-engagement with learning and mathematical sense-making." (Venkat and Graven, 2008**,** p.41)**.**

5.4.2 Emulation of teaching styles of tutors/peers

They were able to emulate their tutors, the methods of practice they used and adopt it with success in their classes. It was clearly evident that the teachers were very impressed with their tutors and clearly indicated that they used the very same methods that their tutors used to teach their own learners. This was possible with the NMMU students since their content that they covered at the university was based on Grades 10/11/12 work at school and the textbook that they used at the university was also a textbook that they could use at school. **NCBH, GTN, AN** and **SSG** stated, "the tutors were well prepared …methods in which the tutors were teaching us helped me …applied the same method with my learners." **TJK, JBM,** and **TCM** stated, "…the methods learnt revived my methods of teaching mathematics" and "methods used enabled me to move from what the learners knew to the unknown." Using Lave and Wenger's learning component of meaning community and practice emerged prominently since the participants saw meaning in what they were learning and practicing at their classes. The teachers also felt that they learnt methodology from their peers, especially when they were tasked to deliver lessons as part of their assessment task at the lectures. Through observation and critique they were able to develop their own pedagogic content knowledge. They also benefited when they were critiqued on their own lessons by their peers. Lave & Wenger (1991), Wenger (1998) and Graven (2006) view the community of practice as a primary base. In this situative learning the newcomers are inducted into new practices of the community by more experienced members and this seems to be the role played by the tutors.

5.4.3 Developing Skills in Task designs

The assessment on developing tasks for learners in ML must be appropriate for the learners of the community that they teach in. Hence we see that the design of these tasks is an important part of content specific pedagogy. Task design was a part of the tasks of the teachers as part of the methodology module. Teachers worked individually as well as in groups. It was also very evident that they worked as a NMMU community and learnt from each other through debates and discussions. The teachers were so confident of their methods as well as the content knowledge learnt from each other that they even taught and conducted workshops with other classes and teachers in their own school. According to Isaac (2009), "the depth of content knowledge determines the strength of the activities designed for teaching." (Isaac, 2009, p.82) shows that true learning has taken place in the ACEML program through a community of practice. The teachers were expected to design tasks as part

of their studies so that they could develop the necessary skills required. Some of the teachers developed innovative work examples while others still struggled to design tasks that covered the different levels of the taxonomy. **HDJ** often struggled a bit but designed a model of a service station that he had done for his project in the ACEML class. He has since, carried this to his own classroom and uses it as a display and model for his learners to emulate in their projects. Bansilal and Wallace (2008) stated that it was an enormous task for the teachers who had done the ACEML to develop tasks since tasks must be formed in terms of contexts. Task design forms a huge form of PCK. Language barriers, gaps in content knowledge and tasks that have too much ambiguity were detrimental in the setting of tasks in terms of contexts. However teachers indicated that they had improved in the development of tasks, through their tutors and peer discussions

5.4.4 Developing Skills in Assessments

Isaac (2009) states, "the depth of content knowledge determines the strength of the activities designed for teaching." This confirmed the students' reaction to the success of the lessons, assessment tasks and their confidence in their presentations of the lessons to their particular learners within their community of practice. The study also indicates that the teachers through their own research in the form of assignments were able to compare and contrast the depths of their own insights into the content and the pedagogical content knowledge in comparison to other teachers in their study. The tasks drawn up by the following teachers, **HDJ, GBN and PJM** as seen in chapter four were critiqued by the tutor and other teachers in the group as well as by themselves. As their content knowledge increased and they became more familiar with the context and levels of questioning and the types of assessment improved. Their assessment tasks showed that all of them displayed different types of assessment rating from poor to average and displaying poor use of context and levels of questioning. This helped them to determine their strengths and weakness which in turn helped them to grow progressively. They felt that they would not have had this opportunity to grow if they had not had these contact sessions. As seen in the analysis of the assessment tasks some of the teachers presented good tasks while others were not confident in the use of the taxonomy. The fact that teachers were able to communicate with different teachers from differently resourced schools, different cultures, different backgrounds both rural and urban had in fact a positive influence on the thoughts on the subject ML, its content, beliefs and pedagogic content knowledge. Teachers were able to also share assessments for their own learners, debate on the levels of question of their own tests and examinations, engage in debates about the levels of questioning which also made things clearer to them.

5.4.5 Identifying Misconception

The teachers' assessment of lesson presentation was a highlight of their study. They became reflective teachers since they were able to reflect on their own teaching, their strong points and their weaknesses. **HDJ** stated "it was a teaching learning situation…..we had time to rectify our mistakes and we had time to adjust ourselves." **SSG** also stated that they were able to accept criticisms and were able to transform in a way that made them confident teachers and were able to see presentations from another teachers' point of view as well as

from another perspective. This was one of the ways that they grew professionally. According to Venkat & Graven (2007) it was clearly evident that all teachers were unsure of how and what to teach in the ML curriculum, how to assess, but after engaging in the program all concepts became clearer, and if they had any misconceptions then these were clarified as well. It is important for teachers to identify their own misconceptions as well as that of their own learners when preparing tasks and this is one of the demands of content specific pedagogy. **TJK** stated that the concept of the zone of proximal development, they had learnt in the methodology class helped him in teaching the learners in his own class by taking them through the different stages of learning.

It was revealed in some instances that teachers felt that after they had completed the ACEML program they could change and adapt their teaching strategies at any given point in their lesson according to the demands of their class, the way their students understood the context and content at that given point. **HDJ, PJM** and **JBD** explained that they would then reflect on the lesson and if need be reteach by making specific changes and improvements and this was due to observation and criticisms that they had specifically done in the methodology modules in the program especially when they had to deliver lessons critique, their own as well as the lessons of others. They learnt how to become reflective and accept criticism. Being experienced teachers they also realised that change was important in a persons' life since learning has taken place. Changing practices within a community, by changing the subject that one has been teaching, changing their content knowledge, pedagogic content knowledge and their beliefs and identity was in fact largely due to reflection. Reflection of the teachers' view of themselves as ML teachers, practitioners in the classroom and the ability to deliver skills in the classroom is what the ACEML program has taught the teachers.

5.5 Changes In The Identity And Beliefs Of The Teacher

Wenger (1998) stated that learning through participation in a community of practice involved four components namely practice, meaning, identity and community. Identity and community of practice is "the main entry points into a social theory of learning." (Wenger, 1998, p.12). He goes on to state that as teachers' learning changes, his or hers identity changes in many ways.

Under this category I consider the following:

5.5.1 Improvement in the confidence levels and how teachers view themselves as professionals

All of the teachers, as per the response from the questionnaire perceived themselves as becoming experts in the teaching of ML after completing the ACEML certificate. In fact they were so motivated and confident in themselves that the teachers who were surveyed at NMMU were presently completing their B.Ed. honours in mathematics and ML. The whole two years spent studying the ACEML certificate made them feel positive since they were achieving good marks in their assessments and examinations, the results of their learners in their tests and examinations were good, their confidence level in the classroom was high and the comments from the peers and superiors at school was excellent. This comment was

reiterated by **JBM, TPM, PCM, SPM, TEM, OBN, and SNZ** and nearly every participant in the survey. This had a great impact on the teachers' professional development. From the response to question 8.4 and question 16 on the questionnaire it was clear that teachers took ownership of the subject ML and felt that they were the most qualified to teach the subject. They also felt that they had authority hence their confidence levels grew even more and also felt that mathematics teachers could not teach the subject as well as the ACEML students. The confidence levels of the ACEML teachers was so high that ninety eight per cent of the teachers 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 teachers even preferred to be identified as ML teachers rather than the subjects that they had taught previously. This result also emerged in the research done by Nel (2009). Also in her research some teachers were identified as having a "dual identity." (Nel, 2009, p78). This was also evident in this study where at least 40% of the teachers were teaching their other specialist subjects but they taught more ML periods.

TERM also stated in his interview that he enjoyed teaching ML more than his old teaching subject, mathematics, since the context made the problems real and easier to solve. He also stated that his confidence grew because his learners enjoyed the ml that he was teaching since they understand fully what content he is imparting. This was also due to the fact that he knew exactly what content to teach and how he has to teach it. He also pointed out the fact that he could change his teaching strategies, context and methods during the course of his discussions with his learners. Hence he found that that he was able to do this because he had evolved professionally and that his confidence levels were high. **HDJ** was one of the teachers who bubbled with enthusiasm and excitement because he felt energised, renewed and confident as a teacher. According to Graven (2002) one only becomes a confident teacher when they have mastered the profession of teaching in relation to a process of meaning, practice, identity and community.

Empowerment and confidence goes hand in hand. PJM felt empowered after completing the whole course since everything he studied was relevant to real life situations. Wengers' (1998) theory that a person's identity changes when that person attaches meaning to the learning experience is evident. According to Benita Nel (2012) "notion of identity related to being a professional" has taken place. (Nel, 2012, p145). Wenger's (1998) and Graven (2002) theory suggests that the learning is enhanced when the participants become part of the community of practice. The teachers who were involved in the program were experienced teachers teaching subjects other than ML for a number of years. Hence working together with other experienced teachers for a continuous prolonged period of two years made learning very meaningful and strengthened their power of completing the studies, since they were able to identify with the strengths and weaknesses of each other. This culminated in them working together as a community, and at the same time developing their identities and confidence as ML teachers.

5.5.2 Development of beliefs and a change in identity in ML

There was evidence that the teachers wanted fulfilment. **SSG, GTN, TCM, PJM, BFM, TPM** and **NMM** wanted to develop themselves in mathematics and felt that ML was a new form of mathematics and hence through the ACEML certificate they have enriched their

knowledge in ml and developed professionally. In their new subject they felt that they had reached another milestone in their lives and that the subject revived their passion for teaching. Their new content knowledge as well as the new pedagogic content knowledge and all these developments have boosted their self-confidence.

They have evolved professionally and are eager to impart their knowledge of ML. On engaging in the ACEML program, the teachers felt that in order for learners to learn ML with a conceptual understanding, the learners have to be actively involved in the learning process, by means of discovery, experimentation and reason, group discussions and group or individual activities, similar to their involvement in the ACEML program. **TERM** in his interview stated "… moving away from that kind of teaching … give problems to learners, …we are all involved together. …All those methods we applied when we were doing the ACE to use what method." **PJM** felt very happy teaching, using the new approach since "it gave more time for the learners to engage themselves in the class." The teachers also found that through their on-going discussions with their peers in the ACEML program they were able to share knowledge and learn co-operatively and the same would work with the learners in their own classes. Unlike mathematics, ML was a 'hands on' subject and not just made up of rules and information given by the teacher. Most of the teachers in my research also believed that as second language learners in English discussion of the context makes solving of the problem easier. The beliefs of the teachers now shifted towards the realisation that the context in which the problem was given determined the procedure that had to be followed in order to solve the problem. It also determined what mathematical rules and algorithms are to be used. Ball (1990) argues that a "teachers practice is strongly influenced by his knowledge as well as his beliefs," and this is evident here too.

What is very evident in this research is we have seen that learning has taken place through the teachers participating in the ACEML program, which is through a community of practice, and this has changed their beliefs about the subject ML and the manner in which they should teach it. Also evident is the fact that a social theory of learning has taken place. We have especially seen a change in the thinking processes in relation to their new status as ML teachers, their implementation of the new curriculum, their development of a totally new content knowledge and the learning of new skills and strategies in teaching the contexts.

Through their active participation in the program they were able see themselves belonging to a new community of ML teachers and can now compare themselves locally and globally with new learning trajectories. This ideal relates directly to Wenger's (1998) theory of the teachers practicing in a community, getting new meaning to a new subject ML, and seeing themselves changing as teachers in terms of their identity.

Nel (2012) found that that the ACEML program was

> "designed to expose participants to knowledge and understanding of the ML curriculum(meaning), development of an integrated approach to teaching and learning, classroom didactics, lesson plans(practice), and group work activities where active participation and dialogue in lectures were encouraged (community). The programme design aimed to promote a change in the teachers way of being (identity)." (Nel, 2012, p.144).

Nel's theory was clearly evident in this research as well Jansen (2001) defined a teachers' identity in terms of a "transformation of their knowledge and beliefs, dispositions, interest and their orientation towards work and change." The teachers developed strong identities as "ML teachers'. The program also helped them to become team members of the ML community since they were able to share their knowledge, pedagogic content knowledge,

contexts and any other problems that they had with other teachers locally and globally through technology in an on-going process. Hence we see that the program had developed a strong form of affinity and an on-going development of professionalism. The teachers also found themselves working with teachers of other races, which was not evident previously since this type of exposure was not common. Working with mixed race classes at NMMU and UKZN enabled teachers to break the barriers of racial tensions if there was any and also realise that sharing of ideas from different cultures broadened their knowledge especially during group discussions and also gave deeper meaning to the teaching of other subjects like history, English and consumer studies. This sharing of culture assisted in their task designs involving the use of cultural objects and customs. This learning assisted the teacher in developing professionalism as ml teacher especially in the post-apartheid period within South Africa. Learning within this NMMU and UKZN community enabled networking to continue even after the program had been completed. This highlighted a great victory for the participants since many of them had come from poorly resourced rural and urban schools, and also schools consisting of classes of multi-racial learners in the post-apartheid period. Teachers did not feel insecure in teaching multi-racial classes because they had become more confident, in terms of the pedagogic content knowledge that they had acquired, as well as the ties that they had forged with other groups at their ml classes at the university.

5.5.3 Access to Professional bodies and opportunities within the department of education

The teachers' involvement in the ACEML increased their participation in other communities of practice. Many joined the Association of Mathematics Educators of South Africa (AMESA), met other mathematics colleagues and involved themselves in problem solving and mathematical activities. **NM** and **GBN** stated that they had become interested in this association, met colleagues and had attended conferences. AMESA is a professional body for mathematics educators. Teachers also saw the importance of making themselves known and belonging in the different communities of learning. This sense of becoming known and belonging to a particular community of learning illustrates the high level of professionalism that the teacher has attained through this two year study of the ACEML program. Since these were fully trained teachers in ML they were given high ranking positions in the DoE namely subject advisors (those who would mentor and advise fellow educators in content and methodology in ML), chief markers and deputy chief markers in the senior certificate examinations. **PL** was a deputy chief marker at the grade12 final examinations in the mathematical literacy paper 2. **MCM** had been appointed in the DoE and is office based. Through the NMMU and the UKZN studies many teachers became head of the ml subject, in their schools as well as leader teachers within their cluster of local schools. **SSG, TERM, NSD, TJK, and JBD** and a few others were promoted to heads of department. Teachers saw themselves as role models and mentors in the subject ml and assisted other teachers who had not gone through the ACEML program. Many of the teachers went on to teach grade eight and nine mathematics at their schools after completing the program since they were confident with their new knowledge and skills and also because they wanted to expand their knowledge and skills at grade ten, eleven and twelve levels. **NM, GBN, SPM** stated that they have learnt a lot more by teaching the grades 8 and 9 learners, while **TERM, PL** and **SPM** stated that although they had taught grades 8 and 9 previously they taught it now with more meaning and really enjoyed space, shape and measurement after they had completed the ACEML.

These teachers showed a renewed sense of professionalism towards teaching and learning. Teachers now showed a positive attitude to teaching and learning. Their positive feeling clearly had positive repercussions in the classroom since the teachers' exuberance and enthusiasm were reflected when the learners in their classes showed a tremendous improvement in their tests and examinations. The teachers felt that they were equipping the learners for life due to the real life contexts and the appropriate content that was taught. In terms of Wenger's theory of community of practice the teachers have attached meaning (their experiences) to their practice, (that of teaching their learners) with the community of learners. They have positively influenced their learners' beliefs. This in turn has had a positive influence on the learners' marks in their tests. The whole community, namely the teachers and learners have hence changed in terms of their identity.

5.6 A model to explain how the ACEML program enhanced the professional development of the teachers.

In trying to represent the findings of the study, I offer the following model in figure 5.1. As depicted in the figure, the study has shown that the professional development of the participant teachers was enhanced. Their content knowledge and pedagogic content knowledge improved in ways described in section 5.2 and 5.3. As their knowledge improved, this led to an increasing amount of confidence about themselves as ML teachers. Another component "confidence" emerged as a striking factor within this research. However this component was derived from the content knowledge and the PCK that was obtained from the program. There was a strong link between the change in beliefs and identity and the confidence of the teachers as well. As the teachers' beliefs and identity changed towards ML, they felt more confident in the classroom. It is through meaningful participation of members of the community of practice that meaning, beliefs and identity are changed as stated by Lave and Wenger.

Figure 5.1 shows the relationship that existed and that was interpreted according to my research. The teachers were more assured about the content they were required to teach and they had a repertoire of strategies that they had learnt. The development of their content knowledge and PCK also impacted on their own identities and beliefs about the value of the subject ML as described in 5.4. And as they developed a stronger identity about themselves as ML teachers, they were able to take further steps (such as enrolling for further studies etc.) in order to improve their proficiency as ML teachers.

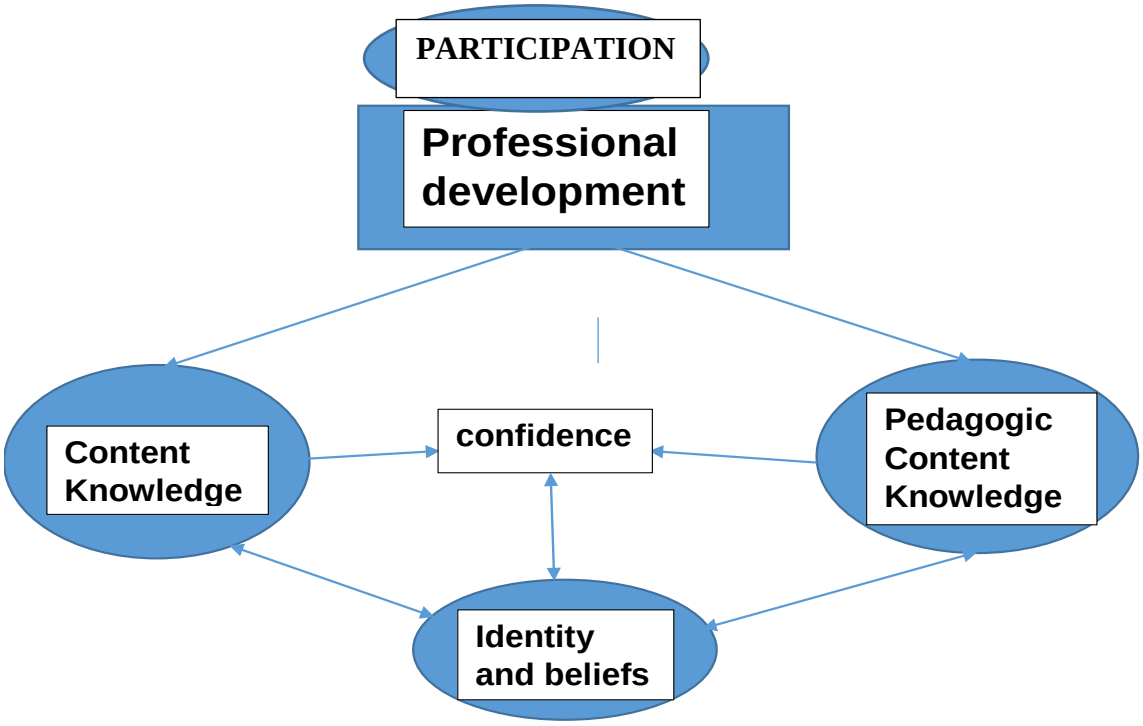


Figure 5.1 MODEL OF THE PROFESSIONAL ENHANCEMENT OF TEACHERS THROUGH THE ACEML PROGRAM

5.7 Implications of the study

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

5.7.1 Implications of the study in relation to the teachers

The teachers agreed that by successfully completing the ACEML program it had contributed to their professional development. This revealed that in-service training, content training workshops, pedagogic content knowledge workshops and certified programs are an essential form of on-going training for teachers. By involving themselves in the types of programmes above they would update their content and strategies and skills of teaching and develop more confidence. Through their participation in the ACEML the teachers found that they needed to

network with other teachers, work in groups, work on their strengths and get rid of their weakness so that teaching and learning can be improved and that they should not be afraid of constructive criticism but should embrace it and must be willing to learn from one another since learning is a form of transformation and transformation leads to confidence and professional development. The teachers learnt that research is another important factor that they should engage in since it improves knowledge and keeps them updated. This they learnt through doing research tasks as part of their assessments. Poor language skills were barrier to learning since learners found it difficult to access a problem and understand the questions on that context. Myburgh, Oersen, Poggenpoel and Van Rensburgh (2004) also noted that through the political changes in South Africa, many classes became multicultural in nature, and to many the language of instruction was different from their home language. As a result it poses a lot of problems to learners who study English as a second language and this was one of the problems highlighted by the teachers who were surveyed and interviewed. One of the solutions that some of the participants found useful was code switching. Code switching involves explaining the context and the questions in the home language of the learner and then translating it in English. GBN and TERM stated that they found code switching very useful in their class since the ml context was in English, by code switching learners got more meaning and were able to comprehend easily. Hence we see a need for teachers to become versatile in the languages of their learners. Teachers also felt that their participation in groups and peer teaching and learning that took place in the ACEML program encouraged group discussions and peer learning to take place in their own classroom.

5.7.2 Implications of the study in relation to the school

The teachers reported that as soon as they had begun their training in the ACEML program they felt enriched in their content knowledge and their pedagogic content knowledge and a belief in the new subject ML. Prior to that they lacked the skills and knowledge. However at some schools the management had not provided, or if they did, provided minimal support to the ml teachers. These were comments made by participants in the program: **Pl, SPM, PJM** and **SSG** stated that they had not received much support from management since they themselves were in the dark about the subject, while **HDJ, NM** and **GBN** stated that they were supported by their heads of department to a certain extent. However the ACEML program ensured that the teachers are always kept updated on all aspects of teaching and learning, content and skills training in order to ensure that quality teaching and learning is taking place at the school. Schools must ensure that when the new curriculum is introduced they must provide that extra support to their teachers. Hence we see that there is a necessity for management to become skilled themselves in any part of the curriculum is introduced and to provide as much support to their teachers as possible. There also has to be a great deal of support from the management and peers in terms of motivation and assistance needed with regards to content and pedagogic content knowledge training. Management at schools need to ensure that schools are well resourced in terms of teaching personnel, technology and teaching materials and give recognition to the teachers' meaningful endeavours. Teachers who completed the ACEML programs changed their identities, became more confident and applied a positive approach to ML, hence changing priorities to teaching and learning positively enhancing the reputation of the school. Schools should encourage all teachers to enrol for the ACEML program or any other program that would uplift the moral of the

teachers and the process of teaching with meaning, since ml teaches one about real life problems, and more importantly ML is found and integrated in many school subjects like consumer studies, business studies, geography, tourism studies. This would in turn give them greater insight into teaching these subjects.

5.7.3 Implications of the study in relation to the Department of Education

The DoE should use the success of this model of the ACEML programme to provide an on-going teacher development program to ensure their needs in terms of content knowledge and pedagogic content knowledge is provided. In-service training and workshops ensure that teachers are kept abreast with new techniques and skills. This is only ensured through a process of correct funding by the department of education. The following comments were made by teachers; **JBM** stated, "The basics must be taught thoroughly at GET level." **SCM** and **SPM** stated, "Make sure that teachers receive a thorough training session … at beginning of each term since my learners are very happy with the subject now." **TM** said, "To have subject advisors supporting teachers so that they know exactly what to do in class." **ZPN** stated, "Give bursaries to teachers who want to enrol and…. Hire specialist to assist teachers in school." This study also revealed that some teachers are poorly skilled in designing assessment tasks and they need support and guidance in this area. Furthermore, in this study it was not possible to ascertain whether the teachers' content knowledge was strong enough. The DoE should also set tests for teachers that they can use in confidence to ensure that teachers are allowed to test themselves to see if they are competent on certain content and hence be trained on what they require as teachers and not on all the content that they teach. The DoE should appoint more subject advisors so that they can monitor and assist a smaller group of teachers and assist them with their content and pedagogy on a more intimate basis, since at the moment subject advisors see teachers in large groups. Subject advisors must be appointed according to their qualification and their expertise. Majority of the participants in this survey are teachers who have been motivated by the ACEML program and are now completing their B.Ed. honours program with NMMU. However they stated a funding by the department would have been very helpful. The DoE should also encourage teachers who have completed the ACEML to continue with the post graduate study in ML. **HDJ, NM** and **GBN** did not continue with the B.Ed. honours since they could not afford the fees for the study. The DoE should provide a funding for this post graduate study so that professional development would continue. The DoE should also offer an opportunity to teachers of other subjects to study ML so that they can develop professionally and incorporate the ml in their subjects like hospitality studies, tourism studies etc.

5.7.4 Implications of the study in relation to the universities

Universities should constantly review the curriculum, the content and its applicability to the learners of South Africa. They should also include in their content for the teachers much more than is required by the school curriculum. Teachers need to be extended beyond the content that was included in the ACEML. The model used by UKZN and NMMU were different. NMMU used the model of teaching the grade 10, 11, and 12 curricula in each semester and the methods module separately. A textbook 'Mathematical Literacy' by Marc

North was used in conjunction with modules and guides complied by Aarnout Brombacher. UKZN studied the LOs across the grades with content derived from the curriculum. The participants felt that content that is taught in mathematics at grade eight and nine levels at the school must be included. The content of grade eight and nine levels must also be extended so that when the teachers are teaching ml they understand the dynamics that the context involves. **TERM** stated, "Others who were with me in the group and did not have a maths background struggled and those with a maths background found it easy she would have liked the university to have shown them some skills in mathematics." **NM** said that she would have liked the university to have shown her how to handle past year exam papers or exam type questions beyond the content and skills that they had taught them. All the participants agreed that the support that they got form the university was what motivated them to go on with their studies. They also felt that workshops should be provided by the university well after the ACEML programme had ended.

5.8 Limitations of the study

This study shows an overwhelming success rate of professional development in terms of the enhancement of content knowledge and pedagogical content knowledge which in turn resonated in a change in beliefs and a new ML identity and also a boost in the confidence levels of the teachers. ML was a new subject just introduced over a period of six years at the time of the study. Hence teachers were unsure about the dynamics of the subject. Everyone including the universities was unsure about what depth of knowledge that should be imparted to the teachers as well as the learners. There was a great deal of uncertainty. Of the thirty one teachers who were surveyed twenty nine of them continued with the post graduate study in ML while two did not and of the six teachers interviewed two of them did not continue with the post graduate studies. Hence I was unable to explore the development of the content and pedagogical content knowledge of the two teachers after the studies. I was also unable to investigate the teachers' knowledge prior to the study of the ACEML since these teachers came from different parts of the province. These teachers were also unable to be contacted hence I was unable to determine why they had really dropped out of the program. An overall surveyed would have made the data more accurate and conclusive. Hence this study could also not determine exactly how many of the teachers are teaching ML only or a combination of ML and their previous subjects, as well as those who are not teaching ML but only their previous subjects.

As much as the teachers were asked to be honest and unbiased to the survey and the interview the "Hawthorne effect" was not really 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.1).

This study is based on the teachers' perception of the contribution of the ACEML program. Hence they could have exaggerated the positive benefit and minimized the criticisms.

5.9 Recommendations

- It is important for teachers who are teaching ML to have some mathematical background, at least at grade 9 level, since ML does require the use of a minimum grade 9 mathematics. Hence universities should use the criteria that teachers must have some mathematics as an entry level into the ACEML program. According to Goba et al (2011) there is some uncertainty about the "extent of mathematical depth required to become an effective ML teacher." (Goba et al, 2011, p.159).
- In terms of teacher support programs, the universities should broaden the curriculum of the ACEML program and incorporate greater depth to the content knowledge. The content knowledge offered in the curriculum should be further intensified so that teachers are not only equipped with the knowledge that is required in the grade ten, eleven and twelve curriculum at school but beyond. This would enable them to handle all levels of question at school. The Pedagogic content knowledge should incorporate practical work where teachers could learn skills in tackling real life problems so that they could teach learners how to manage these problems at school.
- The DoE had trained many of the teachers in the ACEML from the primary and high schools and many of these teachers at the high schools are currently not teaching ML or teaching some classes of ML since they are teaching their old specialist subjects, while the primary school teachers have remained at the primary schools. On the other hand many high schools do not have qualified ML teachers. Hence, the DOE has to investigate and redistribute these teachers accordingly.
- Universities should offer the ML courses in their B.Ed. honours programmes so that the country is not depleted of ML teachers since most of the teachers who have trained will eventually exit the system in a few years.
- There has to be an on-going process of in-service training for the ML teachers since the subject is fairly new. Updating the teachers on the content and context as well as the pedagogic content knowledge is important in providing quality education to the learners at school.
- Since this is a new subject incentives must be given by the DoE and the universities to encourage further research into curriculum of subject ML.

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5.10 Conclusion

The aim of my study was to explore the contributions made by the Advanced Certificate of Education in Mathematical Literacy program towards the participating teacher's professional development and how the professional development of the teachers' who studied the Advanced Certificate of Education in Mathematical Literacy was enhanced.

My study revealed the following:

Teachers who had completed the ACEML programed had benefited tremendously through the program. Many were once teachers who taught subjects that were becoming either non-existent, or there were too many teachers teaching it, or they were bored of teaching it. Hence they realised that a change in subject especially one that was new, and where there was a shortage of teachers would be a challenge for them, as well as a new learning experience.

Indeed it was, since those teachers who completed the program reported a development of new content knowledge, pedagogic content knowledge, confidence, and a change in identity and beliefs.

In terms of content knowledge they had learnt new knowledge as well as being able to determine the content from within the context. Most of all they were able to develop their own contexts out of real life problems. They also learnt how to draw up assessments and tasks for the learners. In terms of pedagogic content knowledge teachers were overwhelmed by the different and new strategies that they were equipped with in the ACEML program. By working together in the NMMU and the UKZN community of practice they learnt to work as a team, to work in groups, using different strategies to cope with different cultures of learners and skills in handling different contextual problems. The teachers' fear of teaching ml disappeared as their knowledge expanded and they saw themselves as experts in the field of ml .They got new meaning to their career of teaching, as they learnt new content knowledge and pedagogic content knowledge, and they saw a transformation in their beliefs and identities which in turn was reflected in their confidence. Lave and Wenger's theory of a meaning, community, practice and identity is clearly a focal point in the ACEML program. They drew ideas from their peers and their tutors and took back these skills to their own classrooms. As the teacher participated increasingly in practices and various processes of doing, talking, interpreting, thinking etc., he/she made sense of the new curriculum and the content knowledge, then this whole process of accumulation of knowledge became meaningful and productive

The ACEML program seemed to have rejuvenated the life of the teachers and changed their beliefs and identity. Through the ACEML program they took ownership of the subject ML. They had become confident with their new content knowledge and the pedagogic content knowledge that they had learnt in the ACEML program. They had emerged from the program as transformed teachers. The ML teachers were given recognition by the school and many were promoted to head of department, or subject advisors. Their role as leaders of a community of practising ML teachers became evident. Teachers of ML are now in fact recognised as professionals and all the teachers who had gone through the program left the program feeling that they are the only ones who can teach the subject successfully. The teachers have even joined professional bodies like AMESA and participate in the activities of this body. The teachers also felt that they have become technologically advanced since many of them had not even used a computer previously and are now capable of using internet. Networking through research projects has enabled them to be computer literate. The teachers also emerged as innovative teachers since they could even handle misconceptions of their learners and design lessons to eradicate these misconceptions.

The schools are now resourced with qualified ML teachers who are equipped with sufficient content knowledge and pedagogic content knowledge in the newly introduced subject. The teachers who studied the program came back to school with a renewed spirit of enthusiasm, feeling energised and filled with optimism which proved very encouraging and uplifting. The dedication and commitment of the teachers who had completed the ACEML program was strong since they were eager to practice and share what they had studied at the program and also wanted their learners to enjoy their lessons the way they had. Both the UKZN and the NMMU curriculum consisted of material that encompassed grade ten, eleven and twelve work. The task designs and assessment strategies leant in the ACEML program enabled

participants to become confident in their tasks at school. So going back and teaching what the teachers had learnt was highly successful for both the teachers and the school. Through the activities and participation of the teachers with professional bodies the school also becomes recognised both locally and globally. Schools have more teachers who have become technologically advanced in terms of the use of the computer since the program also developed teacher skills in the use of the computer for assessments and projects.

The DoE had spent a lot of money to implement the program in each province through funding of bursaries to one teacher in each school. Although many teachers dropped out of the program, the department was very successful with the ones who stayed on and completed the course. The department was now resourced with qualified ml teachers, enhancing service delivery in terms of teacher resources. Its aim is to enable “learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse and solve problems” has been very fruitful. The ACEML program is seen as the initiator of professional development within the post-apartheid period in South Africa. It serves as a stimulus for an on-going series of workshops and teacher development programs that would build up teacher content knowledge, pedagogical skills and confidence boosters and strengthen the quality of teaching and learning in the country.

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APPENDIX 1

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18 March 2011

Dr. S Bansilal (856)
SMTE

Dear Dr. Bansilal

PROTOCOL REFERENCE NUMBER: HSS/0122/011
PROJECT TITLE: Exploring the impact of the ACE programme in KZN

EXPEDITED APPROVAL

I wish to inform you that your application has been granted Full Approval through an expedited review process:

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....

Professor Steven Collings (Chair)
HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE

cc. Dr. A James
cc. Ms./Mrs. B Goba
cc. Dr. HB Khuzwayo
cc. Dr. L Webb

APPENDIX 2

TEACHER QUESTIONNAIRE

ACE - Mathematical Literacy Questionnaire

Dear Participant

Thank you in advance for your participation in 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 19 questions that are divided into THREE sections.

Name: _____ School: _____

University:_____

Section A: About yourself

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

Subject (s)	**Grade (s)**	**How long?**
e.g. Accounting	*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 were your reasons for enrolling in the ACE ML?

From the options below, make a cross (X) next to the one or those that suit 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 about the programme

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

1 Strongly disagree	2 Disagree	3 neutral	4 agree	5 Strongly agree

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. The name of the centre I attended is _____. In my centre:

6.1 the conditions were good 1 2 3 4 5

6.2	there was sufficient resources	1 2 3 4 5
6.3	the university appointed centre manager was available and useful	1 2 3 4 5
6.4	the centre owner/manager was welcoming	1 2 3 4 5
6.5	we felt welcome at the centre	1 2 3 4 5

Any other comment: _____

7. I found that the communication by the university was good with respect to:

7.1	the process of the calculation of the DP	1 2 3 4 5
7.2	DP appeal process	1 2 3 4 5
7.3	Special requests	1 2 3 4 5
7.4	timetables	1 2 3 4 5
7.5	Feedback on tests and assignments	1 2 3 4 5
7.6	registration details	1 2 3 4 5
7.7	examination results	1 2 3 4 5

Other comments _____

8. As a result of my participation in the ACE (ML) programme:

8.1	my *content knowledge* has improved .	1 2 3 4 5
8.2.	my *teaching strategies* has improved .	1 2 3 4 5
8.3	my *assessment skills* has improved.	1 2 3 4 5
8.4	my *confidence as an ML teacher* has increased.	1 2 3 4 5
8.5	the ML results of my learners have improved	1 2 3 4 5

Any other comment: _____

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

9.1	the materials (guides) were readable, clear and useful	1 2 3 4 5
9.2	the tutors were supportive	1 2 3 4 5
9.3	the tutors were knowledgeable	1 2 3 4 5

9.4. there was a good link between what we learnt in the sessions and what we were assessed on.

1 2 3 4 5

9.5 the other students in my class were supportive and helpful 1 2 3 4 5

Any other comment: _____

10. My studies were made easier because

10.1 I had a supportive family network 1 2 3 4 5

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

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

10.4 I had sufficient time to study 1 2 3 4 5

10.5 the centre is not very far away from me. 1 2 3 4 5

Any other comment: _____

11. The ACE (ML) programme has a large drop out rate. Some reasons for this could be that students:

11.1 do not have a supportive family network 1 2 3 4 5

11.2 do not have support from their school management and colleagues 1 2 3 4 5

11.3 find contact sessions to be too intensive and poorly paced 1 2 3 4 5

11.4 do not have sufficient time to study 1 2 3 4 5

11.5 have too far to travel to the centres 1 2 3 4 5

Any other comment: _____

12. Have you ever considered dropping out of the programme? (YES or NO) .....

13. Briefly describe what **stopped** you from dropping out:

.....

.....

.....

14. 1. Which module (s) would you describe as the **most useful** to you:

.....

.....

.....

.....

14.2. Which module (s) would you describe as **least useful** to you:

.....

.....

.....

.....

15. 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: **General**

16. Here are a series of statements. Indicate your level of agreement or disagreement with each one.

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

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

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

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

16.5 The ACE(ML) programme has introduced you to new teaching strategies that you have been able to use in your classroom teaching. 1 2 3 4 5

16.6 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

16.7 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

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

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

16.10You 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 ACEML 1 2 3 4 5

16.11You see yourself as belonging to a group of professionals after studying the ACEML.

1 2 3 4 5

16.12 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

16.13 You would recommend to any ML teacher that they should study in this programme

1 2 3 4 5

17. If we (university) were to offer short inservice courses to teachers, what topics do you suggest we offer

_____

_____

_____

18. What suggestions would you give to UKZN/NMMU in order to improve this programme?

_____

_____

_____

_____

_____

_____

19. If you were the minister of education, what are the issues that you would attend to immediately, in order to improve the quality of learning and teaching Mathematics, Science and Technology in our schools?

_____

_____

_____

_____

_____

Thank you

APPENDIX 3

NAME	UNIVERSITY	1. SUBJECT	1.1 GRADE	1.2 HOW LONG	2. CURRENT POST LEVEL	2.2 QUALIFICATION
1 MS	NNMU	ML/Math	10to12/8to11	7/21 years	L1	1,2and3
2NSD	NNMU	ML/Math	10to12/10to12	7/15years	L1	1and2
3JBM	NNMU	ML	10to12	7years	L1	1and2
4JBD	NNMU	Biology/ML/Math	All subj. 10to12	20/11/7years	L2	1,2and3
5TGM	NNMU	life Science/ML	10to12	2/7years	L1	1and2
6PJM	NNMU	Accounting/ML	10 to 12 both	4/7years	L1	1and2
7MCM	NNMU	Eng./Life Sc./ML	10 to 12 all	18/18/3years	L3	1,2,3,and 4
8WNK	NNMU	ML	10to12	7years	L1	1and2
9SCM	NNMU	Physical Sc./ML	10to12	10/4years	L1	1and2
10TJK	NNMU	ML	10to12	6years	L1	1and2
11TERM	NNMU	Maths/ML	10to12 both	16/7years	L2	1and2
12SPM	NNMU	Maths/ML	10to12 both	7years	L1	1and2
13NBS	NNMU	Biology/ML	10and 11 /0	10/0years	L1	1and2
14NM	UKZN	ML/Math	10to12both	7years	L1	1,2and3
15PL	UKZN	ML/Math	10to12	7years	L1	1and2
16NMM	NNMU	Acc/Eco/ML	10to11	6/6/7years	L1	1and2
17MTS	NNMU	ML	10to12	7years	L1	1and2
18TGM	NNMU	Physical Sc/ML	10to12	19/7years	L2	1and2
19OBN	NNMU	Physical Sc/ML	10to12/10to11	2/4years	L1	1and2
20SNZ	NNMU	ML	10to12	7years	L1	1.
21BFM	NNMU	ML	11and12	7years	L1	1.
22TPM	NNMU	Bio/AgriculSt/Ml	10and11/10/10to12	4/6/7years	L1	1and2
23NCBH	NNMU	Eng/ML	10to12/10		L1	1,2and3
24GTN	NNMU	life Science/ML/NS	10to12both/8and9	20/4/7years	L1	1,2and3
25 AN	NNMU	lO/ML	9/10to12	4/1years	L2	1,2and3
26 H D J	NNMU	Hist/Geog/ML	10to12all	28/3years	L1	1,2,3and4
27SSG	NNMU	Maths/ML/bio	10to12both/10	20/7/3years	L1	1,2and3
28TM	NNMU	Maths/bio/Ml	8to12both/10to12	6/4/7years	L2	1,2and3
29ZPN	NNMU	Acc/Zulu/ML	10to12/9/10to12	12/7/7years	L2	1,2,and3
30LS	NNMU	Eco/Bst/Ml	10to12all	11/2/7years	L1	1,2and3
31GBN	NNMU	Bio/Math/Zulu/ML	10to11/8/8/10to11	15/4/10/5	L1	1and2

NAME	3. REASONS FOR ENROLLING	3.1 OTHER	4. CURRENTLY TEACHING ML Y/N	4.1 IF NOT REASON
1 MS	Retrain		yes	
2NSD	Retrain		yes	
3JBM	Retrain		yes	
4JBD	retrain/only teacher in school interested		yes	
5TGM	Retrain		yes	
6PJM	Retrain		yes	
7MCM	Retrain		no	office based
8WNK	retrain/only teacher in school interested		yes	
9SCM	retrain/only teacher in school interested		yes	
10TJK	retrain/only teacher in school interested		yes	
11TERM	Retrain		yes	
12SPM	Retrain		yes	
13NBS	Retrain		no	
14NM	retrain/only teacher in school interested		yes	
15PL	Retrain		yes	
16NMM	Retrain		yes	
17MTS	retrain/only teacher in school interested		yes	
18TGM	Retrain		yes	
19OBN	Retrain		yes	
20SNZ	Under-qualified		yes	
21BFM	Under-qualified		yes	
22TPM	retrain/only teacher in school interested		yes	
23NCBH	retrain/only teacher in school interested		yes	
24GTN	retrain/only teacher in school interested		yes	
25 AN	Retrain		yes	
26 H D J	retrain/only teacher in school interested		yes	
27SSG	Retrain		yes	
28TM	Retrain		yes	
29ZPN	Retrain		yes	
30LS	retrain/only teacher in school interested		yes	
31GBN	Retrain		yes	

NAME	5.1	5,2	5,3	5,4	5,5	5.6 OTHER
1 MS	5	5	5	5	5	keep it up
2NSD	5	3	3	3	4	
3JBM	3	4	5	4	5	
4JBD	4	4	4	4	5	
5TGM	5	4	4	4	4	
6PJM	4	4	4	4	4	
7MCM	4	5	5	4	4	
8WNK	5	4	3	2	4	
9SCM	4	4	4	5	5	
10TJK	5	5	5	5	5	
11TERM	5	4	4	5	5	
12SPM	4	5	5	5	5	
13NBS	4	4	3	4	4	
14NM	4	3	3	4	4	
15PL	3	4	4	4	4	
16NMM	4	4	4	4	5	
17MTS	5	5	5	4	4	
18TGM	4	5	5	4	5	
19OBN	5	4	5	4	4	
20SNZ	4	5	5	5	5	
21BFM	5	5	5	5	5	
22TPM	5	5	5	4	5	
23NCBH	4	4	4	4	4	empowering ourselves
24GTN	4	4	4	4	5	tutors taught everything with understanding
25 AN	4	3	3	4	5	
26 H D J	4	5	5	5	5	had well planned structured/interesting lessons
27SSG	5	4	4	4	4	
28TM	4	4	4	5	5	
29ZPN	4	4	4	4	5	
30LS	4	4	4	3	3	
31GBN	4	4	4	4	4	

NAME	6,1	6,2	6,3	6,4	6,5	6.6 OTHER
1 MS	4	3	4	4	3	improve condition at centre
2NSD	3	3	3	4	4	
3JBM	3	3	3	4	4	
4JBD	3	4	5	5	4	
5TGM	3	3	3	3	3	
6PJM	4	4	3	4	4	
7MCM	4	4	4	4	5	
8WNK	4	4	4	4	4	
9SCM	5	3	4	5	5	
10TJK	5	5	5	5	4	
11TERM	4	4	5	4	5	
12SPM	5	5	3	3	3	
13NBS	4	4	4	3	4	
14NM	4	3	3	3	3	
15PL	4	4	4	4	4	
16NMM	4	4	4	3	3	
17MTS	4	3	3	3	3	
18TGM	3	4	4	3	3	
19OBN	4	4	4	4	4	
20SNZ	5	4	5	5	5	
21BFM	5	5	5	5	5	
22TPM	3	4	5	4	5	
23NCBH	4	4	4	4	4	
24GTN	4	4	4	4	4	primary school furniture not appropriate
25 AN	5	4	4	4	4	
26 H D J	5	5	3	5	5	tutors attitude positive
27SSG	5	4	4	4	4	
28TM	4	4	4	3	3	
29ZPN	4	4	4	4	4	
30LS	3	3	3	3	3	
31GBN	5	4	4	3	5	

NAME	7,1	7,2	7,3	7,4	7,5	7,6	7,7	7.8 OTHER
1 MS	4	4	4	4	4	4	4	
2NSD	4	4	4	4	4	4	4	
3JBM	3	4	3	5	5	4	5	
4JBD	5	5	4	5	5	5	5	
5TGM	2	2	2	2	2	2	2	
6PJM	4	4	4	4	4	4	4	
7MCM	5	3	3	5	5	5	5	
8WNK	4	3	3	3	2	3	2	
9SCM	3	3	1	1	4	1	1	
10TJK					5	5		
11TERM	5	4	5	5	5	4	5	
12SPM	5	5	3	2	5	5	1	
13NBS	4	4	4	4	4	4	4	
14NM	4	4	4	4	4	4	4	
15PL	4	4	4	4	4	4	4	
16NMM	3	3	4	4	3	3	4	
17MTS	4		3	3	5	5	5	
18TGM	5	5	5	5	5	5	5	
19OBN	4	4	4	4	4	4	4	
20SNZ	4	3	4	4	5	3	3	
21BFM	5	5	5	5	5	5	5	
22TPM	5	5	5	5	5	5	5	
23NCBH	4	4	4	4	4	1	5	
24GTN	3	4	3	4	4	3	4	
25 AN	4	3	3	4	4	3	4	
26 H D J	5	5	5	5	5	5	5	good support from department
27SSG	4	4	4	4	4	4	5	
28TM	4	4	4	4	4	4	4	
29ZPN	5	5	5	5	5	5	5	
30LS	2	2	2	3	3	2	2	
31GBN	4	3	5	4	4	4	5	

NAME	8,1	8.2	8,3	8,4	8,5
1 MS	5	5	5	5	5
2NSD	4	4	4	4	4
3JBM	5	4	4	5	4
4JBD	4	4	4	4	4
5TGM	4	4	4	4	4
6PJM	5	5	4	4	4
7MCM	5	4	4	4	4
8WNK	3	3	4	4	4
9SCM	5	4	3	4	4
10TJK	5	5	5	5	4
11TERM	5	5	5	5	5
12SPM	5	5	5	5	5
13NBS	4	4	4	4	4
14NM	5	5	5	5	5
15PL	3	4	3	4	3
16NMM	5	4	5	5	4
17MTS	5	5	5	5	5
18TGM	5	5	5	5	5
19OBN	4	4	4	4	4
20SNZ	5	5	4	5	5
21BFM	5	5	5	5	5
22TPM	5	5	5	5	4
23NCBH	5	5	5	5	5
24GTN	4	4	4	4	4
25 AN	5	5	5	5	5
26 H D J	5	5	5	5	5
27SSG	5	5	5	5	5
28TM	5	3	3	4	4
29ZPN	5	5	5	5	4
30LS	4	4	4	5	5
31GBN	4	4	4	3	5

NAME	9,1	9,2	9,3	9,4	9,5	9.6 OTHER	10,1	10	10,3	10,4	10,5
1 MS	4	4	4	4	4		3	3	3	3	3
2NSD	3	4	4	4	4		2	1	2	1	2
3JBM	4	4	4	4	5		4	3	5	5	5
4JBD	4	4	4	4	5		3	2	4	3	5
5TGM	4	4	4	4	4		4	4	4	4	4
6PJM	4	4	4	4	4		4	4	4	4	4
7MCM	5	5	5	5	4		4	3	4	3	3
8WNK	4	4	4	4	2		2	4	3	4	4
9SCM	2	4	5	4	3		4	2	3	4	5
10TJK	5	5	5	5	5		5	4	5	5	1
11TERM	5	5	5	5	5		4	3	5	5	4
12SPM	3	2	5	5	5		5	5	5	5	5
13NBS	4	4	4	4	4		4	4	4	4	4
14NM	3	3	4	5	1		5	1	1	1	1
15PL	3	3	4	4	3		3	3	4	3	4
16NMM	5	5	5	5	5		5	5	4	3	5
17MTS	4	3	3	5	5		5	5	5	3	5
18TGM	5	5	5	5	5		4	5	5	4	4
19OBN	4	4	4	4	4		4	4	4	4	2
20SNZ	5	5	5	4	5		5	5	5	5	5
21BFM	5	5	5	5	5		3	4	5	4	5
22TPM	4	4	4	4	5		4	5	5	3	5
23NCBH	4	4	4	4	3		3	3	3	3	1
24GTN	4	4	4	4	3		3	3	3	4	4
25 AN	4	4	4	4	3		4	3	3	3	1
26 H D J	5	5	5	5	5	had good rapport with tutors and peers/RCL rep	5	5	5	5	5
27SSG	5	5	5	4	5		5	4	4	4	4
28TM	4	4	4	4	4		4	3	3	2	2
29ZPN	5	5	4	5	5		4	4	5	4	2
30LS	4	4	4	4	4		3	3	3	3	3
31GBN	4	4	4	4	4		4	4	5	4	5

NAME	11,1	11,2	11,3	11,4	11,5	12 CONSIDER DROPPING OUT Y/N	13. WHAT STOPPED YOU		
1 MS	3	3	3	3	3	N			
2NSD	2	3	2	2	2	N			
3JBM	3	3	3	4	4	N			
4JBD	2	1	2	2	2	N	course interesting/eager to help learners not capable of doing maths		
5TGM	5	5	5	5	5	N	figured out the importance of doing ML as I do not have mathematics		
6PJM	4	4	4	2	4	N	wanted to achieve my objectives		
7MCM	3	3	3	4	4	N	am passionate about learning and we had a very good tutor in the ACEML program		
8WNK	4	4	4	4	4	N			
9SCM	5	2	2	2	5	N	I wanted to finish what I had started		
10TJK						N			
11TERM	3	3	1	2	2	N	persuasion by fellow students		
12SPM	5	5	5	5	5	N	modues very interesting and relevant to chapters done at school /grades10to 12		
13NBS	1	1	1	1	1	N			
14NM	1	3	4	4	5	N			
15PL						N			
16NMM	5	5	5	5	5	N			
17MTS						N			
18TGM	4	3	2	2	3	N	enjoyed ML and it was life related		
19OBN	4	4	3	4	5	N	working very hard all the time		
20SNZ	2	2	2	1	1	N	I was under-qualified, I only received a certificate of attendance		
21BFM	2	1	1	5	2	N	I like to gain knowledge of the new subject and tutors were delivering the subject content in a very interesting way and were always ready to answer questions asked		
22TPM	4	4	2	4	3	N	I wanted to enrich my knowledge on ML and it has helped me.		
23NCBH	3	3	4	4	5	N	I had an intention to graduate with this to empower myself in teaching strategies		

24GTN	3	3	4	4	4	N	my desire to obtain more knowledge and the hope that after my graduation my salary will improve kept me going		
25 AN	3	3	3	3	5	N	a supportive spouse		
26 H D J	1	1	1	5	1	N			
27SSG	3	4	3	3	4	N	I wanted to develop myself with something new, since there was a change in curriculum		
28TM	1	2	5	4	2	N	I was about to finish		
29ZPN	4	4	2	2	5	N	no one was going to touch ML in the school if I dropped out. I will have to pay back money to department		
30LS	4	4	4	4	4	N	was afraid to pay back state bursary		
31GBN	4	4	4	4	4	N	Wanted to teach ML		

Name	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	16.10	16.11	16.12	16.13
1 MS	1	1	4	1	5	2	1	4	4	5	5	5	5
2NSD	2	2	4	2	4	2	4	4	4	5	5	5	5
3JBM	2	2	5	2	4	2	5	5	3	4	4	4	5
4JBD	3	4	5	1	5	1	4	4	3	5	3	4	4
5TGM	4	1	4	1	5	1	5	5	5	5	5	5	5
6PJM	2	2	5	2	4	2	2	4	4	5	4	4	4
7MCM	1	3	4	1	4	1	4	4	4	5	3	5	5
8WNK	1	1	1	1	4	1	5	5	4	3	3	3	4
9SCM	1	5	1	5	4	1	5	4	4	4	4	3	2
10TJK	1	2	5	1	5	1	5	5	5	5	5	5	5
11TERM	2	1	5	1	4	1	1	5	4	5	5	5	5
12SPM	1	1	5	1	5	1	5	5	5	5	5	5	5
13NBS	1	1	4	1	4	1	4	4	3	4	4	4	4
14NM	1	1	5	1	5	3	4	5	5	5	5	5	5
15PL	1	1	4	3	4	4	3	4	4	3	3	3	3
16NMM	1	1	4	1	4	4	4	4	5	5	5	5	5
17MTS	2	2	5	4	4	4	4	4	4	4	5	4	5
18TGM	1	1	5	5	5	1	5	5	5	5	5	5	5
19OBN	2	2	5	4	4	4	4	4	4	4	5	5	5
20SNZ	1	1	5	5	5	5	5	5	5	5	5	5	5
21BFM	1	1	5	1	5	1	5	5	5	5	5	5	5
22TPM	3	1	5	5	5	2	5	5	3	4	5	5	5
23NCBH	5	5	5	5	1	1	5	4	5	5	5	5	5
24GTN	1	1	5	1	4	4	4	5	4	4	4	5	5
25 AN	1	2	5	1	4	1	5	4	4	4	5	4	4
26 H D J	1	1	5	1	5	1		5	3	5	5	5	5
27SSG	2	2	5	2	5	2	5	5	5	5	5	4	4
28TM	1	1	5	1	4	1	5	5	3	5	5	5	5
29ZPN	1	1	4	1	4	1	4	4	2	5	5	4	4
30LS	1	1	4	1	5	2	1	4	4	5	5	5	5
31GBN	1	1	4	1	5	1	1	4	4	5	5	5	5

APPENDIX 4

INTERVIEW QUESTIONS

1 Why did you do the ACEML program?

2 How did the program benefit you?

3 Did the program meet the needs?

Of the content knowledge that is required to teach ML?

4 How confident do you feel as a ML teacher?

5 In which section in ML do you feel you have total confidence or lack the confidence and why?

6 What makes ML A practical subject?

7 How is ML different from Mathematics?

8 Do you feel disadvantaged in the classroom because you have not taught grade 8 or 9 Mathematics?

9 Explain how the program meet the needs of your professional development?

10 Do you wish to continue you studies in ML at a post graduate level ? Why?

11 What are the learner' misconception in ML and how do you cope with these misconceptions?

APPENDIX 5

INTERVIEW No. 1

INTERVIEWER:P BRIJLAL

INTERVIEWEE: TERM

A: Welcome to this session, I am very grateful to you for accepting my offer to do this interview. This interview is an interview for which I am doing towards the master's programme on the investigating the professional development of students who has passed the Ace Math Lit programme. in NMMU. My first question what was your reason for enrolling on this Ace programme?

B: Our principal asked all the teachers in my school to apply for the Math Lit Ace Programme. She said we must take the advantage because it was sponsored by the government it's all paid for and that's why we all applied and fortunately it was only me in my school that was chosen by the department.

A: Do you also look at it as a reason to upgrade?

B: Not exactly because I did not know what the math lit ace was all about. When I started the course I knew it was only helping me to understand Math Lit because they said it was not for upgrading for those who have done the Bed for a degree but those who were having three years it was upgrading for them because they would move to another scale or notch or something like that.

A: Do you think the learner content, do you think it was easy to teach, do you enjoy teaching it, the other subject you were teaching before this.

B: Actually I after I did math lit I enjoyed Math Lit more, I was teaching math before and I enjoyed teaching Math Lit more than teaching math after the Ace Programme.

A: Why did you think that you would enjoy it more, what made you think that you would enjoy teaching math lit better than teaching math where the students did better or?

B: It was because it was easy to explain its not for solve for x and the learners not able to get it but this one was in context its easy to work with the problem that is based on context so it was easy and we were able to discuss and share and learners knew what was expected of them and what they supposed to do.

A: How did this programme impact on your professional development in terms of the content knowledge?

B: As I have said the content was clearer, many things were easy to apply and deliver because it was based on context... I remember I was teaching before there was this thing of standard grade and higher grade.

A: How did it impact on your professional development in terms of the teaching methods, how you taught it in the classroom.

B: The teaching as well was made easy by the very same fact that it was based on the context so it was easier to relate to learners when the problem is based on the context and the book that we were using it was simple, it was easy to understand. It was moving from that kind of teaching, give problem to the learners, here we were all involved together now there is more understanding between learners and teachers when we are teaching the math lit.

A: So you think you are able to vary your methods, use a variety.

B: Yes, In fact we were talking about the many teaching methods like the group discussions, all of those methods we applied when we were doing the Ace to use what method when we doing a section. Books.

A: How did this programme impact on your professional development in terms of your confidence as a teacher in the classroom?

B: The confidence was high because it was not like math which I was teaching where some learners feared math when they do math lit and you explain to them they seem to enjoy it, they understand it and there is that about the new subject which is called now as pure math and they did accept out morale as math lit educators because we and our learners are now moving together.

A: How has this programme impacted on your professional development in any other aspects, we spoke about content knowledge, teaching methods, confidence, are there any other aspects that you want to discuss about your professional development?

B: I think it is about post student teaching, how we impart with the knowledge impart to our learners and pass it along. The way we approach our teaching.

A: What is in your opinion, what do you think about time tabling, mode of delivery and the contact sessions during your studying of the Ace Math Literacy while you were in that programme?

B: The contact sessions?

A: The contact sessions, the mode of delivery and what did you think about time tabling?

B: It suited me well because we were doing it on Saturdays unlike us were supposed to go for afternoon sessions. It was fine.

A: In NMMU they did not do modules, they did not offer modules in the programmes, they did grade ten, eleven and grade twelve in the two years that you studied, what was the most useful aspect of those different grades that you did, most useful aspects in all that you studied.

B: Although we were not taught like now because it was the book that was used, there were four modules, in 2006 I was in the first group, I remember that the other three modules were very

good because they involved math and the last one was more theory and I didn't enjoy that because I was used to math.

A: What is your opinion about the materials was it sufficient?

B: It was sufficient because when we were doing it was very easy.

A: Do you think that you needed more materials. The programme should have supplied more textbooks,

B: I think at that time it was sufficient; we were having handouts as well. The Mark. book was very good. Even when you write the exam and test everything was easy. At that time it was enough.

A: What is the opinion about the quality of the tutors?

B: The tutors were fine, I must say in my group my tutors seem to be understanding and knew what he was doing and he presented the matter very well so we can understand and he was compassionate about Math Lit helping us. We had a good tutor.

A: What was your opinion about the content covered in the modules?

B: I think it was sufficient because math lit offered those learners and everything we covered was enough.

A: What was your opinion about the administration support, administration queries, results, dps.

B: I can't talk much about this because I never had any problem.

A: What is your opinion about the centre and the venue?

B: We started in Umbumbulu and it was fine then we moved to Durban teachers centre it was fine but it was far because I am coming from Hammarsdale but it was manageable.

A: Which section in Math Literacy do you feel you have total confidence or you lack the confidence and why?

B: Because I have taught it for many years now I think all the sections are more or less the same now. I have confidence in all of them. I started teaching math lit in 2006 and more or less the same topics I think I mastered it.

A: Now you told me you were a math teacher so that means you taught grade eight and nine math.

B: Yes at that time.

B: Yes, I was teaching grade eight, nine and ten.

A: While you were doing your Ace math lit. Do you think this helped you in teaching math literacy?

B: Yes it did a lot and I could see the others who were with me the group did not have a math background struggled and those with a math background found it very easy except for the theory part, the last module that we did but the other modules were fine.

A: What can you say about academic support, what is your opinion about the support the university offered and how could they improve on this?

B: did not see anything problematic in this Ace programme because the tutors helped us a lot there.

A: You started the programme, what has stopped you from dropping out of the programme?

B: I was enjoying it, it was easy. That is why I applied for Bed honors because I thought it was going to be the same thing only to find out that it is very different, more of a theory now in honours.

A: How would you advise the university to improve on the programme?

B: I enjoyed it; I don't know where they can improve except personally I did not enjoy the theory part.

A: What are the learners misconceptions in math lit and how do you cope about these misconceptions, some students have misconceptions when you teach math lit.

B: The misconceptions happen in certain areas and if you would have picked it up as a teacher it is easy to deal with these misconceptions. If you prepare your work you will know what to expect from them, it will be easy to pick up those misconceptions you will sit with them and discuss with them and know how they are approaching things and the reason behind their thinking and they have a problem of understanding this here and then this should be done like this then it is easy to deal with it.

A: Thank you very much I really appreciate your responses. Thank you for allowing me to conduct this interview.

END OF INTERVIEW

INTERVIEW NO 2

A: INTERVIEWER: P BRIJLAL

B: INTERVIEWEE: HDJ

A: Welcome to this Ace Math Lit interview, its all about knowing how did the Ace Math Lit Programme benefit you during your study and if it is benefiting you now.

What was your reason for enrolling on this Math Ace programme?

B: Our new dispensation started in 2008, 12 and there have been 10 ------ before and it got you into a situation where I can offer my services to the new dispensation because the learners are waiting for us to teach them I was equipped with Ace programme of Math and imparted the knowledge to the learners as no one. No true as a teacher I had to upgrade myself for current curriculum in class. The third point is I like math.

A: Did you do it for any upgrade purposes.

B: The answer would be yes for upgrading purposes in terms of having enough knowledge in math and furthermore I am qualified in certain subjects, well qualified and because of a fear of math I wanted to upgrade myself.

A: Did the principal ask you or heard about it from somebody else or is it your own decision?

B: A circular came to school that was in 2004 and there was this programme for people to apply and in our school a lot of teachers applied for that course and I took interest in it and out of all the teachers that applied I was chosen to do that course. No 2 my principal encouraged me.

A: How did this programme impact on your professional development in terms of content knowledge?

B: In terms of content knowledge it added to my content in terms of the math itself. With that content I was able to use that to empower my students to do better in their classroom.

A: How did this programme impact on your professional development in terms of teaching methods, the confidence in the classroom or any other aspects?

B: In terms of the impact it changed the way I did business with learners in terms of teaching methods, in the classroom itself and in terms of patience. I was able to get into that situation to explore situations and I can talk very proudly to other doing Math Lit and their support and the group support.

A: Did you find that after doing this Math Lit it helped you in teaching your other subjects. Did it give you a little bit more confidence in teaching those subjects?

B: I think in the new curriculum, the integration programme, we don't teach a subject in terms of isolation, and this subject here was able to help me especially in the geography in grade 10, 11 and 12 whereby I was able to use the different formulas to find additions on the map and able to use scale drawings on maps we use in classroom. In terms of history in terms of time, space and measurement whereby I took the Taj Mahal and I was shocked to find the building inside is only 56 square, I was able to work out whether the length is short using the mathematics ace programme I was able to work out this formula. No two in looking at it globally, speaking in terms of literal I was able to use the globe in geography and showed the learners that you can use math calculations to find time, distance and speed. The learners learned that.

A: What about your confidence?

B: I was very confident.

A: What was the most useful module you did; I know in NMMU we did grade 8, 9 and 10 context.

B: And since you was my lecturer I think you know very well in time space and measurement, you see here this is the model I made for time space and measurement and I am sure I got very good marks for this here and this here is drawn to scale and I enjoyed doing that and there were some learners ho helped me also I still use it in the classroom today. Here you find the measurement, square and rectangle, you find a semi-circle and that is my big section and I also do building in my part time as a hobby, I use my skills in math lit to do it.

A: What was the least useful model and why?

B: I think it is probability, you see that section of probability for the learners not in terms of less useful for me for learners is a difficult section and learners need to use it in formulas and in gr 12 it is okay.

A: What is your opinion on the quality of tutors, their knowledge, confidence and their patience?

B: Okay Mam, this I am going to be very frank about. The first term we had a lecturer in Math Lit, she complained, she did not teach at all or did not lecture at all and she always came and asked us questions. We complained and the university changed our lecturer and the lecturer subsequent for the next year and a half was excellent in all aspects in presentation and in delivery.

A: What is your opinion about timetabling, contact sessions and mode of delivery?

B: In terms of the lecture itself?

A: Yes

B: This is my personal experience compared to the previous lectures that I had for the past years, this I think was excellent in terms of time, in terms of delivery and the contact sessions. I think that the contact sessions were more than adequate, it was almost every Saturday and also during the holidays and I think the university did a good job in (too much static and background noise) and especially the tests and exams that we wrote were (word not audible).

A: What are your opinions about the materials, were they readable, was it sufficient and the exercises given, the explanations were they good or poor and the relevance of the material?

B: You see the answers I am giving you as I told you the positive aspects to that course were 99% and any other university that can beat that course I would like to see that. The lectures was relevant to us as teachers the same thing we did in class, it was not something out of context from the class, very practical and we were able to relate it to learners and the textbooks we had was sufficient material plus our lecturer gave us a lot of information to use as well and that helped us a lot

A: What is your opinion about the admin support that was offered by the university?

B: Excellent, that is the word I can use.

A: What is your opinion about the centers and the venues that were used, the distance you used to travel and the cleanliness?

B: I think that the university has organized all these lectures where we were comfortably and especially for me I live in Reservoir Hills and I am 5km away from the centre in Overport and because it is a teachers centre in terms of classrooms and aircons and the physical building itself and the facilities were there for us to use, the table and chairs were very comfortable and spacious.

A: What can you say about the academic support?

B: Excellent again I am not being biased but that is the truth,

A: How can you advise the university to improve their program.

B: They can improve by the quality of the paper itself, those papers are very practical and simple. We need some challenging questions maybe a level four question.

A: What can you say about your previous qualification, did it help you with this programme, do you think that the work you did then was very different.

B: Yes mam, compared to previous courses we did it was very difficult getting materials from the lecturer but this course here was amore a teaching learning situation. We had time to rectify our mistakes and we had time to adjust our self to a new situation but as far this course in concerned with presentation the lecturer was tops.

A: What makes math a practical subject?

B: It is a hands on subject, where you take your syllabus and what I do for gr 11 and 12 and in this classroom over here we ask learners to bring their rulers, bring their pencils, tape and they measured the height of the chair and they measured the height of the desk , they know the size of the desk and they know the height of the door and they know they can't have a door more than 2 meters because nobody is more than 2 meters right the door will be 1 meter wide because nobody can get fatter than 1 meter and we use whatever we got as equipment and measure things. They can see here is the perspective and the perspective is either small or big.

A: Do you feel disadvantaged in the class because you have not taught grade 8 or 9 mathematics.

B: Yes mam, I do to a certain extent. If I taught grade eight or nine, what we do in grade eight or nine is pure math coming to grade ten and the many aspects which is done in grade eight or nine is not in done in the Ace programme and to link children from grade nine to ten is not difficult I will know where their weaknesses are.

A: Do you wish to continue your studies in math lit at a post graduate level.

B: Yes, I wanted to do that about two years ago but due to time constraints and finance.

A: What are the learners misconceptions in math lit and how do you cope with this misconception.

B: I do think the learners have misconceptions because they are coming across to math lit for the first time in grade 10 and it is a new subject although it is an offshoot of math itself learners

think that this is very easy not knowing that you have to involve yourself and they don't take math's because they say it is difficult.

A: Okay thank you Mr. Juganathan, I appreciate your time and I am hoping to use your answers in my study as well.

B: Thank you and you are a lovely lady and I am very fond of you and can I take you out.

A: Laughs

END OF INTERVIEW

INTERVIEW NO 3

A: INTERVIEWER: P BRIJLAL

B: INTERVIEWEE: PJM

A: Good morning my name is Priscilla Brijlall and I am my masters at UKZN and at the same time I am also doing a survey about all those who did their Ace Math Lit

at NMMU and UKZN.

B: My name is PJM and I am a Math lit teacher and I am attending my Bed honors at NMMU.

A: What was your reason for enrolling on the Math lit programme?

B: I have taught accounting for many many years and I felt I needed a change so Math Lit was interesting for me since it was dealing with figures.

A: Did you feel that you needed to upgrade or did the school ask you to participate in the programme?

B: It was for upgrading and I taught it was an opportunity at the same time and it was something that was offered by the government at the same time so I had to this.

A: How did this programme impact on your professional development in terms of your content knowledge?

B: I think the whole course empowered me as a person because when I started math lit I did not know exactly what it was about when I started the course I realized it was more relevant so for me it was more empowering. It related to the things I would encounter in life.

A: How did this programme impact on your professional development in terms of your teaching methods?

B: If you look at the new approach of teaching and I am an old teacher, I have been in the profession for more than 20 years and so we started the math lit there was this new approach of teaching in class for me it did make a difference equipping myself with the new methods of teaching in class.

A: How did this programme impact on your professional development in terms of your confidence?

B: It brought more confidence in me during the duration of the course we were dealing with all sort of problems. I felt more comfortable in terms of mathematical problems.

A: In any other aspect in the classroom how did this programme impact on your professional development?

B: The fact that the subject is relevant and it is easy to relate to the learners looking at things we will normally encounter. It was more empowering and it was relevant to the learners and they could easily relate to it because it is things that are in the real world.

A: What was the most useful module you studied and why. In NMMU we studied grade 10, 11 and 12. In all that you did which did you find more useful and contributing to work in the class.

B: I don't understand Mam.

A: In the first semester you did all the grade ten work and second semester you did grade 11 and then grade 12. Which of those did you find most useful to you.

B: I think it is grade 12 it is more of mathematics than math lit. For me grade 12 was more relevant and I am not saying grade 10 and 11 was not

A: What was your opinion about the university time-tabling mode of delivery and the contact sessions?

B: I was fortunate that the person that was our tutor then and he was able to bring confidence in us to handle different problems but the time factor was little but with the amount of time that we had we were able to handle a number of issues we had particularly with math. I was comfortable with it but if we were given more time it was going to make a big difference.

A: What was the least useful module you studied in Ace math lit and why?

B: This theory pattern, it was too complicated not necessarily complicated but the language used in some of the stuff we were handling it was a little bit difficult. Most of this stuff is written from people from abroad so they are using language that they use there.

A: What do you think about the content covered in the module? Do you think it was good?

B: It is difficult to say whether the content was good enough because you are not comparing it with anything but for me what was there I am happy with what was there. Most of the things that are there are very useful. Before I was not a math teacher I was teaching accounting so I had to change to math lit so with the knowledge I acquired during that course I was able to stand in front of the class and teach math lit.

A: What do you think about the quality of the tutors?

B: Our tutor was a very good guy. He helped me a great deal by bringing me confidence and I felt comfortable with that guy. At one stage he taught I was a math teacher and he was surprised when I told him I am a math lit teacher.

A: What is your opinion about the administration support from the university with regards to registration, queries and dps.

B: I don’t think there was any problem with regards to administration as you know I was one of the first students that were trained by the department and it seemed to be in order and we never experienced any problems. With regard to exams and timetables we never had any problem.

A: What is your opinion about the centre, venue, travel distance, cleanliness and resources?

B: With regards to traveling distance I think it was a bit too far but the fact that we were coming from different places I don't think that venue was very much big. In terms of the facilities in the institution itself I don't have a problem with anything.

We were in a very nice environment.

A: What is your opinion about the support that was offered, how can we improve on the support and what are some of the ways you felt supported and at any time did you feel that you wanted to drop out of the course and why.

B: I never thought about quitting at any time because of the kind of support we were getting. I don't know whether it was fortunate or unfortunate we were taught by one person who was very much supportive to all the students who were attending his class. He was giving us all this support and I believe that it is the policy of the institution itself. All the tutors give 100% support to all their students.

A: What can you say about your previous qualification, did it help you with this programme, and do you think the work you then are very different to now.

B: I can say that we are the product of the old system and we were trained under the new order. I want to believe there is a difference and if you look at the old system and the way we were taught to teach it was primitive and when we were trained for this course it was drastically changed. The approach to teaching was totally different from how we were trained before so there is a big difference with the approach.

A: Are you happy with the new approach?

B: I am very much happy with the new approach it gave more time for learners to engage themselves in the class and they consider what the learners are engages in outside and before the classroom climate was totally different to no so that is the difference.

A: Do you think that is necessary to teach grade 8 and 9 math and if your are not teaching it do you think that you are disadvantaged.

B: I think it is important that learners are taught math in grade 8 and 9.

A: By yourself?

B: No it is a problem because when I started teaching grade ten math lit and there were thing that were expected to be known by us of which I did not know and it was difficult to find out whether they did those things or not because I was not there but it is an advantage to teach them from the lower grades and you know what they know and move up with the grades you are even preparing them for that and you know what is required of them and you put more effort in that information because you know they require it in the future.

A: Do you feel disadvantaged with your ethnic background or your language and if you have to look at the language that you have to teach do you feel disadvantaged in any way.

B: Too some extent yes, but maybe I am lucky in the sense that I am in an urban area rather than a person from rural area and also the fact that I am an in the profession for too long and it not too much bad for me but that does not mean for another person it is the same situation but more particularly learners from rural areas they might experience problems taking into the fact the math lit is total content and what if they are not exposed to that so what happens.

A: Do you think it is the content or the context that gives problems.

B: I think it is the content that is the problem because you know the learner from the rural area is not exposed to a lot of things they don't know some of the things known by the learners from the urban area. So the learner from the urban area will have the advantage than from the learner from the rural area but in terms of the language itself it becomes an disadvantage even for the in the urban area and if he does not know the language it is a problem. It is also a problem for the teacher as well but maybe if you have been teaching for a long time then maybe it won't be such a big problem. It will be very easy if the subject is taught in the home language. It is fact that some learners out there that they don't understand the content but the language.

A: Thank you very much. I really appreciate the time that you have given me to ask questions and the university will use your responses in the evaluation of the programme. Do you think that the university can improve on this programme.

B: The problem is the fact that whilst we are furthering our studies with the university as the same time we must teach there is a lot of work and it is demanding a lot of our time and I don't know how we can draw a balance by doing it because there is too much work and it is difficult.

Thank you very much.

END OF INTERVIEW

INTERVIEW No. 4

A: INTERVIEWER : P BRIJLAL

B: INTERVIEWEE: SPM.

A: Good afternoon I am Priscilla Brijlall and I am very grateful that you have agreed to do this interview and I have a few questions on the Math Lit Ace Programme that you studied a few years ago in NMMU.

B: Nice to know you Priscilla, I am SPM, I am coming from Harding.

A: Are you teaching Math Lit at the moment?

B: Usually I was teaching grade 12 but this year I am teaching grade 11.

A: What was your reason for enrolling in this Ace Math Lit Programme?

B: Because Math Lit was a new subject so I wanted to know what this new subject was all about so I went there and learnt myself before I teach my learners.

A: Did you do it for upgrading or did the principal ask you?

B: I did it because I was a teacher who was going to teach Math Literacy and I went there because I was told there is an opportunity and it is free and then I took that opportunity.

A: How did this programme impact on your professional development in terms of your content knowledge?

B: The project really counts us Math Lit teachers because the topics that were covered it was really what the learners were going to do in class. When we went there we were just math teachers but when we went there to study math literacy we find out that at the beginning it was not easy but as time goes on and this math literacy we get used to it and it really help us

as well as the learners. You learn more about the learning outcomes, we know them by heart and all the assessment standards and what is expected from you as a teacher.

A: How did this programme impact on your professional development in terms of your teaching methods?

B: This programme helped me a lot because the teaching methods we learnt there like the methods you teach the learners whereby to do the area or perimeter. There are some topics in pure math you find out that when you were teaching the learners you were not talking to yourself, probability we were unable to do it but now as I am teaching math literacy I can teach those chapters very well, the area of the circle and all those things. I used to run away from those topics but now they call us to teach for them.

A: How did this programme impact on your professional development in terms of your confidence?

B: I am very much confident when I am teaching the Math Lit because I know the skills of teaching math lit and I know all my learning outcomes and I know what is expected of me to teach learning outcome no 1 and learning outcome no 2, I know everything.

A: What was the most useful module that you did and why?

B: Grade eleven, it was nice especially the material they gave us it was excellent. The module for grade eleven was wonderful.

A: What is in your opinion about timetabling, the contact sessions, what do you think of it.

B: We used to go there for a week and we did not stay at home for one week. We stay for one week without the family, there was too much attending but it helped us a lot. When we used to write exams, we used to go there and spend one week there.

A: Which module was least useful and why?

B: The last one, it was not useless but there was too much reading and the grade ten was very challenging.

A: What is your opinion about the study materials, were they sufficient exercises and explanations.

B: Yes, the grade ten books were very helpful. Those books from Mark are very good. You can still use it even if the learners are in grade twelve.

A: What is your opinion about the admin staff from the university in terms of registration, queries, and dps?

B: For the Ace course it was very nice and simple because we would just come to the dates that they prescribed even our schools they were supporting us when we go there. There were no fusses at all.

A: What is your opinion about the centers?

B: The venue was quite very good and the atmosphere was good and the travel distance was just one hour.

A: What can you say about the academic support, is there any way that they can improve it? At any time did you feel like dropping out?

B: No I did not feel like dropping out because as I said that the course was quite relevant. The most relevant Ace course is here at NMMU. You know exactly what to do in class and it was very good.

A: What can you say about your previous qualification, you were a teacher of another subject, did it help you with this programme and do you think that the work you did then was very different from what you are doing now.

B: Yes a little bit different. In math lit there was a lot of material and we were getting the support to do the course but the previous qualification you have to find the books yourself, you go to the library for research whatever. We have to sweat and sweat for it but with the Ace most of the things were provided. The materials were available with the Ace.

A: Do you think it is necessary for a math lit teacher to teach grade 8 and 9, is it necessary? Do you think if you have a non math teacher like an accounting teacher who is teaching math lit now do you think it was necessary for them to have taught grade 8 and 9 math.

B: Yes I think it is necessary what I have seen in grade 8 and 9 math (too much static cannot hear the words) so maybe if the teacher has got a background of math they can teach grade 8 and 9. Like for instance in my school there is a teacher that is teaching math grade 8 and 9 they used they used to call us math lit teachers to teach probability even the grade 12 teacher should to call us so I think they can.

A: The pass rate for the ladies in the math lit was lower than the men. Why do you think this is so?

B: I am not sure on that one. I think it is normal not in math only maybe because even of the load we carry at home when we are adults you see, we have a lot of work to do than men. So I think it is a matter of time. Maybe we spend a little time on school work, I don't know.

A: Do you think as an African teacher you are disadvantaged to teach math because of the context.

B: Yes we find out that as we are teaching in black schools most of our learners have got a language barrier, they have difficulty in answering questions, you find out that in the test the learner has failed the test but when you explaining to them they say that they know it, it was just a problem of the language.

A: So do you think that language is kind of a barrier?

B: Yes, there is a lot of reading in math lit; you have to follow the story before you answer the question.

A: Okay think you very much. I do appreciate the fact that you gave some time to interview you and this information you have given me will help in the long run.

If the university had to improve on the ace math lit programme what do you think they should do. Can they improve on the programme or is the programme good enough.

B: Maybe the university can improve on learning outcome no three because you find out that teachers don't teach outcome no 3, space and shape and measurement and at the end of the day especially during exam time our learners are unable to answer most of the questions in paper 2 so maybe I think there should be more work the university supply on paper 2 especially the learning outcome no 3.

A: Okay thank you very much.

END OF INTERVIEW

INTERVIEW NO 5

A: INTERVIEWER: P BRIJLAL

B: INTERVIEWEE: NM

A: Welcome to this Ace Math Interview, thank you very much for agreeing to be interviewed, this research is actually going towards the masters programme I am doing and it will also help the university with their research as well to find out what happened to the Ace math lit students that did that programme, whether they were enriched by this programme.

B: My name is NM and it is a pleasure to be interviewed.

A: What was your reason for enrolling in this Ace Programme, did you feel that you needed to upgrade or did the principal ask you?

B: Firstly I have been a teacher of languages for a very long time and I think I needed a change as well. Mostly to upgrade and do something new.

A: How did this programme impact on your professional development in terms of your content knowledge?

B: I can say that it helped to a certain extent because math literacy is a diverse subject. The programme touched on aspects of math literacy that we are doing in school it did not go into the deeper aspects of it. It gave me a broader knowledge of it. It helped into getting me into a new subject.

A: How did this programme impact on your professional development in terms of your teaching methods?

B: Basically when we saw how the lecturers got us to do new stuff and to get children to draw graphs and we introduced them to graphs like things like that. Also the different ways we can use to introduce our lessons.

A: When you taught previously in another subject did you find it different to how you teach now in math lit.

B: Languages is a different subject all together and I think we use different methods.

A: So this training that you had did you feel like you learnt a lot, how you felt when you taught in the classroom.

B: There are so many aspects in the general aspects it gave me a lot of confidence to teach so it did help.

A: Did the Ace programme impact on your confidence?

B: It did because it broadened my knowledge, there was such a bulk of knowledge that we were given and it did not touch on math lit only it touched on the entire math spectrum. Looking at the content, the content was quite intense and if you look at the notes they give you, the source material that they give you and past year exam papers as well, it was very helpful. We should have an additional course to update our knowledge as the new work comes in.

A: What was the most useful module that you studied and why?

B: I liked data handling a lot because we had very good lecturers for that giving us more content to take back.

A: What was the least useful module you studied and why?

B: I don't think that there was a least useful module; I enjoyed all the modules, every one of them because the lecturers made it very enjoyable.

A: What was your opinion about the time tabling, the mode of delivery and the contact sessions?

B: We had quite abit of contact sessions I enjoyed the fact that we could go during the holiday time and during the weekends. Whatever knowledge we were getting I was enjoying because it was just enriching us.

A: What was your opinion about the materials, were they readable, and were there sufficient exercises and explanations?

B: Yes they were because when I did grade 8 and 9 math all the knowledge I got from math lit helped me to teach grade 8 and 9 math, rotations and transformations.

A: Do you think that it is essential for math lit teachers to teach grade 8 and 9, do you think that you were disadvantaged when you starting teaching grade 10 math lit where you had not taught grade 8 and 9 math.

B: Not as such because math literacy is different from grade 8 and 9 math. Grade 8 and 9 math is much more application though you have word problems in grade 8 and 9 it is not intensive as math lit. Its more word problems and literacy coming in.

A: Don't you think the basics are done in grade 8 or 9.

B: Yes there are some basics like sections like the children have learnt I would not have known that our pupils knew volume and surface area before hand because I did not do 8 and 9 math before that because we doing substitution, solve for x ,all these things and transposing and stuff you need to know all these things and even in grade 12 math when you solving for x you got a division there and then you got a transpose they are forgetting they have to multiply at the other end to solve for x and yet they have done it before and I always remind them this is grade 8 work and this is grade 9 work and had I had not done grade 8 and 9 I would not have known that they have done all the stages it seems impossible because they have done it before but in math lit it is like everything they are doing is now new. The grade ten always ask me what do you in math lit is it different to pure math. There is not much difference as such because though you are doing math lit you are working with very similar stuff.

A: What is your opinion about the content covered in the modules?

B: As I said math lit is a subject that if I am going through my math modules now the question I am doing in grade 12 now is new stuff are constantly changing, its different angles the examiner will test children the same concepts the examiner will test children, they always want the children to go a step further. In math paper 2 grade 12 it is very much thinking out of the box compared to now the module we did in math lit.

A: What do you think about the quality of tutors?

B: As I said the tutors were of very high quality, its either they were teachers who have taught for many years and very experienced teachers, lecturers from Mongosuthu Technikon very into to the stuff and very approachable people and all the knowledge we got from them we understood.

A: What is your opinion about the admin support the university offered to you like registration, queries etc.

B: Very efficient.

A: What is your opinion about the centers, venues and the travel distance?

B: Easily accessible because the Edgewood college is very near and the Pinetown Boys too was very accessible. We had no problem getting to our destinations.

A: What is your opinion about the academic support and how can they improve on it. What are some ways you felt supported. What has stopped you from dropping out?

B: It was so interesting I don't think I would have want to leave the course because every module that we did we basically get a lot of information and I did not feel de-motivated or anxious. It was a challenge and I enjoyed it. It was an opportunity that was given and I enjoyed it.

A: How would you advise them to improve the programme?

B: Constantly updating the knowledge we are teaching in grade 11 and 12, we are doing the caps and getting that knowledge we are doing in school as such and applying it to the course. You find in school that you are dealing with a whole lot of new stuff and going through past year papers to find out how to handle it.

A: What suggestion do you have?

B: To have more training with such that they don't teach you just the basic content but go into past year papers because textbooks just give you a water down version and the examiners will start chopping and changing questions into different ways to challenge the children, to challenge the learners so what they need to do is to work with the papers and show us exactly, the new students how to handle it and how to give their learners the best knowledge.

A: What can you say about your previous qualification, did it help you with this problem and do you think the work you did then very different to the work you doing now.

B: My previous qualification was a teachers qualification and I practiced to be a teacher and basically what happens is that you switch like languages first and then you go into math but basically you still in the mode of getting learners to learn and understand and I have always watered down stuff for them to make it simple and accessible so your standard of teaching will not change because you would always want children to learn and understand. And you those to get to the easiest and quickest method to understand and obviously with HOD'S and colleagues who would get you the best method to get the knowledge into their heads basically. The methodology has not changed.

A: According to the survey only 38% of the female and 51% of the males graduated in that expected time. Why do you think that there was a lower pass rate for women?

B: I think because most females have families because of the intensity of the course and they have to attend lectures, such intensive lectures, I did not realize the drop out rate was so high. I remember one of the ladies that were in our group was pregnant at that time and she did not write that particular course and I am not sure whether that was in all the classes and probably in that two years some of them fell pregnant. They also have children and the pressure of having a family and some people may find it too overwhelming to cope with families and to cope with studies and to cope with a career and you have to juggle that in that two years. Some people it could have been years when they studied. This is the first time some of them studied on a pert time level and to be married and to have a career. You still have to submit assignments and do tests and weekends were taken up basically and that was a factor.

A: What other reasons made you continue this course.

B: I always wanted to persevere even when I started my first degree because I always had a goal and I had to finish it and if I start something I have to always finish it.

A: Is math lit different from math.

B: It is as you said it is more contextual based with math it is either a wrong or a right answer and with math lit you can say yes and no and give your opinion, basically it is your perspective.

A: Do you wish to continue your studies in math lit at a post graduate level.

B: Not at the moment but I would like to. To ask questions basically this time around because now that I am teaching it and I would like to be proactive in my questions to the lecturers.

A: What are the misconceptions in math and how do you copes with these misconceptions within the class and are there any barriers?

B: The only barrier that we have is that we have such large class numbers. It is very difficult to teach 45 children and to get everybody's attention especially when we are doing probability or when we are doing anything for that matter and that class number is not going to go down

any time soon. With the matrics I want it much nicer because we have smaller numbers and there you can get individuals to work with you to understand and learn better.

A: What are their misconceptions?

B: Sometimes when they are sitting in the math lit class they feel that they are weaker than the others. They feel that none of the subjects are related to each other. That is not true because if we look at math and math lit there are sections that are linked.

A: Do you think the context give the learners a problem?

B: Yes, the contexts are giving them a problem the straight forward questions like percentages and simplifying the ratio is fine but when it comes to applying they forget to invert, the little things posts barriers.

A: Did you find that the Ace math lit programme prepared you for this.

B: To a certain extent.

A: Okay thank you very much. I do appreciate you giving up your time and you were able to answer my questions. I wish you well in your teaching.

B: Thank you

END OF INTERVIEW

INTERVIEW NO. 6

A: INTERVIEWER: P BRIJLAL

B: INTERVIEWEE: GBN

A: Hello GBN, how are you. Welcome to this programme. I am actually interviewing people who have studied the Math Lit Ace Programme. You have been on that Math lit Ace programme and we are doing a survey so I am just going to ask you a few questions. okay first question what was your reason for enrolling on this Ace Math Lit Programme.

B: In fact I wanted to improve my qualifications and this was a new subject in the school and I was the first in my school to get into this programme to teach for grade ten which was going to be grade ten for the first time so I was the first teacher to teach that for the first time and I had to go there.

A: Was there any other reason for enrolling in this programme, for upgrading or did the principal ask you.

B: To have a new knowledge of what is happening and I was interested in getting to know it.

A: What subject did you teach before it?

B: I was teaching different subjects, science and commerce and natural sciences.

A: Did you upgrade when you went on this course, did you go on the next grade?

B: In fact I have tried to go further to another course and I have been trying to do honors and I had problems and through the years I have stopped.

A: How did this programme impact on your professional development in terms of content knowledge, your methods of teaching in the classroom, confidence that you have as a teacher and any other aspects. Lets deal with content knowledge.

B: The content of math lit is related to our world, it is interesting because we are dealing with things we are doing in our daily life. So I find it very interesting and I also gain knowledge of some other thing like statement of account, to know where this account is coming from, how it is calculated.

A: And your teaching methods think of how you taught in your other subjects and how would teach math lit. How did you gain professionally?

B: I think when comparing math lit with other subjects you have to obtain what you have to do in class. That is where you get the experience and gain confidence and you know what you have to find out in the classroom and you have to start by when they were teaching us. It has given us a lot of knowledge to know what is expected from us.

A: How did you feel when you taught in the classroom after you taught math lit?

B: I think in the classroom it was not so easy because it involved language. Problems with math lit with kids in the classroom. They don't like to learn this long statements. In math lit you have to read and understand so they like short statements. The main problem is that they don't like to read the information given to them.

A: How did you go about teaching it to them? Like the methods you used. Did the problem help you in solving the problem?

B: Yes because of the workshop, it is helping. The Ace math lit was a good workshop.

A: Did the course help you to gain confidence in the classroom.

B: Yes, math lit me have no with, the way we were thought and the way we were writing our assessments.

A: What was the most useful module you studied? In NMMU you did not do any modules you did grade 10, 11 and 12.

B: I think we started grade ten it was not so simple and not used to the style they were teaching us but the content was relevant and grade 11 and 12 was becoming more simple and easier. In fact I passed with flying colours.

A: Which section did you feel was the best?

B: Shapes and measurement I enjoyed it. In pure math this was very difficult to understand shapes and measurement but in math lit the way they were doing it became simpler to do it.

A: What was the least useful module and why?

B: Probability, sometimes the kids find it difficult to understand. They can understand now and they forget.

A: Was there anything that you did not like.

B: I can't say that there was something that I did not like. I was comfortable with all the topics.

A: What is in your opinion about the timetabling, mode of delivery and contact sessions?

B: The contact sessions was taking up a lot of our time but it also helped us a lot by gaining more knowledge and at the same time we were complaining because during holidays we were always there.

A: What is your opinion about the materials, were there sufficient exercises, and were the materials good?

B: The books that were given to us from the beginning, it was relevant and I think that the teachers were also good. They were not treating us like adults; they were treating us like kids in the classroom. They were taking us by step one by one.

A: What is your opinion about the content covered in the module was the content enough to actually teach at school.

B: I think it was well enough to teach all grades. All the content is related.

A: What is your opinion about the quality of the tutors?

B: We had two lecturers. The first one if I can remember went away, I don't know the reason but he was not so bad he was just average but the young man that came to us he was very good. This man was from Chatsworth and he was very good and this is the lecturer I remember.

A: What is your opinion about the admin support, regarding registration, queries dps.

B: Yes, we were having support.

A: What can you say about academic support, what is your opinion about the support they offered.

B: I think they are doing more because the content is increasing.

A: What stopped you from dropping out?

B: I find it very challenging in the Bed honors and some of things I am being taught is irrelevant.

A: I am talking about the Ace.

B: I did not drop because I was progressing very well, I could manage it because the course was going to help me in future.

A: What can you say about your previous qualification, did it help you with this programme, do you think the work you did then is more difficult than the work you are doing now.

B: I think math lit was a different subject all together. There is no relationship with these two things. Ace was the third course I was doing, the second course I was doing part time also and I had no time and we were very helpless sometimes and in the second module you have to struggle on your own and there was no teacher at the time but in math lit the teacher was following you all the time.

A: Why is it that the ladies in the programme had a lower pass rate than men? 38% of the females passed and 51% of the males passed. Why do you females drop out more than males, what are the challengers for females.

B: I think we are the same and females have a lot of things to do like at home men have got a lot of time. At home the females have to do everything at home. So after they do their schoolwork they are very tired.

A: Do you wish to further your studies after math literacy at a post graduate level.

B: I am still interested in studying, in fact I am half way through my Bed honors and I like to learn.

A: Do you feel disadvantaged in the class that you have not taught grade 8 and 9 math.

B: No in fact I have no problem with that. I taught grade 8 and 9 and I think it is useful to get the knowledge of pure math.

A: When you teaching math lit what are your learners misconceptions?

B: In fact I have explained it to them one by one so I can make them understand all the concepts of math. I have to repeat one thing for one week if they don't understand I will have to repeat until they understand it.

A: Do you have any methods or do you have any creative ideas on how to solve these problems?

B: Maybe if they have written a test and after that I have to give them the feedback and do the revision and you find sometimes the problem is the language and sometimes you find that you have to teach them some language skills.

A: I observed your lesson and I found that you code switch when you have an isizulu class you teach in Zulu and you teach in English, do you think that this helps.

B: Sometimes you find the Zulu speaking children although they understand something and those things that they can't understand I will switch a little bit to try and explain them in their own language what is required of them.

A: Do you think this is going to help because they write their exam papers in English, this code switch do you think it is going to help.

B: I think it helps a little. I used to tell them that the content is in English so you must be prepared to understand in English because I won't be there to explain to them in English.

A: What makes math lit a practical subject?

B: Because what we are dealing with in math we are coming across it everyday and you have to understand everything surrounding you. It gives you ideas on things we need to know.

A: Do you think math students will benefit if you give two math lit periods a week.

B: In fact there is not much difference between the both because they are working with numbers and yes I think that they can gain.

A: What makes math lit different from math?

B: It is related to what we doing in daily life, math lit. In pure math they don't like solving for x, something that you don't understand so in math they are speaking about things they don't

understand. They don’t understand calculus, sometimes they are negative and they don’t like to do those topics in pure math. In math lit most of the topics they are familiar with.

A: Thank you for this interview. I enjoyed your answers. I hope you did as well.

END OF INTERVIEW