

**EXPLORING THE PRACTICES OF TEACHERS  
IN MATHEMATICAL LITERACY TRAINING  
PROGRAMMES IN SOUTH AFRICA AND  
CANADA**

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Dissertation submitted in fulfilment of the requirements for the degree *Master of Education* in Teaching and Learning at the Potchefstroom Campus of the North-West University

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September 2010

# **ACKNOWLEDGEMENTS**

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First and foremost I thank my Heavenly Father for the fresh supply of strength He blessed me with every morning while I was busy with my study. I acknowledge that without Him this study would not have been possible.

I want to sincerely thank all the participants for their co-operation and valuable input in this study.

I will forever be grateful to my supervisor and friend, Dr. Marthie van der Walt, for her continuous support and intellectual contributions in helping me finding my feet in the research world. She really surpassed all my expectations and went pass the line of duty to make sure I stayed focused and committed, even in dark days.

My sincere thanks and gratitude also goes:

To my Canadian co-supervisor, Prof. Joyce Mgombelo, for being there for me during my stay in Canada, together with Prof. Mary-Louse Van der Lee, making sure that it was the most memorable educational visit I ever had.

To the Director of the School for Continuing Teachers' Education, Prof. Manie Spamer for his guidance and never saying no when I needed his assistance trying to juggle work and studies in a too short 24-hour day.

To my Dean, Prof Petra Engelbrecht who in spite of numerous other engagements stayed interested and involved in my studies and made it possible for me to kick-start my research career with an international overwhelming conference AERA in 2008.

To my colleague and friend, Mr. Elroy Zeekoei for taking care of academic matters when I was not available because of my study. Also for the long hours we could talk about some pressing matters in our subject field.

To Ms. Maria Arangies for the editing of my thesis and Ms. Susan van Biljon for technical assistance.

I will always be grateful to my husband, Aubrey Fransman, for giving me the space and taking care of our children during the time I was in Canada, while supporting me all the way.. I would also want to thank my children, Santino, Gabriela and Zilandre for bearing with me, understanding and supporting me during my entire study. To my dear sisters, Zeenat, Evelien and Willa, my big brother Derick, and my two dearest friends, Magrit and Esme, who were there for me every time I needed encouragement and support. A big thank you to my parents, Pa Willem and Ma Eva, who were helping in every way they possibly could to make it easier for me.

I also want to thank my colleagues, each and every SCTE staff member for the unique way in which each one of them contributed to me being able to complete this study; whether it was an encouraging smile, handshake, embrace or a positive word.

Last, but not least, I want to thank the North-West University (Potchefstroom campus) and the Foreign Affairs and International Trade Canada (DFAIT) 2008 Graduate Students' Exchange Programme (GSEP) for their financial assistance.

# SUMMARY

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The implementation of Mathematical Literacy as subject in the South African school curriculum in 2006 necessitated the re-training of suitable teachers to teach the new subject. Can we as developers of Mathematical Literacy teacher training programmes in South Africa, learn from teacher training programmes for similar subjects in Canada? This was the driving question behind the study with its emphasis on the experiences of in-service and pre-service teachers registered in mathematical literacy training programmes at the North-West University in South Africa and Brock University in Canada.

The Advanced Certificate in Education (Mathematical Literacy) programme is presented on a part-time basis by the School of Continuing Teacher Education at the North-West University while the Intermediate/Senior teacher education programme is delivered full-time at Brock University. The literature review focuses on mathematical literacy, the training of the teachers and the methodological implications of teaching of mathematical literacy subjects and courses.

The study can be seen as a multiple case study due to its dual contexts: The South African population comprises of 189 in-service teachers and the Canadian context consists of 30 pre-service teachers. Qualitative data was collected via questionnaires collected from 61 South African participants and 12 Canadian participants, five focus group discussions; six individual interviews and three lesson observations. The data was analysed using ATLAS.ti.5.0 – a computer-aided system used for the analysis of qualitative studies.

It was found that South African teachers formed a 'new status identity' as Mathematical Literacy teacher. A large difference between the two countries is the strong mathematical background of the Canadian pre-service teachers compared to the poor mathematical background of the South African in-service teachers. It was concluded that South Africa as developing country can indeed learn from Canada in that we should place more emphasis on the mathematics content knowledge of in-service teachers in mathematical literacy teacher education programmes.

# **KEY WORDS AND CONCEPTS**

Mathematical Literacy

Mathematics teacher education

Developed country

Developing country

Mathematics content knowledge

Mathematics-for-teaching knowledge

In-service teachers

Pre-service teachers

Mathematical literacy teacher training programmes

Mathematical background

# **OPSOMMING**

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Die implementering van Wiskundige Geletterdheid as vak in die Suid-Afrikaanse skoolkurrikulum in 2006 het die heropleiding van geskikte onderwysers vir die vak genoodsaak. Kan ons, as die ontwikkelaars van Wiskundige Geletterdheid Onderwys opleidingsprogramme in Suid-Afrika leer by onderwys opleidingsprogramme vir soortgelyke vakke in Kanada? Hierdie vraag was die dryfveer van hierdie studie wat fokus op die ervarings van indiens- en voordiensonderwysers wat geregistreer het vir wiskundige geletterdheid opleidingsprogramme by die Noordwes-Universiteit in Suid-Afrika sowel as die Brock Universiteit in Kanada.

Die Gevorderde Onderwysertifikaat (Wiskundige Geletterdheid) program word op 'n deelydse basis aangebied deur die Skool vir Voorgesette Onderwysopleiding by die Noordwes-Universiteit, terwyl die Intermediêre/Senior onderwys opleidingsprogram by die Brock Universiteit op 'n voltydse basis aangebied word. Die literatuurstudie fokus op wiskundige geletterdheid, die opleiding van die onderwysers en die metodologiese implikasies wanneer wiskundige geletterdheidsvakke en -kursusse onderrig word.

Hierdie studie kan as 'n meervoudige gevallestudie beskou word as gevolg van die dubbele aard daarvan: Die Suid-Afrikaans populasie bestaan uit 189 indiensonderwysers, terwyl die Kanadese konteks saamgestel is uit 30 voordiens onderwysers. Die kwalitatiewe data is ingesamel deur middel van vraelyste wat deur 61 Suid-Afrikaanse deelnemers en 12 Kanadese deelnemers ingevul is; vyf fokusgroep gesprekke; ses individuele onderhoude en drie les waarnemings. Die data is geanaliseer met behulp van ATLAS.ti.5.0 – 'n rekenaar-ondersteunde stelsel wat gebruik word om kwalitatiewe studies te ontleed.

In hierdie studie is bevind dat Suid-Afrikaanse onderwysers 'n 'nuwe status identiteit' ontwikkel het as Wiskundige Geletterdheid onderwysers. 'n Groot verskil tussen die twee lande is die goeie wiskundige agtergrond van die Kanadese deelnemers in teenstelling met die swak wiskundige agtergrond van die Suid-Afrikaanse deelnemers. Die gevolgtrekking is dat Suid-Afrika, as ontwikkelende land, inderdaad kan leer by Kanada in soverre dat daar meer fokus geplaas moet word op wiskunde inhoudskennis van indiensonderwysers in wiskundige geletterdheid onderwys opleidingsprogramme.

# **SLEUTELWOORDE EN KONSEPTE**

---

Wiskundige Geletterdheid

Wiskunde onderwys opleiding

Ontwikkelde land

Ontwikkelende land

Wiskunde inhoudskennis

Wiskunde-vir-onderrig kennis

Indiensonderwysers

Voordiensonderwysers

Wiskundige geletterdheid onderwys opleidingsprogramme

Wiskundige agtergrond

# **LIST OF ABBREVIATIONS**

---

ACE	Advanced Certificate in Education
DoE	Department of Education
FET	Further Education and Training
J/I	Junior/Intermediate
MoE	Ministry of Education
NCS	National Curriculum Statement
NPDE	National Primary Diploma in Education
NWU	North-West University
OECD	Organization for Economic Co-operation and Development
PISA	Programme for International Student Assessment
P/J	Primary/Junior
PTC	Primary Teacher Certificate
SAIDE	The South African Institute for Distance Education
SCTE	School for Continuing Teacher Education
I/S	Intermediate/Senior
REQV	Relative Education Qualification Value
RPL	Recognition of prior learning
TIMSS	Trends in International Mathematics and Science Study
UNESCO	United Nations Educational, Scientific and Cultural Organisation

# **EXPLANATION OF TERMS**

Access Course:	The Access Course is a course in which teachers that are not in possession of grade 12 Mathematics on their Senior Certificate is enrolled to be provided with the basic mathematical knowledge and real life applications of basic Mathematics content knowledge for grade 8 to grade 12.
Associate teacher:	Teacher of a class in which a teacher candidate is placed during teaching block (practicum) in order to practise his/her teaching.
Concurrent program:	A teacher education program designed to allow students to complete simultaneously a Bachelor of Education degree and another undergraduate degree.
Consecutive programme:	A post-graduate teacher education programme in a Faculty of Education where students spend one year completing courses and practical experience in order to obtain a Bachelor of Education degree.
Credits:	Universities in Ontario require students to complete 90 credits (15 full year courses) to obtain a Pass degree and 120 credits (20 full year courses) for an Honours degree.
Distance education:	Mode of delivery in which classes are a mixture of contact classes (of-campus) at identified centres and self study by teachers enrolled in teacher training programmes.
Mathematical Literacy:	Subject that was implemented in 2006 in the Further Education and Training band of South African Schools
mathematical literacy:	The capacity to identify, understand and engage in mathematics and to make well-rounded judgments about the role that mathematics plays in an individual's current and future life as a constructive, concerned and reflective citizen (OECD, 2003:47)

Paradigm:	A set of assumptions or beliefs about fundamental aspects of reality which gives rise to a particular world-view (Nieuwenhuis, 2007a:47).
Practicum:	While in a teacher education program, candidates are required to work side-by-side with a qualified teacher in a classroom setting. This is called a Practicum in which a candidate gains experience through various tasks such as observations, assessments, lesson planning and behaviour management.
Pre-service programme:	A programme offered by a Faculty of Education to gain initial qualifications to teach in Ontario.
Teachable subjects:	A focus on one or two academic subjects is required for entry in J/I and I/S Pre-service Programs in Faculties of Education in Ontario. This subject is called a teachable.
Teacher candidates:	Students who are preparing for teaching careers enrolled in teacher training programmes at tertiary institutions.

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**CHAPTER 1:**  
**ORIENTATION**

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## 1.1 INTRODUCTION

The complexity of mathematics teacher education is acknowledged by many researchers within the wider mathematics teacher education community (Bishop, 1991:173; Lerman, 2001:87; Da Ponte & Chapman, 2002:223; Malara & Zan, 2002:535; Ball & Bass, 2003:3; Adler, 2005:163; Brown & Schäfer, 2006:2; Graven & Venkat, 2007a:67). Mathematical Literacy teacher education is no exception. The implementation of Mathematical Literacy<sup>1</sup> in South African schools in 2006, with all its good and noble intentions, necessitated the development of effective Mathematical Literacy teacher education programmes for the training and retraining of prospective Mathematical Literacy teachers. Mathematical Literacy was introduced as alternative subject to Mathematics in the Further Education and Training (FET) band of the South African school curriculum for learners who do not intend to follow mathematics-based careers. These programmes should prepare prospective teachers of Mathematical Literacy to teach the subject in such a way that it does not become the “watered-down” version of Mathematics that people in the mathematics education arena fear it might become (AMESA, 2003:1). Even worse, that it should not become just another subject that Mathematical Literacy learners must pass in order to gain their Senior Certificates.

The above situation gives rise to the following important question:

What constitutes an effective Mathematical Literacy teacher education programme?

Finding an answer to the question above is not an easy task: There are various factors that compound the answer to this question, factors which revolve around two major strands:

The **kind** of teacher **whom** this programme should prepare; and

The **nature** and **purpose** of the subject Mathematical Literacy.

### 1.1.1 The kind of teacher whom this programme should prepare

Lott (2004:176), although addressing quantitative literacy which could easily be substituted with mathematical literacy in this context, makes a strong case for the kind of teacher whom the programme should prepare when he asserts that:

*We need to examine who can teach what is needed. Many elementary teachers may not be comfortable with the necessary mathematics because of their own*

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1 For the purpose of this study “mathematical literacy” without capital letters will refer to the capacity to identify, understand and engage in mathematics while “Mathematical Literacy” with capital letters will be referring to the subject that was implemented in 2006 in the Further Education and Training (FET) band of South African Schools.

*backgrounds. Middle school teachers have mixed mathematics backgrounds, and secondary teachers are typically more comfortable with traditional mathematics than with the mathematics presented in a quantitative literacy program. Teacher preparation programs therefore must change. Without such change, a quantitative literacy movement has little chance of success. Expecting that teachers other than mathematics teachers either know or understand what might be considered quantitative literacy is equally unrealistic (Lott, 2004:176.).*

In South Africa, the teacher whom has been earmarked for Mathematical Literacy training would most likely not be a Mathematics teacher, because of the fact that there was already a dire shortage of Mathematics teachers in the country prior to the implementation of Mathematical Literacy in 2006. This left other teachers, who do not have post-matric Mathematics training, to be included in the list of prospective Mathematical Literacy teachers. This situation is made worse by the fact that most of these teachers themselves did not take or pass grade 12 Mathematics in achieving their Senior Certificates. Within the South African context this means that such teachers either dropped Mathematics in grade 9; and subsequently have no knowledge of grade 10, 11 and 12 Mathematics; or these teachers did take Mathematics in grades 10, 11 and 12, but failed the subject in the Senior Certificate Examination. It can rightfully be said that the mathematical background of such teachers is not up to standard for teaching Mathematical Literacy the way it ought to be taught.

This poses great challenges for the development of effective Mathematical Literacy programmes. Having said all of the above, we should keep in mind that the main focus should be on how best we can improve the learning of mathematics and the application thereof and not just to focus on producing teachers who know more about mathematics (Ball & Bass, 2003:3).

### **1.1.2 The nature and purpose of the subject Mathematical Literacy.**

One of the aims of implementing Mathematical Literacy in 2006 as alternative subject to Mathematics in the FET band in South African schools was *to ensure that our future citizens are highly numerate consumers of mathematics* (DoE, 2003:9). It stands to reason that an effective mathematical literacy teacher education programme should consist of components that prepare teachers to teach Mathematical Literacy in such a manner that our learners will become citizens who are highly numerate consumers of mathematics. The tasks, discourse and environment should all work together to foster the development of the learners' mathematical literacy (De Lange, 2004:75; Lott, 2004:76). The particular nature of the subject therefore requires an explicit focus on mathematical literacy competencies, like reasoning and problem-solving, in the outcomes of effective Mathematical Literacy teacher education programmes. The subject, Mathematical Literacy also requires a good

Mathematics knowledge base, from both the learner and teacher, to be able to solve the problems based on real-life situations in order to develop mathematical literacy in the learners taking the subject. Thus, it becomes clear that the Mathematics knowledge base of the prospective teacher as well as the Mathematics-for-teaching knowledge of the teacher should be enhanced.

### **1.1.3 Some statistics on Mathematical Literacy in South Africa**

The year 2008 marked the first year in which learners wrote a National Senior Certificate Examination in Mathematical Literacy. The 589 912 candidates who wrote the Senior Certificate Examination in 2008 were the very first group of learners to write a national school leaving examination that is based on the National Curriculum Statement (Appel, 2008:1). It was also the first year in which all learners wrote a mathematics paper, whether it was the Mathematical Literacy paper or the Mathematics paper. According to Appel (2008:1) the Education Department Director General, Duncan Hindle, told the media, in a 2008 Senior Certificate Examination results press release, that it is positive for the country that 207 230 out of the 263 464 candidates who wrote Mathematical Literacy passed the exam. However, this optimism by the director general is not shared by everyone. It seems as if there is great concern and doubt about the quality of the passes that were achieved in the 2008 Senior Certificate Examination, especially in the natural science, mathematics and technology subjects. Chisholm (2008:34) asserts that the debate about Mathematics in the 2008 Senior Certificate Examination focussed primarily on the “dubious quality” of the mathematics, science and technology matriculants. Chisholm (2008:34) furthermore makes the bold statement that the quality of the mathematics, science and technology matriculants of 2008 was questionable because of the little trust the public has in the quality of Mathematics teachers and Mathematics teaching in South Africa.

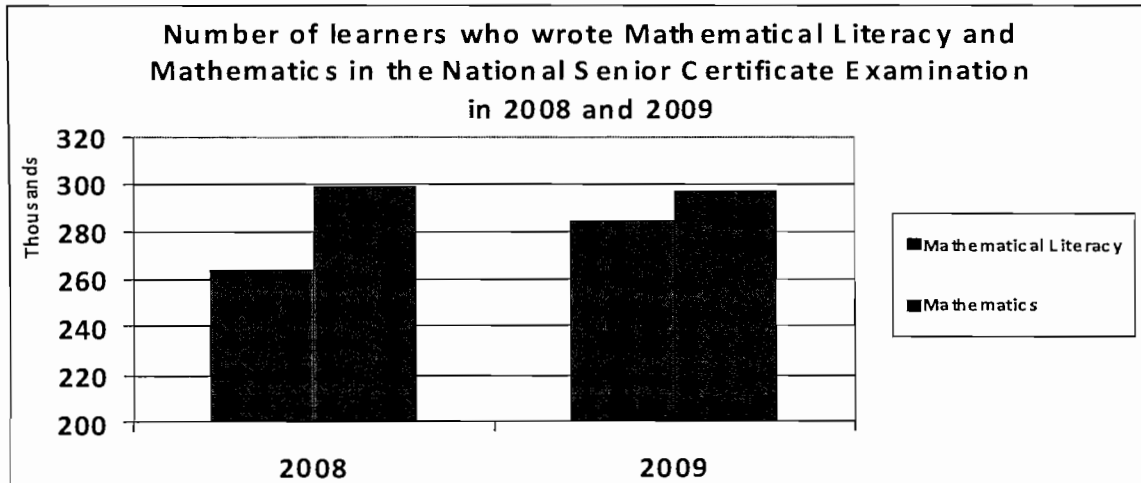
The following statement was made by the Minister of Basic Education, Mrs Angie Motshekga, on the announcement of the National Senior Certificate grade 12 examination results for 2009 at the Media Centre, Union Buildings, Pretoria on 7 January 2010: *A positive feature of the 2009 exams has been that more learners have registered for Mathematics (296 659) than for Mathematical Literacy (284 309).* What the Minister failed to mention was that the number of enrolled learners for Mathematics decreased with 2 162 while the number of registered learners for Mathematical Literacy increased with a staggering 20 845 since 2008. Table 1.1 indicates the number of learners who wrote Mathematical Literacy versus the number of learners who wrote Mathematics in the 2008 and 2009 Senior Certificate Examination.

**TABLE 1.1 ENROLMENTS IN MATHEMATICAL LITERACY AND MATHEMATICS FOR 2008 AND 2009**

Subjects	2008	2009	Increase/decrease
	Total Enrolment	Total Enrolment	
Mathematical Literacy	263 464	284 309	20 845 increase
Mathematics	298 821	296 659	2 162 decrease
Difference	35 357	12 350	

Source: Department of Basic Education, 2009:18 table adjusted

If one takes a closer look at the numbers of enrolment for the Senior Certificate Examination in Mathematics and Mathematical Literacy for the past two years (2008 and 2009), one cannot help but notice how rapidly the gap between the numbers of learners registered for the two subjects have shrunk (from 35 357 to only 12 350). Figure 1.1 provides a picture of how the gap between learner enrolments in the two subjects has narrowed in the past two years.



Source: Department of Basic Education, 2009:18

**FIGURE 1.1 NUMBER OF SOUTH AFRICAN LEARNERS WHO WROTE MATHEMATICAL LITERACY AND MATHEMATICS IN THE 2008 AND 2009 SENIOR CERTIFICATE EXAMINATION**

Although the class of 2009 in South African schools was only the second cohort of learners who had to register for either Mathematics or Mathematical Literacy in their final examination, it is very clear that Mathematical Literacy as a subject is rapidly gaining ground, making the need for competent Mathematical Literacy teachers so much bigger. Table 1.1 and Figure

1.1 shows that in terms of learner numbers enrolled in the subject for the past two years, Mathematical Literacy is becoming a force to be reckoned with. Therefore, studies like this one becomes critically important in order for researchers, curriculum developers and other relevant people within the wider mathematics education community, to take note of the subject and start to prioritise Mathematical Literacy teacher education within the bigger field of Mathematics teacher education.

#### **1.1.4 The re-training of in-service teachers in South Africa**

Mathematical Literacy training is a first for South Africa - a new professional training programme aimed at equipping both in-service and pre-service teachers with the knowledge, skills and the practical competency to facilitate Mathematical Literacy for learners who have not chosen Mathematics as subject in the FET band of the school curriculum.

The North-West Department of Education approached the North-West University (NWU) with the request to provide training and re-training for selected teachers who would be enrolled in an in-service training programme for a maximum of two years. The NWU agreed to provide the re-training and developed a part-time professional teacher education programme that had to be delivered via distance education, *viz.* the Advanced Certificate in Education (ACE) in Mathematical Literacy. The teachers who were enrolled for the ACE in Mathematical Literacy mostly taught various other subjects previously, like History and Geography. Some of the teachers who enrolled for Mathematical Literacy training did not even have grade 12 Mathematics. The following criteria were used for the selection of teachers to be trained:

Teaching at a secondary school;

No post-matric mathematics teacher training.

The reasoning behind the first criterion was that Mathematical Literacy was only implemented in grade 10, 11 and 12, which forms part of secondary school. The Department of Education (DoE) did not want to include primary school teachers because this would mean a relocation of teachers from primary schools to secondary schools. The reason for the second criterion is that it did not make sense to increase the shortage of qualified Mathematics teachers in schools as the demand for qualified Mathematics teachers still far outweighs the supply of qualified Mathematics teachers.

#### **1.1.5 Mathematical Literacy in Canada**

Canada was selected to form part of the study because it was ranked third when the mathematical literacy of its learners was assessed in the Programme for International Student Assessment (PISA) by the Organisation for Economic Cooperation and

Development (OECD). In this international assessment the 15-year-olds of some 42 countries (including South Africa and Canada) were assessed in order to find out how well these learners could use the mathematics they have learned during their schooling and how well they could apply it in every day real-life situations (OECD, 2003:2).

Another reason for selecting Canada was because I was granted an opportunity to do research in Canada as an exchange student as part of the mutual agreement between the Faculty of Educational Sciences of the NWU in South Africa and the Education Faculty of Brock University in Canada.

The final reason for studying the Canadian teacher education programme was that Mathematics for Work and Everyday Life and Applied Mathematics are two courses which forms part of the Canadian Mathematics teacher education programme and can be seen as the counterpart of Mathematical Literacy in South Africa. These courses also came about in order to make mathematics more accessible to all learners and are offered in grade 9, 10, 11 and 12 to learners who do not need Mathematics for further study.

#### **1.1.6 Acknowledgement of the differences in the teacher education programmes in South Africa and Canada**

It is acknowledged that the programmes in South Africa and Canada differ by way of delivery and duration: The Advanced Certificate in Education (Mathematical Literacy) programme at the NWU in South Africa is a **two-year off-campus** programme which is delivered through distance education for **in-service** teachers, while the mathematics teacher education programme in Canada is an **on-campus** teacher education programme for **pre-service** teachers which consists of **five years** of mathematics education. What is important, however, is that both programmes at the different universities provide teachers with training to teach the same kind of subject. A more detailed description of the two mentioned programmes will be given in Chapter 2.

## **1.2 RATIONALE**

### **1.2.1 The development of sustainable high quality Mathematical Literacy teacher education programmes**

The statistics mentioned earlier (see 1.1.3), that shows the increasing number of learners taking Mathematical Literacy, are indicative of the need for not only more, but also competent Mathematical Literacy teachers. Taking into account the already dire shortage of Mathematics teachers in the field, “non-Mathematics” teachers that were initially trained in other subjects like Geography, History etc. had to be re-trained when Mathematical Literacy

was implemented as subject in 2006. Mathematical Literacy teacher education also encompasses the teaching and learning of Mathematics which in itself is not an easy task if it should be structured befitting teachers of whom many were labelled as failures in their school grades and of whom most have internalised negative self-images about their knowledge and ability in Mathematics. This contributes to the complexity of Mathematical Literacy teacher education in South Africa and as such, makes the development of quality Mathematical Literacy teacher education programmes critically important. Teacher education programmes should prepare prospective Mathematical Literacy teachers to teach this well-intended subject in such a way that it will not be labelled as a “second-degree mathematics” subject. It is therefore crucial to be aware of the practices of teachers who are enrolled in existing Mathematical Literacy teacher education in order to strengthen “what works” and highlight “what does not work”. This makes finding answers to the following two questions very important:

1. How do teachers in the aforementioned programmes experience the programmes?
2. What are the practices of teachers in these programmes that might inform their teaching in Mathematical Literacy classrooms?

In the light of the above it seemed necessary and appropriate that a study like this should be undertaken. It is envisaged that through this study valuable reflection would be gained, not only on our own programme here at the North-West University in South Africa, but also valuable insight from the training of teachers for mathematical literacy in Canada. More importantly: an investigation of this nature would highlight “what works” and “what does not work” which are pivotal for the development of sustainable high standard teacher education programmes in any country.

### **1.2.2 Internationalisation and globalisation**

Secondly, a study like this which involves both Canada as developed country and South Africa as developing country, can contribute to the broad internationalisation and globalisation of mathematical literacy and more particularly to mathematical literacy teacher education in the world. Literature (Reid & Petocz, 2007:251) suggests that internationalisation has a significant role to play in the relationships between learning and teaching, universities and professional bodies, traditional approaches and the integration of new research-based knowledge. On a more personal note, this study already contributed to my own internationalisation when I had the opportunity to visit Canada and be part of the mathematics teacher education programme at Brock University when I was allowed to attend one of the courses in the teacher education programme for a period of four months (September – December.2008).

For Reid and Petocz (2007:149) internationalisation is seen as the umbrella term for the **enticement** of students from around the globe to study in another country. I also hope, as researcher and passionate Mathematical Literacy teacher educator, that this study will indeed entice prospective Mathematical Literacy teachers from South Africa to study in Canada and prospective teachers from Canada to study in South Africa in order to prepare them to teach Mathematical Literacy here in South Africa or to teach Mathematics for Work and Everyday Life in Canada. According to Skovsmose (2007:5) globalisation

refers to distinctive processes which are facilitated by information and communication technologies;

appears to be directly linked to free-growing capitalism;

refers to an opening up of new markets;

processes do not follow any simple predictable route;

includes distribution and redistribution of '*goods*' and '*bads*', meaning that the production of goods on a global scale is good, but this production of goods might sometimes be accompanied by "bads" in the form of pollution and damage to the environment or to the people involved in the production;

could turn into *ghettoising*; meaning that it operates as a dumping ground for people who have no role to play in globalised capitalism; and

could be *armed*, meaning that it tries to control minorities that are located at strategic positions, for example close to oil pipelines.

It is envisaged that through this study information regarding the "goods" of mathematical literacy teacher education will be distributed when the participants in this study each receive a copy of this research report and by means of reading the report become aware of how things can be done differently. The seven points above make it clear that one should attempt to think globally when concerning oneself with justice and equality on a global scale. The rationale of this study therefore also hints towards making participants and readers of this research report aware of the various opportunities that exist and not to be narrow-minded and only aware of what is happening locally. More so, if one considers that to know and apply mathematics in our everyday life is a worldwide phenomenon and the intellectual currency of the technology-driven world in which we live: "Mathematical knowledge is the intellectual currency of the technological age" (Dossey *et al.*, 2002:25). In this regard Julie (2006:68) asserts that:

*Globalisation, the availability of technology allowing for the access to knowledge in an unprecedented way and the world-wide thrust for regular testing of the state of Mathematical Literacy in a country through international comparative studies such as TIMSS contribute favourably to the maintenance of Mathematical Literacy.*

### **1.3 CONTEXTUALISING THE STUDY**

There is general agreement that mathematics is no longer just a prerequisite for those who choose to pursue mathematics related careers, but a fundamental right of every person Steen (2001:6). South Africa, just like every other country in the world, needs a well educated population to actively contribute towards the shaping of society and a broadly qualified work force, all of whom are able to activate mathematical knowledge, insights, and skills in a variety of situations and contexts. This ability to use mathematical knowledge and skills to cope with the demands of everyday life is referred to worldwide by various terms such as mathematical literacy, numeracy, quantitative literacy, quantitative reasoning or mathemacy. For Steen (2001:6) these different terms convey different nuances and connotations that might be interpreted differently by readers. Whatever this ability might be called, learners need teachers to help them to develop this ability and as such it is of pivotal importance that prospective Mathematical Literacy teachers are effectively prepared. This study is an attempt to understand which pedagogical practices relating to mathematical literacy teacher education still need to be improved, embraced, or redefined.

#### **1.3.1 The historical context of Mathematical Literacy**

Mathematical Literacy might be the new subject that was recently implemented in the FET band of South African schools, but mathematical literacy as the ability to use mathematics in everyday life, already existed in ancient times: *Mathematics in Babylonia grew out of necessities of record keeping for administrative and trade purposes* (Kline, 1961:15). In the case of Babylonia “mathematics for administrative and trade purposes” can be seen as practises of mathematical literacy in those ancient times because they developed mathematics (and utilised it) in order for them to cope with their everyday needs. Historical cultural groups, such as the Egyptians, Babylonians, Chinese and Romans to name but a few, had their own way of writing and expressing their numerical system. Steen (2001:79) gives another angle to this argument when he asserts that the role of quantitative literacy in ancient times were more metaphorically inclined than for measurement purposes, while this necessity to be able to use numbers in everyday life emerged very slowly in the Middle Ages. It was only in the late twentieth century that quantitative literacy became more prominent as a basic and important ability for all citizens. Steen (2001:79) maintains that this expectation

for ordinary citizens to be quantitatively literate is primarily a phenomenon of the late twentieth century.

How then do mathematical literacy training programmes at the North-West University in South Africa and at Brock University in Canada accommodate this priority in existing training programmes?

### **1.3.2 Mathematical literacy as a worldwide phenomenon**

The world of the twenty-first century demands quantitative thinking in order to function effectively in a world awash with numbers. This importance was highlighted in the *Standards for School Mathematics* which was published in 1989 by The National Council of Teachers of Mathematics (NCTM). Not only is mathematical literacy a worldwide phenomenon, it is also a focussed priority in mathematics education since nearly three decades ago with the publication of the well known Cockcroft report in 1982. According to Steen (2001:85) the Cockcroft Report is widely regarded as the first major document to urge that numeracy or quantitative literacy - whatever this particular ability might be called - should be a priority in mathematics education. According to Skovsmose (1994:117) mathemacy, in the Scandinavian context, *implies that the guiding principles for mathematics education are not any longer to be found in mathematics but in the social context of mathematics.*

Bearing in mind the continuous worldwide emphasis on mathematical literacy as a necessary ability, it came as no surprise when Mathematical Literacy was implemented as a subject in South African schools in January 2006.

### **1.3.3 Mathematical Literacy in the South African context**

The inclusion of Mathematical Literacy as a subject in the FET band in South African schools was not only due to the worldwide emphasis on mathematical literacy alone. The subject also came about because of the following two reasons: Firstly, there were the injustices of the previous education system:

*South Africa has come from a past in which poor quality or lack of education resulted in very low levels of literacy and numeracy in our adult population (DoE, 2003:9).*

Mathematics education in South Africa before 1994 was part of an education system that divided people by discriminating against and differentiating between groups of people based on race. With 19 different education departments, the education system prepared children differently for the positions they were expected to occupy in the social, economic and political life, with only a privileged few who were offered exposure to Mathematics from kindergarten right until grade 12 (Steen, 2001:79).

The second reason is the poor performance by South African learners in international assessments like the Trends in International Mathematics and Science Study (TIMSS, 2003) and the PISA framework (2003). South African learners ranked 46<sup>th</sup>, the last place, in the TIMSS 2003, with an average of only 264 in Mathematics for Grade 8 learners against the international average of 466 (TIMSS, 2003:2). These findings are echoed in statements like the following:

*International studies have shown that South African learners fare very poorly in mathematical literacy tests when compared to counterparts in other developed and developing countries (DoE, 2003:9).*

Since 1994, the South African education system tried to bring people together and to provide quality education for all with a curriculum designed to prepare all learners for the 21<sup>st</sup> century, in a democratic, just and caring society, based on the values of our Constitution. Curriculum 2005 is seen as the first big step in a long process of restructuring the education system in South Africa. This new curriculum for the very first time provided some sort of mathematics education to all learners from grade 1 to grade 12, whether it is Mathematics or Mathematical Literacy.

## 1.4 THE RESEARCH PARADIGM

### 1.4.1 Continuums, paradigms and world views

“How can we know?” called epistemology, and “what is truth or reality?” called ontology, are questions which cause endless academic and philosophical debate (Nieuwenhuis, 2007a:52).

How researchers answer these questions place them on a continuum or line with the scientific view (positivist/rationalist/objectivism) at one end and the emerging view (qualitative) at the other end as illustrated in Table 1.2.

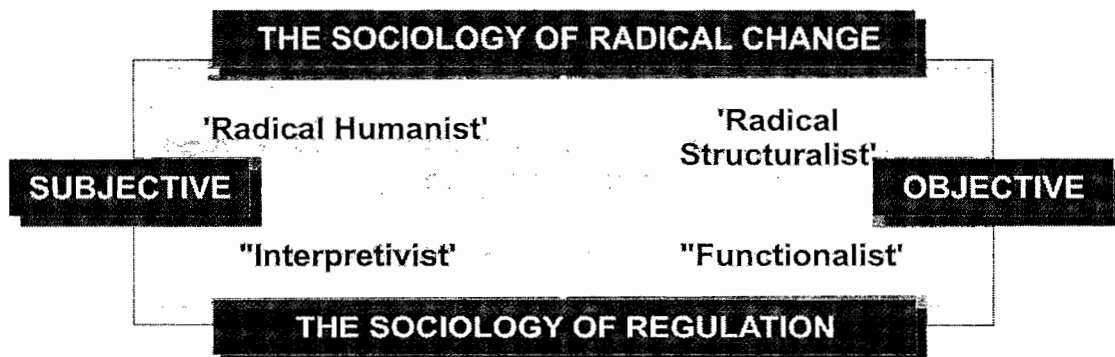
**TABLE 1.2 CONTINUUM EXPLAINING THE EMERGENT WORLD VIEW**

	<b>SCIENTIFIC METHOD</b>	<b>EMERGING VIEW</b>
	<b>KEY TERMS</b>	<b>KEY TERMS</b>
<i>What is knowledge?</i>	<i>Rationally produced Discovered by experimentation Absolute truths/immutable laws</i>	<i>Relationally produced Largely perceptual Provisional answers/tentative</i>
<i>What are phenomena?</i>	<i>Observable Can be empirically studied</i>	<i>Ideational Empirical study as a process</i>

	<i>Simplistic/reducible to essential aspects</i>	<i>Complex relations/holistic</i>
<i>Relationship between phenomena</i>	<i>Fixed order/hierarchical Linear relations Predictable behaviour</i>	<i>Fluid/systemic/messy Integrative orders/complex relations Open system/behaviour not predicable</i>
<i>How is causation viewed?</i>	<i>Linear cause-effect Unidirectional interaction Explained by deductive reasoning</i>	<i>Multi-causality Complexity of interaction Deductive/inductive/lateral reasoning</i>
<i>What is use of research?</i>	<i>Measuring/classification/categorisation of phenomena Describing/verifying of theory Prediction and control</i>	<i>Interpreting/understanding Describing/generating theory Approximation of truth in terms of what is</i>

Source: Nieuwenhuis, 2007a:57

According to Nieuwenhuis (2007a:55) the positivists believe that knowledge can be revealed or discovered through the use of a scientific method while qualitative researchers believe that the way of knowing reality is by exploring the experiences of people regarding a specific phenomenon. Nieuwenhuis (2007a:57) further asserts that the positivist view argue that this “scientific method produces precise, verifiable, systematic and theoretical answers to the research question”, while the emerging world-view argue that precise, verifiable, systematic and theoretical answers are not possible and that every cultural and historical situation is unique and “requires analysis of the uniquely defined, particular contexts in which it is embedded”.



Source: Burrell & Morgan, 1979:22

**FIGURE 1.2** FOUR PARADIGMS FOR THE ANALYSIS OF SOCIAL THEORY

The interpretivist paradigm, which is one of four paradigms (see Figure 1.2), is the direct product of the German idealist tradition of social thought and is founded on the theoretical

belief that reality is constructed socially and is subject to change (Burrell & Morgan, 1979:31). Guba and Lincoln (1994:106) suggest four underlying paradigms for research, namely positivism, post-positivism, critical theory and constructivism, that are competing for acceptance to serve as paradigms that guide inquiries. In addition to this categorisation, Orlikowski and Baroudi (1991:1) suggest the following three categories that are based on the underlying epistemology: positivist, interpretive and critical. How can one make sense of all of this? One way is to acknowledge, like Nieuwenhuis (2007a:57), that in practise these distinctions are not always clear-cut because most of them have evolved into hybrid forms that overlap and/or complement each other.

#### **1.4.2 My position**

For the purposes of this study I positioned myself within the interpretive paradigm. According to Burrell and Morgan (1979:iv) it is important for a theorist to understand the assumptions on which his/her own perspective is based in order to understand alternative points of view.

I have turned to the interpretive paradigm and not to the radical humanist paradigm because, although the radical humanist is also very subjective, I found the radical humanist paradigm to be too ideographic to employ in my study. According to Burrell and Morgan (1979:31) the consciousness of man is dominated by the ideological superstructures within which he interacts. Interpretivists seek explanation within the “realm of consciousness and subjectivity” (Burrell & Morgan, 1979:32). The radical structuralism as paradigm was too objectivistic which would not be appropriate for the focus on the perceptions and experiences of the participants. The functionalist paradigm was also not suitable because the viewpoint of this paradigm tends to be *realist, positivist, determinist and nomothetic* (macro-economic and quantitative) according to Burrell and Morgan (1979:26). In this study I assume that reality, as we know it, is constructed inter-subjectively through the meanings and understandings developed socially and experientially. We can therefore assume that what we know is always negotiated within our cultures, within our social settings and within our relationship with other people and as such we cannot separate ourselves from what we know. My study subsequently focused on the meanings and understandings that the participants developed in their interaction with each other, with the instructor (Canada) and with the facilitator (South Africa) within specific cultures and social settings.

### **1.5 THEORETICAL FRAMEWORK**

Theories that framed this study focussed mainly on mathematics teacher education. However, a scholarly learning community meeting in early November 2008 at Brock University in which the book “Engaging Minds” by Davis Brent, Summara Dennis and Luce-Kapler Rebecca (2008) was discussed piqued my interest in the complexity theory which was

very prominent throughout the book. In our discussions during this meeting the issues about learning, thinking and intelligence were related to our own experiences in our teacher training programmes at the various universities. I decided to use the complexity theory<sup>2</sup> to interpret the engagement in learning and teaching of the pre- and in-service teachers in the mathematical literacy teacher training programmes that I focused on in this study.

## **1.6 PROBLEM STATEMENT**

The 21<sup>st</sup> century, with all its changes and technological demands, necessitated some form of mathematical teaching to all learners. The purpose of the subject Mathematical Literacy is to equip learners with the ability to use mathematics in their daily lives and make mathematics applicable because it is learned in the context of real-life meaningful experiences. The nature of this subject encompasses not only knowledge of mathematics but also how to apply this knowledge in the multicultural technological environment found in South Africa as well as a 21<sup>st</sup> century world which raises questions like:

What is the level of existing mathematical knowledge required from teachers who wish to enrol for the training programme?

“Contexts are central to the development of Mathematical Literacy in learners” (DoE, 2003:42). Should context drive content or should content drive context in the teaching and learning of mathematical literacy subjects and courses?

Mathematical Literacy was only recently (2006) implemented in the FET band of the South African school curriculum. Learners in grade 12 wrote the first national examination in Mathematical Literacy at the end of 2008. The training of teachers for this new subject was piloted at various universities while the programmes for Mathematical Literacy training were implemented at the North-West University in 2006. This programme is therefore quite “young” which necessitates some investigation as to whether the programme is on the right track by looking at established counterpart programmes at universities in developed countries. The question that now arises is: How should a Mathematical Literacy training programme be structured in order to effectively train teachers to teach this new subject?

The aim was to explore the practises of teachers in existing Mathematical Literacy training programmes, on the one hand in a developing country like South Africa, and on the other hand in a developed country like Canada. It is envisaged that the training of teachers in South Africa to enable them to teach Mathematical Literacy effectively in a developing country might be improved by looking at the training of teachers to teach Applied

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2. The complexity theory will be employed in the follow-up doctoral study in more detail.

Mathematics or Mathematics for Work and Everyday Life in a developed country like Canada.

## **1.7 PURPOSE OF THE STUDY**

Although Mathematical Literacy is a new subject in the South African school curriculum for the Further Education and Training band, a variety of research has already been done in this field: These studies (Brown & Schäfer, 2006:46; Vithal, 2006:38; Frith & Prince 2006:55) envisage modelling, research tasks and project work as possible approaches to teacher education. However, little research has been conducted to ascertain how a training programme for teachers, who are enrolled in these programmes, should be rolled out. What should be the extent and level of mathematics in the programme? The purpose of this study was, therefore, to explore the practices of teachers in the mentioned two training programmes and identify components in Mathematical Literacy teacher training programmes that have positively informed the teaching practices of teachers in the two participating countries.

In essence, this is an explorative study into the phenomena of Mathematical Literacy teacher training, with the purpose to generate questions that can be investigated in more detail in possible future studies. These questions will be generated through careful analysis of the descriptions of the intentions, beliefs, values, reasons and self-understanding of the teachers in the two aforementioned programmes. This study was exploratory in that it aimed to discover best practices in both the programmes. The aim was also to use the outcomes of the study to improve the existing training programme that is currently offered at the North-West University in South Africa. Therefore, the analysis is expected to provide the basis for the planning of improvements, bearing in mind that adjustments may be necessary to fit best practices to the unique situation in South Africa.

This study investigated, through qualitative research methodology, possible ways on how best to structure a training programme to meet the needs of South African teachers regarding Mathematical Literacy.

## **1.8 CONTRIBUTION OF THE STUDY**

### **1.8.1 Contribution to the subject area or discipline**

The central question involved an investigation into the nature and scope of Mathematical Literacy teacher training (for grade 10 to 12 learners) in South Africa and teacher training for Applied Mathematics and Mathematics for Work and Everyday Life in Canada. The purpose of these subjects being the preparation of current learners for future adulthood. Addressing

this question is critical since the findings can serve as a basis to guide instruction in the sustainable teacher training efforts for the effective teaching of the subject Mathematical Literacy in a developing country like South Africa.

### **1.8.2 Contributions to the research focus area**

This study intends to:

challenge the boundaries of theory, research, practice and assumptions regarding Mathematical Literacy and the training of the teachers to enable them to teach the subject;

contribute to international as well as local efforts in the continuing search for the most effective ways of learning and teaching mathematical literacy; and

play a role in ensuring that role-players stay on par with the never ending changes that education in general is subjected to, due to a technologically-driven 21<sup>st</sup> century.

## **1.9 RESEARCH QUESTIONS**

### **1.9.1 The primary research question**

Can we as developers of teacher training programmes for Mathematical Literacy teachers in South Africa learn from the teacher training programmes for similar subjects in Canada in order to improve our own programmes?

### **1.9.2 The secondary research questions**

1. How do teachers in an in-service Mathematical Literacy training programme view the Mathematical Literacy training and how did they experience the programme?
2. How do teachers in a pre-service mathematical literacy training programme view the training for Applied Mathematics (grade10) and Mathematics for Work and Everyday Life (grade 11-12) and how did they experience the programme?
3. What are the similarities and differences between the mentioned training programmes offered at the two universities?

The previously mentioned questions will be answered in an attempt to find out how the existing Mathematical Literacy teacher training programme in South Africa can be improved.

## **1.10 RESEARCH DESIGN AND METHODOLOGY**

I made use of a qualitative multiple case study research approach because of the **dual contexts** of this study: The South African context and the Canadian context. The multiple case study was selected as research design because this study aimed to provide greater insight into, and understanding of the dynamics of the situation surrounding mathematical literacy training at two specific universities in the two different countries. Qualitative researcher, Merriam (1998:19), views the case study as a design that is employed to gain an in-depth understanding of the situation as well as a better understanding of the meanings that those involved assign to the situation. The same understanding of a case study is echoed by Henning *et al.* (2004:41) who view the case study as a study which is characterised by the focus on a phenomenon that has identifiable boundaries and in which a description of how, where, when and why things happen are of central importance and form an essential part of the study. In this case it would be the how, where, when and why things happen for the participating teachers in the mathematical literacy training programmes at the two participating universities that will form the focus of the study.

## **1.11 LIMITATIONS OF THE STUDY**

### **1.11.1 Difference in mode of delivery**

The first limitation of this study is the difference in the mode of delivery of the training programmes at the two universities. In Canada teacher candidates are enrolled full-time in the teacher training programme and classes are offered on campus, while in South Africa, teachers are enrolled part-time in the teacher training programme and classes are offered through distance education.

### **1.11.2 Developed country Canada versus developing country South Africa**

Another factor that limited the study is the circumstances in a developed country versus the circumstances in a developing country which influenced the resources available to teachers in the aforementioned training programmes.

### **1.11.3 Poor mathematical knowledge background**

A further limitation is the poor mathematical knowledge background of the South African participants as not all of the teachers who enrolled for the teacher training programme passed grade 12 Mathematics, compared to the strong mathematical knowledge background of the Canadian participants.

#### **1.11.4 Time spent in Canada**

The time factor was another limitation as I had less than four months (17 September – 28 December 2008) to do research in Canada. Firstly, my application for ethical review of the research had to be approved by the Research Ethics Board (REB) at Brock University. I received their approval only by the middle of November 2008, which left me with only one and a half months for data collection in Canada.

### **1.12 OUTLINE OF THE REMAINING CHAPTERS IN THIS STUDY**

Chapter 2 offers detailed descriptions of the two mentioned training programmes in both countries and the nature of the mentioned subjects and courses from both the countries.

Chapter 3 consists of an in-depth review of theoretical and empirical literature in which I aim to synergise the literature on mathematical literacy and the training of teachers for the subject Mathematical Literacy and Mathematics for Work and Everyday Life in both the countries.

Chapter 4 provides a detailed description of the methodology and procedures that were employed in this study, as well as the reasons why this particular methodology was selected.

Chapter 5 contains the systematic reporting and analysis of the empirical data.

Chapter 6 concludes the study with a summary of the data as well as recommendations for further research.

### **1.13 SUMMARY AND CONCLUSION**

This chapter introduced the study as an investigation into the practises of both in-service and pre-service teachers in existing teacher training programmes in South Africa (at the North-West University) as well as in Canada (at Brock University). Before we take a look at what has already been said about mathematical literacy, both as ability and as subject, a closer look into the nature of mathematical literacy and the courses as well as the training programmes involved in this study, is necessary to enhance the understanding of the problem statement. This is done in the following chapter.

CHAPTER 2:  
**THE NATURE OF  
MATHEMATICAL LITERACY  
TEACHER TRAINING  
PROGRAMMES**

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**The Advanced Certificate in Education (Mathematical Literacy) Teacher Training Programme at North-West University in South Africa and the Intermediate/Senior Mathematics Teacher Education Programme at Brock University in Canada**

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## 2.1 INTRODUCTION

In Chapter 1, I introduced this study and contextualised mathematical literacy as an ability and Mathematical Literacy as subject within the framework of mathematics teacher education, in which mathematical literacy teacher education is embedded, historically, internationally and nationally. I also provided the theoretical perspective from which the study was approached.

In this chapter, I will be zooming in on the Advanced Certificate in Education (Mathematical Literacy) Teacher Education Programme as it is offered at the North-West University in South Africa as well as the Mathematics Teacher Education Programme as it is offered at Brock University in Canada in order to illuminate the training of mathematical literacy teachers in a **developing** country like South Africa and in a **developed** country like Canada. It should be noted that although I am addressing some differences between the two programmes in this chapter; and similarities where they exist; it is not the aim of this inquiry to make a comparative study of the two teacher education programmes in their respective countries. The summary of similarities and differences at the end of this chapter is only provided to address the third secondary research question. This chapter is divided into three phases. The first phase attempts to give a context for the subject and courses in terms of teacher education in the two countries and focuses on the following issues:

Teacher Education in South Africa, including Distance Education;

Teacher Education in Canada;

The Advanced Certificate in Education (Mathematical Literacy) Teacher Training programme at North-West University (NWU) in South Africa;

The Intermediate/Senior Phase Teacher Education programme at Brock University in Canada.

The second phase of this chapter deals with the subject and courses that the pre-service and in-service teachers are being prepared for in the aforementioned programmes in the two countries. The aim with this is to give an overview of what the intention was with the implementation of this subject and courses in an attempt to enhance the understanding of the reader in terms of the particular nature of the subject and courses. The following matters are focused on in phase two:

The nature of Mathematical Literacy as subject in the South African school curriculum;

The nature of Mathematics for Work and Everyday Life and Applied Mathematics as courses in the secondary school curriculum in Canada;

This chapter then concludes with phase three which draws on the first two phases and comprises of the differences and similarities between the two teacher education programmes in the different countries as well as the subject or courses for which the participants in the study are being prepared to teach.

## **2.2 TEACHER EDUCATION IN SOUTH AFRICA**

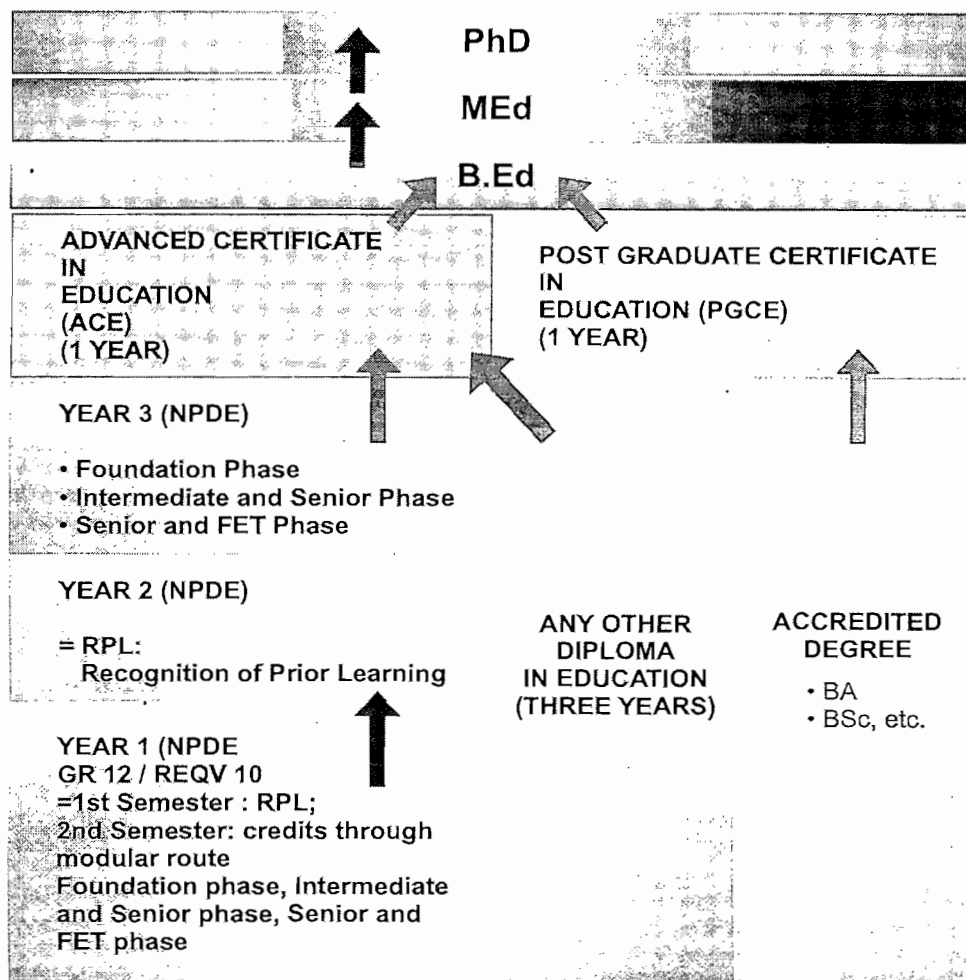
### **2.2.1 Background**

Since 1994, currently serving teachers have had to cope with both the rationalisation of the teaching community into a single national system and the introduction of new curricula (DoE, 2006:6). During this time the provision of teacher education was very fragmented. This fragmented and unstructured state of teacher education provision was highlighted by the first-ever National Teacher Education Audit (DoE, 2006b:6) which was commissioned by the Ministry of Education in 1995. The Audit also reported high numbers of unqualified and under-qualified teachers as well as a mismatch between teacher supply and teacher demand (DoE, 2006b:6).

Teachers who are teaching at any South African school are required to have at least a three year teaching qualification (diploma), although in some schools this does not happen due to the constant shortage of qualified teachers in South Africa. Teacher education in South Africa consists of both pre-service and in-service programmes which are offered at higher education institutions.

### **2.2.2 Initial Teacher Education in South Africa**

Several higher education institutions in South Africa provide further training qualifications after the final school year of learners. In pre-service programmes candidates complete a four year teaching degree at an education faculty or any other relevant degree in other faculties at a university, or a three year diploma at a college. A student who obtained a non-teaching degree and who wants to become a teacher has to complete an additional Post Graduate Certificate in Education (PGCE), (see figure 2.1). Advanced diplomas and other post-graduate programmes are also available to people who want to upgrade their initial qualifications.



Source: NWU, 2008:34

**FIGURE 2.1: THE STRUCTURE OF THE NATIONAL QUALIFICATION FRAMEWORK**

### 2.2.3 Continuing Professional Development

The continuing professional development of teachers is the joint responsibility of the teacher and the Department of Education (DoE). DoE sometimes selects teachers to enrol in training programmes which DoE then pays for in the form of bursaries. The Advanced Certificate in Education (Mathematical Literacy) is a good example of such a bursary initiative. In the absence of such initiatives, teachers pay for their own continued learning. These programmes are mostly done on a part-time basis by in-service teachers. At the North-West University programmes for the continuing professional development of teachers are run by the Educational Sciences faculty and specifically in the School for Continuing Teacher Education (SCTE). The Advanced Certificate in Education (Mathematical Literacy) falls under the ACE Professional Educator Development Programme and is one of many ACE programmes of the SCTE. A more detailed outline of the programme can be found later in this chapter.

## 2.2.4 Distance education, Distance learning and E-learning

*Programmes that combine conventional and distance methods are likely to do better than those that rely on a single approach.* (UNESCO, 2002:19). In our technology-driven society, there is a notion that distance education (and even face-to-face instruction) is no longer necessary and can be replaced by e-learning. Is distance education the same as e-learning? Tony Bates is director of a private company specialising in e-learning and distance education. He was also the director of Distance Education and Technology in the Continuing Studies Division of the University of British Columbia in Canada from 1995 until 2003. In an interview with Carolyn Awalt, Bates points out that there is a definite difference between distance education and e-learning (Awalt, 2007:105). In the interview Bates maintains that “distance education is one form of e-learning and e-learning is one form of distance learning” (Awalt, 2007:105). The Advanced Certificate in Education (Mathematical Literacy) in South Africa is not delivered through distance education *per se*; it is rather a variant of distance learning. In-service teachers at the NWU are registered with the university and attend a limited number of contact sessions at identified centres during specific months of each year. The rest of the time these teachers have to study on their own. Registered students in the Methods course in Canada at Brock University make use of face-to-face instruction during daily classes according to a timetable. The different modes of delivery will be focussed on in more detail next.

The South African Institute for Distance Education (SAIDE) comments on the importance of Distance Education in South Africa as follows:

*The advent of South Africa's first democratic government in 1994 signalled the beginning of significant policy changes in education, including a notable emphasis on distance education. Distance Education was identified as a key mechanism for facilitating access, participation and redress, especially in higher education (SAIDE, 2006: 3).*

This notion is supported by Mnyanyi and Mbwette (2009:2) in their study that assessed how staff and students of the Open University of Tanzania view the contribution of distance learning toward their professional development:

*In developing countries distance learning is vital as a means toward professional development as few are educated and trained in specific jobs and that there are limited chances for hiring new ones.*

The flexibility of distance learning is another factor that contributes to the popularity of distance learning as mode of learning for practising teachers and is vital for human-centred development. This flexibility has increased greatly with the advancement and use of information and communication technologies (Dodds, 2001:504). Perraton (2000:227)

addresses distance education referring to non-formal education, traditional secondary education, teacher education, and tertiary programs. The reason for distance education at North-West University is echoed by Perraton in the following statement:

*Developing nations often lack capacity — human, technological, structural, and logistical — to accommodate the overwhelming need and demand for education (Perraton, 2000: 228).*

According to SAIDE there were over 265 000 higher education students studying through distance education in South Africa in 2004. This figure is significant as it constituted approximately 36% of all higher education students in the country. Most of these students were studying part-time. Statistics from the SAIDE revealed that about 80% were over 23 years of age, more than half were women, and 76% were black (SAIDE, 2006:3).

It is clear that while distance education plays an important role in South African education, especially in providing access and redress to hundreds of thousands of South Africans, its potential is still to be fully realised. It is also important to note that in spite of the technology-driven society, there are still places around the world, especially in developing countries, where 'print' is still the main form of distance education. South Africa is a good example where 'print', referring to study guides, tutorial letters, information booklets and readers, are used to inform and support the many students that make use of distance education.

## **2.3 TEACHER EDUCATION IN CANADA**

### **2.3.1 Background**

Teachers who want to work in publicly funded schools in Ontario must be certified to teach in the province and must be members of the College of Teachers. The College is accountable to the public for how it carries out its responsibilities.

The Ontario College of Teachers:

- ensures Ontario learners are taught by skilled teachers who adhere to clear standards of practice and conduct;
- establishes standards of practice and conduct;
- issues teaching certificates and may suspend or revoke them;
- accredits teacher education programs and courses; and
- provides for ongoing professional learning opportunities for members (Brock University, 2009:6).

The majority of future teachers in Canada complete the Consecutive Teacher Education Programme (Brock University, 2009:6). In other words, they will first complete an undergraduate BA, BSc or other degree and then apply to the Faculty of Education to do a BEd degree. In some universities the Faculty of Education collaborate with other Faculties to offer a Concurrent Teacher Education Program in which future teachers complete a BSc, BA or any other degree concurrently with a BEd degree. This means students in a Concurrent Program are registered in two Faculties at the same time. Students are admitted into Concurrent Programs either immediately after high school or after completing one or two years of university, depending on the university.

### **2.3.2 Initial Teacher Education**

Universities in Ontario require students to complete 90 credits (15 full year courses) to obtain a first degree upon which the teacher is granted one of the following three teaching certificates:

The P/J (Primary/Junior ) - teaching qualification: This certificate enables the teacher to teach Junior Kindergarten up to Grade 6;

The J/I (Junior/Intermediate) - teaching qualification: This certificate enables teachers to teach Grades 4 up to 10; *or*

The I/S (Intermediate/Senior) - teaching qualification: This certificate enables teachers to teach Grades 7 up to 12.

### **2.3.3 Continuing Professional Development**

In developed countries, like Canada, Continuing Professional Development (CPD) is usually done on-line. At Brock University in Canada, in-service professional learning is located at the Centre for Continuing Professional Development and is the responsibility of the Ontario College of Teachers (Brock University, 2009:6). In-service professional learning, within the mandate of the College, is identified in Regulation 184/97, Teachers' Qualifications. This regulation includes courses/programs such as Additional Basic Qualification courses, Additional Qualification courses, the Principal's Qualification Program and the Supervisory Officer's Qualification program. Accredited courses support the Standards of Practice and the Ethical Standards for the Teaching Profession (Ontario College of Teachers, 2001:2).

The distance education programmes for in-service teachers at Brock University is different from our own approach here at the North-West University. 50% of the programmes are done on-line while 30% are contact time (Personal conversation with director: Continuing Teacher Education Department). Educators have to do a certain number of these courses in order to move up in level and earn a higher salary. The courses are developed according to the need

of the teachers. These courses are upgraded every three years. The university answers to the Ontario College of Teachers which is the self-regulatory body for the teaching profession in Ontario.

At the particular time of my visit, I could not find a mathematical literacy training course within the in-service professional learning courses that were offered at Brock University and for this reason this study did not focus on continuing professional development in Canada, but on the Teacher Education Programme which included training of candidate teachers to teach the courses Mathematics for Work and Everyday Life for grades 11 and 12 and the Applied courses for grade 9 and 10. An overview of the programme is given later in this chapter.

## **2.4 THE ADVANCED CERTIFICATE IN EDUCATION (MATHEMATICAL LITERACY) TEACHER TRAINING PROGRAMME AT THE NORTH-WEST UNIVERSITY IN SOUTH AFRICA**

This part of the chapter provides a detailed description of the Mathematical Literacy teacher training programme as it is offered at the North-West University in South Africa at the time of this study (2008-2010). Most ACE programmes have a minimum duration of one year (see figure 2.1). The maximum duration of ACE programmes is a period of three years. The Advanced Certificate in Education (Mathematical Literacy) programme is a two year specialisation programme that falls under the Professional Educator Development programme and is designed to provide training in the new subject Mathematical Literacy to practising qualified teachers that are currently teaching Mathematical Literacy or intend to teach Mathematical Literacy in the FET band of the school curriculum. The Advanced Certificate in Education is usually done in one year, but because the teachers are working and have to be at school, this programme is done by the teachers over two years. The North-West University is but one of several universities in South Africa that offers the Advanced Certificate in Education (Mathematical Literacy) programme. For the purpose of this study only the Advanced Certificate in Education (Mathematical Literacy) programme at the North-West University will be focussed on.

The North-West University and the North-West Department of Education have a contractual agreement by which the university provides the training while the Department of Education provides the funding. The programme can therefore be seen as a professional development initiative by the North-West Department of Education, in collaboration with the North-West University, to address the need for qualified and competent teachers to teach Mathematical Literacy. Each year, since 2005, the university was given the names of teachers who should be registered for the programme by the North-West Department of Education.

The ACE in Mathematical Literacy specialisation differs from the ACE in Mathematics specialisation in that it aims to equip in-service teachers with the necessary skills and knowledge for the effective teaching, learning and assessment of Mathematical Literacy in order to develop in their learners the ability and confidence to think numerically and spatially, to interpret and critically analyse everyday situations and solve problems. The ACE in Mathematics Education, on the other hand, trains teachers to prepare their learners for career-orientated studies in which mathematics is required. This qualification consists of four core modules (see table 2.1).

Registered teachers attend twelve contact sessions at five centres, viz. Potchefstroom Campus, Rustenburg Technical High School, Langenhoven High School in Pretoria, Mafikeng Campus and Vryburg High School. These compulsory contact sessions are offered every alternative Saturday or Friday and each session has a duration of four hours. During these four hours two of the modules are offered in each of the two years. In addition to this a holiday session of one week takes place during the June/July holiday and it is compulsory for teachers to attend. Assessment happens both formatively and summatively by way of assignments, tests, portfolios and an examination in each of the modules offered over the two years.

#### 2.4.1 Pre-requisites for the programme

The first and foremost requirement is that students have grade 12 Mathematics on their National Senior Certificates or an equivalent thereof. Where that is not the case, the Access Course must first be completed in order to comply with the expected level of mathematical competency required by the programme. A four year teacher's qualification (460 credits) is a further prerequisite for this ACE curriculum. If the teacher is not in possession of a four year teacher's qualification, four additional generic modules (see table 2.2) with a total of 32 credits must be taken. The following tables list the modules to be taken by registered teachers:

**TABLE 2.1 CURRICULUM STRUCTURE FOR TEACHERS WITH 480 CREDITS**

MODULES FOR YEAR 1		CR	MODULES FOR YEAR 2		CR
MLED 571	Mathematics: Elementary	32	MLED 573	Mathematics: Application	32
MLED 572	Didactics of Mathematical Literacy	32	MLED 574	Mathematical Literacy in Context.	32
<b>Total credits:</b>		<b>64</b>	<b>Total credits</b>		<b>64</b>

Source: NWU, 2008:34

**TABLE 2.2 CURRICULUM STRUCTURE FOR TEACHERS WITH 360 CREDITS**

<b>MODULES FOR YEAR 1</b>	<b>CR</b>	<b>MODULES FOR YEAR 2</b>	<b>CR</b>
ORAK 511: Educational Law, Systems and Management	8	MLED 573 Mathematics: Application	32
ORLK 511: Teaching and Learning	8	MLED 574 Mathematical Literacy in Context.	32
FSET 511: Education Theory	8		
EUCE 511: End-User Computing for Educators	8		
MLED 571: Mathematics: Elementary	32		
MLED 572: Didactics of Mathematical Literacy	32		
<b>Total credits:</b>	<b>96</b>	<b>Total credits</b>	<b>64</b>

Source: NWU, 2008:34

### 2.4.2 Exit Level Outcomes

Teachers who complete the programme are required to show that they are competent measured against the following learning outcomes:

- a) *possess scientific knowledge of and insight into the Mathematical Literacy in the school curriculum;*
- b) *demonstrate certain skills and competencies (amongst others critical problem solving, functioning in groups and integrating acquired knowledge effectively into the education situation) in Mathematical Literacy ;*
- c) *strive after certain values (amongst others excellence in education and integrity in the education situation) on the grounds of his/her studies in Mathematical Literacy (NWU, 2008:33)*

### 2.4.3 Outcomes of the four core modules in the programme

In MLED 571 and MLED 573 mathematics content knowledge is taught and in MLED 572 and MLED 574 the pedagogical knowledge embedded in Mathematical Literacy is facilitated. The outcomes for the four different core modules are as follows (NWU, 2008:33):

#### ***MLED 571 Mathematics: Elementary***

*After completion of this module the learner is expected to be able to apply thorough knowledge and insight with respect to elementary numbers, functions, geometry*

*(including trigonometry), statistics (including probability) and representing this in real-life contexts;*

### **MLED 572 Didactics of Mathematical Literacy**

*After completion of this module the learner should be able to apply thorough knowledge and insight with respect to the content and structure of the mathematical literacy curriculum in the planning and execution of teaching-learning opportunities in outcomes-based classrooms, as well as integrated assessment.*

### **MLED 573 Mathematics: Application**

*After completion of this module the learner is expected to apply thorough knowledge and newly acquired insight with respect to analytical and spherical geometry (including the relationship between the two) and the derivatives of simple and compound functions in solving real-life problems as well as the skills of applying this knowledge in real life problems.*

### **MLED 574 Mathematical Literacy in Context**

*After completion of this module the learner is expected to demonstrate thorough knowledge and acquired insight into mathematical literacy with respect to the historical development of mathematics, and the use of mathematics in the world of work, everyday life and in various cultures; including ethno mathematics.*

## **2.5 THE INTERMEDIATE/SENIOR (I/S) MATHEMATICS TEACHER EDUCATION PROGRAMME AT BROCK UNIVERSITY IN CANADA**

In Canada, and more specific at Brock University, mathematical literacy training forms part of the pre-service mathematics programme for teacher candidates on campus (Brock, 2009:9). However, this study focused on the training programme offered to teachers who wish to teach Mathematics for Work and Everyday Life in Canada. For this reason the Intermediate/Senior (I/S) Teacher Education Programme at Brock University in Canada was the main focus of attention. Two degree programmes can be distinguished here: the concurrent and the consecutive degree programmes. In the concurrent degree programme students are given the opportunity to complete an undergraduate degree simultaneously with the BEd degree leading to the Ontario Certificate of Qualification. Students are then registered with two faculties at the same time. In the consecutive degree programme students complete the undergraduate degree first and then continue with the BEd. degree which also leads to an Ontario Certificate of Qualification (Brock University, 2009:9). Both of these degree programmes are completed in four years. In Ontario the majority of future teachers complete a Consecutive Teacher Education Programme (Brock University, 2009:9).

Both concurrent and consecutive students can register for the Intermediate/Senior (I/S) Programme. Table 2.3 lists the courses that can be taken by concurrent and consecutive students.

**TABLE 2.3 THE INTERMEDIATE/SENIOR MATHEMATICS TEACHER EDUCATION PROGRAMME**

<p>Course Numbering</p> <p>Example: EDUC 8Y04</p> <p>8 = Teacher Education</p> <p>Y = .25 Credit Value</p> <p>04 = Department Code Number</p>	<p>Credit Values</p> <p>L = 2.0 Credits      F = 1.0 Credit</p> <p>P = .5 Credit      D = 1.5 Credit</p> <p>R = .5 Credit      Y = .25 Credit</p>	
<p><b>Required I/S Technological Education Courses</b></p> <p>**** Design and Technology I</p> <p>**** Design and Technology II</p> <p>8L09 - Field Studies, Individualized Instruction, and Practicum</p> <p>8D10 - Instructional Strategies</p> <p>8P04 – Student Assessment</p> <p>8P06 - Classroom Dynamics: Teaching and Learning</p> <p>8Y04 - Current Trends and Issues in Special Education</p> <p>8Y05 – Professionalism, Law &amp; the Ontario Teacher</p> <p>8R** - Two Teachable Subjects from EDUC 8R00-67 (Communications, Construction, Manufacturing, Transportation, Hospitality and Tourism, Personal Services - Cosmetology, Personal Services - Health Care/Medical Technology, Technological Design), for Technology Studies Candidates only.</p>	<p><b>Required Intermediate/Senior Courses</b></p> <p>8L09 - Field Studies, Individualized Instruction, and Practicum</p> <p>8D10/8F11 - Instructional Strategies</p> <p>8P04 – Student Assessment</p> <p>8P06 - Classroom Dynamics: Teaching and Learning</p> <p>8Y04 - Current Trends and Issues in Special Education</p> <p>8Y05 - Professionalism, Law &amp; the Ontario Teacher</p> <p><b>Major and Minor Subject Teachable Courses are from 8F76, 8P65-8P90.</b> Teaching subjects offered are:</p> <p>Business Studies: Accounting, Business Studies: General and Business Studies: Information &amp; Communication Technology, Computer Science, English (First Language), French (Second Language), Geography, History, International Languages (Italian, Spanish, German), <b>Mathematics</b>, Physical and Health Education, Religious Studies, Science-Biology, Science-Chemistry, Science-General, Science-Physics, Theatre Arts, and Visual Arts.</p>	
<p><b>Optional Courses—Number and Title</b></p> <p>8Y96 - Religious Education (Roman Catholic). Not a substitute for Part I of the OECTA/OSSTF Religion course. Candidates anticipating employment in Catholic schools are advised to take this course.</p> <p>8Y97 - Religious Education (non-Roman Catholic)</p>	<p><b>Open to All Education candidates</b></p>	<p><b>Tuition</b></p> <p>A credit course. Additional tuition levied.</p>

Source: Brock University, 2009:9

Consecutive candidates enrol in the following core Foundation courses: EDUC 8Y04, 8Y05, 8P04, 8P06, 8D10. Concurrent candidates take the following Foundation courses: EDUC 8Y04, 8Y05, 8F11. For General Studies, candidates are required to take two subject teachable courses, one in their major subject and one in their minor subject.

The methods course, which forms the 5<sup>th</sup> year of the teacher education programme in order to obtain the Ontario Certificate of Education, is called EDUC 8P81. The purpose of the course is to provide the necessary experience to secondary education mathematics teacher candidates during which they can learn about the mathematics-for-teaching, the mathematics school curriculum (which include planning and assessment of mathematical understanding), as well as about students as learners of mathematics. The course provides the necessary preparation to enable the teacher candidates to teach all the courses which are found in school. This includes Mathematics for Every Day Life and Work as well as Applied Mathematics, the courses on which this study focuses. This course is run over a period of eight months with weekly classes of two hours each. At Brock University these courses are also offered at the Hamilton campus, which is the sister-campus of the Brock campus. The objectives for the course are as follows:

*Students successfully completing the course will develop the knowledge, skills and attributes that enable them to:*

*develop lesson and unit plans;*

*develop a pedagogical understanding of mathematics;*

*develop an understanding of a variety of teaching methods;*

*develop an understanding of strategies and techniques that support planning;*

*develop knowledge of the processes of learning mathematics;*

*develop strategies to assess student work;*

*develop familiarity of relevant Ontario Ministry of Education documents; and*

*develop an understanding of student diversity (Brock University, 2009:10).*

## **2.6 THE NATURE OF MATHEMATICAL LITERACY AS SUBJECT IN THE SOUTH AFRICAN SCHOOL CURRICULUM**

### **2.6.1 Introduction**

According to the Report of the Ministerial Committee for Mathematics and Mathematical Literacy (DoE, 2005:1) the introduction of Mathematical Literacy as subject in South African schools was all about democracy. In 2004, the then Minister of Education, Mrs. Pandor, tasked a group of knowledgeable individuals to conduct an assessment of the following:

*Determine whether Mathematical Literacy, as it has been conceptualised and as the content has been defined, can meet the dual objectives:*

*Of ensuring that all matriculants are able to function competently in a numerate society and world; and*

*Of providing adequate conceptual induction into mathematics so that matriculants are able to successfully engage in disciplines that require mathematical application but do not require mastery of abstract mathematical concepts.*

*Do these objectives require that an intermediate level of Mathematics (between Mathematics and Mathematical Literacy) be introduced e.g. the three to be named MMLS levels 1, 2 and 3 or Mathematical Literacy, Mathematics and Advanced Mathematics?*

*What are the conditions for successful implementation to ensure improved educational outcomes? (DoE, 2005:iii)*

The issue about democracy is further explained by the committee as firstly to democratise Mathematics (mathematics for more people) and secondly it is about mathematics for democratisation (developing skills and knowledge to effectively and independently manage the knowledge and skills that they have developed, contribute in the workplace and be critical citizens) (DoE, 2005:1). Mathematical Literacy as subject in the FET phase, that is grade 10, 11 and 12, has to be taken by all those learners who do not intend to study disciplines which are mathematically based. It is also important to note that a learner who has chosen Mathematical Literacy in grade 10 cannot change to Mathematics in grade 11 and 12 and have to stick to Mathematical Literacy in all future school grades.

## **2.6.2 Definition and purpose**

Mathematical Literacy, the subject, is defined by the Curriculum Statement (2003:9) as follows:

*Mathematical Literacy provides learners with an awareness and understanding of the role that mathematics plays in the modern world. Mathematical Literacy 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 everyday situations and to solve problems.*

This definition received numerous critiques since implementation: According to the Ministerial Committee it does not convey what mathematical literacy is; in fact the very first sentence in the definition: "Mathematical Literacy provides learners with an awareness and understanding of the role that mathematics play in the world" (DoE, 2003:9) creates the expectation that learners of Mathematical Literacy will learn about the great achievements in Mathematics and their role in shaping our world (DoE, 2005:21). The definition should have included an indication of the purpose of the subject. It could have indicated that it would

enable a learner taking the subject to become a self-managing person, a contributing worker and a participating citizen (DoE, 2003:9).

### **2.6.3 Career pathways**

The question whether Mathematical Literacy would give a learner access to universities, causes sleepless nights for many a parent whose child has to choose between Mathematics and Mathematical Literacy at the end of grade 9. Apart from providing learners with confidence to handle mathematical situations in their life, Mathematical Literacy will also satisfy requirements for disciplines such as the Social and Life Sciences at universities. However, learners who intend to study disciplines which are mathematically based, such as the Natural Sciences are not advised to take Mathematical Literacy.

### **2.6.4 Learning Outcomes for Mathematical Literacy**

Mathematical Literacy as subject in the FET phase has the following four learning outcomes, viz.:

#### *Learning Outcome 1: Number and Operations In Context*

*The learner is able to use knowledge of numbers and their relationships to investigate a range of different contexts which include financial aspects of personal, business and national issues.*

#### *Learning Outcome 2: Functional Relationships*

*The learner is able to recognise, interpret, describe and represent various functional relationships to solve problems in real and simulated contexts.*

#### *Learning Outcome 3: Space, Shape and Measurement*

*The learner is able to measure using appropriate instruments, to estimate and calculate physical quantities, and to interpret, describe and represent properties of and relationships between 2-dimensional shapes and 3-dimensional objects in a variety of orientations and positions.*

#### *Learning Outcome 4: Data Handling*

*The learner is able to collect, summarise, display and analyse data and to apply knowledge of statistics and probability to communicate, justify, predict and critically interrogate findings and draw conclusions (DoE, 2003:38-41).*

These learning outcomes appear to be very similar to the learning outcomes for Mathematics. The Ministerial Report (DoE, 2005:24) explains why the two sets of outcomes are so similar:

*At a meeting of the ministerial committee with persons involved in the development of the Mathematical Literacy and Mathematics subject statements, one of these persons reported that the outcomes were developed as an extension of the GET Mathematics Learning Outcomes and linking to the Mathematics (FET) Learning Outcomes (DoE, 2005:24).*

## **2.6.5 The Assessment Standards for Mathematical Literacy**

There were initially more assessment standards but after the curriculum statements were reviewed, it was decided to exclude some of the assessment standards as the curriculum was said to be overloaded (AMESA, 2003:4). This new set of assessment standards are being referred to as the “core assessment standards” and are the only ones to be used for examination purposes in this first cycle of implementation (2006-2010). These assessment standards will be replaced after the first cycle of implementation. However, teachers who felt confident to do so were encouraged to teach all the assessment standards as listed in the Mathematical Literacy Curriculum Statement (2003) by the Department of Education (2005:7). This has some implications for the training of Mathematical Literacy teachers. Developers of teacher education programmes for prospective Mathematical Literacy teachers should take this arrangement into consideration.

According to the Mathematical Literacy Subject Assessment Guidelines (DoE, 2005:12) the assessment to be done in Mathematical Literacy should be based on the Assessment Taxonomy. This taxonomy implicate that several competencies e.g. problem-solving and reasoning should be focussed on, but it is not explicitly stated.

The assessment standards also include assessment of the mathematics embedded in each learning outcome that should be focussed on in each grade (DoE, 2003:38).

## **2.7 THE NATURE OF APPLIED MATHEMATICS AND MATHEMATICS FOR WORK AND EVERYDAY LIFE COURSES IN CANADA**

### **2.7.1 Introduction**

Mathematical literacy is viewed as important and pivotal for the workplace and everyday life in Canada, as is echoed in the following statement from the Ontario Report:

*As knowledge expands and the economy evolves, more people are working with technologies or working in settings where mathematics is a cornerstone. Problem solving, the processing of information, and communication are becoming routine job requirements. Outside the workplace, mathematics arises in everyday situation after situation (MoE, 2004:10)*

## **2.7.2 Definition and purpose**

In Canada, learners in grade 9 and 10 are taking the course “Applied Mathematics” which has as its aim the development of students’ knowledge and skills through practical applications and concrete examples. “Mathematics for Work and Everyday Life”, which enables students to broaden their understanding of mathematics as it is applied in the workplace and daily life, is offered to grade 11 and 12 learners who do not need Mathematics for further studies. All these courses can be seen as the counterpart of Mathematical Literacy in South Africa as it also aims to provide the basic ability to use Mathematics in everyday life.

The grade 9 and 10 mathematics program includes mathematics courses that are offered in two types, academic and applied, which are defined as follows:

***Academic courses** develop students’ knowledge and skills through the study of theory and abstract problems. These courses focus on the essential concepts of a subject and explore related concepts as well. They incorporate practical applications as appropriate.*

***Applied courses** focus on the essential concepts of a subject, and develop students’ knowledge and skills through practical applications and concrete examples. Familiar situations are used to illustrate ideas, and students are given more opportunities to experience hands-on applications of the concepts and theories they study (MoE, 2004:6).*

It must be noted here that for the purpose of this study the focus will be on the Applied courses in grade 9 and 10 which can be seen as preparation for the course Mathematics for Work and Everyday Life in grade 11 and 12.

In most North American teacher education programmes, mathematics courses are offered in Faculties of Science, Faculties of Arts, and in Faculties of Education (Davis & Simmt, 2006: 293). For each course, the Mathematics teacher education programmes identify expectations of the knowledge and skills that prospective teachers are expected to acquire, demonstrate, and apply in their class activities on which achievement is assessed and evaluated:

- The overall expectations describe in general terms the knowledge and skills that students are expected to demonstrate by the end of each course.
- The specific expectations describe the expected knowledge and skills in greater detail. The specific expectations are arranged under subheadings that reflect particular aspects of the required knowledge and skills and that may serve as a guide for teachers as they plan learning activities for their students. (MoE, 2005b:8)

The following table provides the mathematical subject matter that is learned in the grade 10 courses:

**TABLE 2.4 CONTENT OF THE TWO KINDS OF COURSES**

<b>PRINCIPLES OF MATHEMATICS (ACADEMIC)</b>	<b>FOUNDATIONS OF MATHEMATICS (APPLIED)</b>
<p><b>Quadratic Relations of the Form</b> <math>y = ax^2 + bx + c</math></p> <ul style="list-style-type: none"> <li>• Investigating the Basic Properties of Quadratic Relations</li> <li>• Relating the Graph of <math>y = x^2</math> and its transformations</li> <li>• Solving Quadratic Equations</li> <li>• Solving Problems Involving Quadratic Relations</li> </ul>	<p><b>Measurement and Trigonometry</b></p> <ul style="list-style-type: none"> <li>• Solving Problems Involving Similar Triangles</li> <li>• Solving Problems Involving the Trigonometry of Right Triangle</li> <li>• Solving Problems Involving Surface Area and Volume, Using Imperial and Metric Systems of Measurement</li> </ul>
<p><b>Analytic Geometry</b></p> <ul style="list-style-type: none"> <li>• Using Linear Systems to Solve Problems</li> <li>• Solving Problems Involving Properties of Line Segments</li> <li>• Using Analytic Geometry to Verify Geometric Properties</li> </ul>	<p><b>Modelling Linear Relations</b></p> <ul style="list-style-type: none"> <li>• Manipulating and Solving Algebraic Equations</li> <li>• Graphing and Writing Equations of Lines</li> <li>• Solving and Interpreting Systems of Linear Equations</li> </ul>
<p><b>Trigonometry</b></p> <ul style="list-style-type: none"> <li>• Investigating Similarity and Solving Problems involving Similar Triangles</li> <li>• Solving Problems Involving the Trigonometry of Right Triangles</li> <li>• Solving Problems Involving the Trigonometry of Acute Triangles</li> </ul>	<p><b>Quadratic Relations of the Form</b> <math>y = ax^2 + bx + c</math></p> <ul style="list-style-type: none"> <li>• Manipulating Quadratic Expressions</li> <li>• Identifying Characteristics of Quadratic Relations</li> <li>• Solving Problems by Interpreting Graphs of Quadratic Relations</li> </ul>

Source: MoE, 2005a:10

The strands in the two grade 10 courses have similarities, but there are significant differences between them in terms of level of abstraction and degree of complexity, for example: The strand *Quadratic relations of the form  $y = ax^2 + bx + c$*  forms part of both courses but greater degree of algebraic treatment is required in the academic course. Problem-solving in the applied strand relates to the interpretation of graphs that are supplied to students or generated by them using technology, while in the academic course, problem-solving involves algebraic manipulation, techniques in sketching and graphing quadratics effectively using pencil and paper as well as interpretation of supplied or technologically generated graphs.

Although the curriculum document specifies exactly what mathematics are to be learned in the grade 10 Applied Course, it is obvious that the focus in the course is on the application of the mathematics in real-life examples as can be deduced from the following aim:

*This course enables students to consolidate their understanding of linear relations and extend their problem-solving and algebraic skills through investigation, the effective use of technology, and hands-on activities. Students will develop and graph equations in analytic geometry; solve and apply linear systems, using real-life examples; and explore and interpret graphs of quadratic relations. (MoE, 2005a:53).*

## **2.8 COMPARISON OF THE TWO TEACHER EDUCATION PROGRAMMES INVOLVED IN THIS STUDY**

### **2.8.1 Differences and similarities between the subject in South Africa and the courses in Canada**

The main differences and similarities between Mathematical Literacy in South Africa and Applied Mathematics and Mathematics for Work and Everyday Life in Canada can be summarised as in Table 2.5:

**TABLE 2.5 A COMPARISON BETWEEN THE NCS IN SOUTH AFRICA AND THE ONTARIO MATHEMATICS CURRICULUM (CANADA)**

<b>CRITERIA</b>	<b>THE NATIONAL CURRICULUM STATEMENTS IN SOUTH AFRICA</b>	<b>THE ONTARIO MATHEMATICS CURRICULUM IN CANADA</b>
<b>Purpose of the subject or course</b>	Mathematical Literacy aims to develop participating, reflective citizens and contributing workers (DoE, 2003:9).	Applied Mathematics and Mathematics for Work and Everyday Life must engage all students in mathematics and equip them to thrive in a society where mathematics is increasingly relevant in the workplace and in everyday life (MoE, 2005a:53).
<b>Expectations and Learning Outcomes</b>	Mathematical Literacy in grade 10 to 12 has four learning outcomes with assessment standards for each learning outcome in each grade (2.6.4).	Applied Mathematics and Mathematics for Work and Everyday Life courses consist of general and specific expectations (2.7.2)
<b>Categorisation of courses</b>	Differentiates between Mathematics and Mathematical Literacy.	Differentiates between Academic Mathematics and Applied Mathematics.
<b>Target students</b>	All those learners that do not need Mathematics for further study.	All those learners that do not need Mathematics for further study.
<b>Processes</b>	No emphasis on the mathematical processes, although it is implied in the learning outcomes (2.6.4).	Mathematical processes in each course: Problem solving, Reasoning and proving, Reflecting, Selecting tools and Computational Strategies, Connecting, Representing, Communication (MoE, 2004:7)

### **2.8.2 Differences and similarities between the two particular teacher education programmes involved in this study**

The following table was developed to show some of the differences, but also similarities in the specific teacher training programmes in this study.

**TABLE 2.6 A COMPARISON BETWEEN THE ACE (MATHEMATICAL LITERACY) IN SOUTH AFRICA AND THE INTERMEDIATE/SENIOR TEACHER EDUCATION PROGRAMME IN CANADA**

NAME OF TEACHER TRAINING PROGRAMME	THE ACE (MATHEMATICAL LITERACY)	THE INTERMEDIATE/SENIOR TEACHER EDUCATION PROGRAMME
<b>Mode of Delivery</b>	Distance education	Structured on-campus classes
<b>Teachers enrolled</b>	In-service teachers	Pre-service teachers
<b>Pre-requirements for programme</b>	Must have 4 years of teacher training Must have grade 12 Mathematics	Grade 12 in the case of the Concurrent programme or A degree in the case of the Consecutive programme
<b>Duration</b>	A Minimum of two years with a maximum of three years.	One year
<b>Structure of programme</b>	A teacher training programme with a specialisation in Mathematical Literacy.	Forms the last year of the general teacher education programme making up a total of five years.
<b>Aim of the programme</b>	To prepare enrolled teacher students to teach only Mathematical Literacy in the Further Education and Training phase (grade 10 – 12) in South African schools. Focuses mainly on Mathematical Literacy as subject.	To prepare enrolled teacher students for all Mathematics courses in the Intermediate and Senior phase in Canadian schools. No explicit focus on the courses Mathematics for Everyday Life and Applied Mathematics course.

## 2.9 SUMMARY AND CONCLUSION

Now that a focussed view of the subject Mathematical Literacy and the courses Mathematics for Work and Everyday Life and Applied Mathematics, as well as a focussed view on the training of teachers for the subject/course has been given, we can move on to the opinions and views of other researchers about mathematical literacy and the training of the teachers to empower them to teach this subject.

CHAPTER 3:  
**LITERATURE REVIEW**

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### **3.1 INTRODUCTION**

Chapter 2 contained a detailed outline of the Mathematical Literacy teacher education programme at the North-West University in South Africa as well as the Mathematics teacher education programme at Brock University in Canada, in which the South African and the Canadian teachers were enrolled in at the time of the study (2008-2009).

In this chapter I will discuss Mathematics teacher education focussing specifically on the training of teachers to enable them to teach mathematical literacy subjects or courses. This chapter therefore gathers support from literature to explore a range of key areas in mathematical literacy teacher education. The key areas include aspects such as: the definition and importance of mathematical literacy in education, the training of mathematical literacy teachers as well as the theories and philosophies that influence trends in pedagogical practises relating to mathematical literacy teaching and learning in order to provide a framework in which the perceptions, views and unique experiences and practises of the participants might be understood. The discussion is also informed by my experiences as lecturer and coordinator of the existing Mathematical Literacy teacher education programme at the North-West University in South Africa and practises I came across when I attended a Mathematics teacher education programme at Brock University in Canada for a term of four months in 2008.

It is imperative to regard the key areas as contributing factors and along with other factors it influences the holistic preparation of the Mathematical Literacy teacher. These key areas will be portrayed against the background of the complex preparation process that enables the prospective Mathematical Literacy teacher to teach Mathematical Literacy or the Mathematics teacher to teach Mathematics for Work and Everyday Life. Mathematical literacy teacher training can be seen as part of mathematics teacher education and therefore this chapter will also include an overview of mathematics teacher education.

Table 3.1 contains the questions that were structured around the key areas and provides an indication of the paragraphs where these questions are addressed.

**TABLE 3.1 QUESTIONS REGARDING KEY AREAS IN MATHEMATICAL LITERACY TEACHER EDUCATION PROGRAMMES**

<b>KEY AREAS</b>	<b>QUESTIONS</b>	<b>PARAGRAPHS</b>
3.2 Definitions, views and the importance of mathematical literacy	What is mathematical literacy?	3.2.1
	What is the importance of mathematical literacy?	3.2.2
	What are the attributes of a mathematical literate person?	3.2.3
3.3 The landscape of Mathematics and Mathematical Literacy teacher education	What does Mathematics and Mathematical Literacy teacher education entail?	3.3.1
	What is the role of literacy in Mathematical Literacy teacher training?	3.3.2
	What role does mathematics play in Mathematical Literacy teacher training?	3.3.3
	What is the role of the competencies embedded in Mathematical Literacy training for teachers?	3.3.4
3.4 The teaching of mathematical literacy subjects or courses	Should context direct content or should content direct context in mathematical literacy teaching?	3.4.1
	What is the difference between mathematics-for-oneself and mathematics-for-teaching?	3.4.2
	What is the relationship between identity and learning mathematics?	3.4.3

### **3.2 DEFINITIONS, VIEWS AND THE IMPORTANCE OF MATHEMATICAL LITERACY**

The definition of mathematical literacy has been debated for decades, both nationally and internationally. In Madongo’s opinion (2007:iii) there is controversy surrounding the theoretical concept of mathematical literacy within the mathematics community around the world.

Hence, Table 3.2 gives a summary of the various definitions for mathematical literacy by different authors as well as the views of the authors about mathematical literacy and its importance.

#### **3.2.1 What mathematical literacy is**

Table 3.2 lists the definitions and views of mathematical literacy by a variety of authors:

**TABLE 3.2 DIFFERENT AUTHORS' VIEWS AND DEFINITIONS OF MATHEMATICAL LITERACY**

#	Author(s) and year	Views of mathematical literacy
1	<b>AMESA, 2003:2</b>	<i>If literacy is the ability to read and 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.</i>
2	<b>Bowie and Frith, 2006:30</b>	<i>The focus is on defining what a mathematical literate person can do rather than how mathematical literacy is defined.</i>
3	<b>Bussi�re, 2001:86</b>	<i>Mathematical literacy includes the ability to put mathematical knowledge and skills to functional use rather than just mastering them within a school curriculum. To "engage in" mathematics covers not simply physical or social actions (such as deciding how much change to give someone in a shop) but also wider uses, including taking a point of view and appreciating things expressed mathematically (such as having an opinion about a government's spending plans).</i>
4	<b>Cockcroft, 1982:2</b>	<i>Mathematical literacy is an educational goal with two attributes: The first attribute is an at homeness with numbers, by which is meant an ability to make use of mathematical skills to cope with the practical demands of everyday life. The second attribute is an ability to understand information that is presented in mathematical terms.</i>
5	<b>Hoogland, 2004: 2</b>	<i>Mathematical literacy cannot be defined in terms of mathematical knowledge alone; it is rather about the functional aspect of mathematical knowledge. It is about the individual competencies to use mathematical knowledge in a practical, functional way; mathematical literacy in order to..., or mathematical literacy for...</i>
6	<b>Madongo, 2007:41</b>	<i>Mathematical literacy is viewed and portrayed as a competency or embodiment of knowledge, skills, competencies and other attributes, that enable an individual to engage in meaningful social and political issues that are mathematical.</i>
7	<b>MoE, 2004:24</b>	<i>Mathematical literacy should encompass the ability to:</i> <ul style="list-style-type: none"> <li>• <i>estimate in numerical or geometric situations;</i></li> <li>• <i>know and understand mathematical concepts and procedures;</i></li> <li>• <i>question, reason, and solve problems;</i></li> <li>• <i>make connections within mathematics and between mathematics and life;</i></li> <li>• <i>generate, interpret, and compare data;</i></li> <li>• <i>communicate mathematical reasoning</i></li> </ul> <i>This vision also includes being engaged in mathematics – that is, understanding the value of mathematics and having the inclination and the confidence to use it</i>

8	<b>OECD, 1999:41</b>	<i>Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments 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</i>
9	<b>Shava, 2005:46</b>	<i>Mathematical literacy has everything to do with meaningful physical and numerical reality and also has indicators that have significant cultural bearings. In a way, it is a form of interactive dialogue between the individual's aggregate mathematical knowledge indicators and the contextualised real world.</i>

From Table 3.2 one can deduce that a collage of the salient indicators of mathematical literacy would include that mathematical literacy is the individual's abilities and competencies to first make sense of, communicate and engage meaningfully in situations that are encountered in his/her daily life which are numerical in nature and mathematical in structure. More than once, culture is also mentioned in these definitions as well as the ability to communicate in mathematical terms. It is also noteworthy to mention that emotions (confidence, concern and appreciation), which could be described as attitudes and values, also form part of the views and definitions in Table 3.2. It is clear that still more debate will follow before consensus will be reached on what exactly mathematical literacy is.

### 3.2.2 Other terms used to refer to mathematical literacy

Table 3.3 shows the different definitions for Numeracy and Quantitative literacy by the different authors.

**TABLE 3.3 TERMS USED TO REFER TO MATHEMATICAL LITERACY WITH DEFINITIONS AND VIEWS**

TERM		
<b>NUMERACY</b>	Numeracy can be defined as having the competence and disposition to use mathematics to meet the general demands of life at home, in paid work, and for participation in community and civic life.	Willis, 1992: 23
<b>NUMERACY</b>	The Numeracy Framework describes Numeracy as a blend of three forms of knowledge: <ol style="list-style-type: none"> <li>1. <i>Mathematical knowledge – the skills, techniques and concepts necessary to solve quantitative problems encountered in a real context;</i></li> <li>2. <i>Contextual knowledge – awareness and knowledge of how the context impacted on the mathematics being used; and</i></li> <li>3. <i>Strategic knowledge – having the confidence, disposition and skills to find out what needs to be known in order to act numerate.</i></li> </ol>	Hogan, 2000:19
<b>NUMERACY</b>	Turner makes a very strong case for the relationship between a person's daily activities and the appropriateness of the mathematical tools possessed by that person:  <i>If the numerate are those who possess mathematical tools appropriate to their daily activities and are confident about using them, then numeracy will mean different things for different people according to their interests and lifestyles.</i>	Turner, 2007:32

<b>QUANTITATIVE LITERACY</b>	<p><i>A quantitative common-sense, based on basic mathematical concepts, skills, and know-how.</i></p> <p><i>The problem of quantitative literacy is not a deficiency that someone has to be blamed for but a symptom of the monumental changes our nation has experienced during its two centuries of existence. All nations, as they move into a knowledge-based environment, face similar problems and all will have to develop their own solutions that match the special needs of their populations.</i></p>	Wade, 2001:5
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### 3.2.1.1 Synthesis of Mathematical Literacy/Numeracy

From Table 3.2 and Table 3.3 it is clear that all of these definitions and views have one strand in common: ‘using mathematics in a real world setting’. Furthermore, a synthesis of the content of the tables clearly points to the fact that mathematical literacy involves not only the knowledge of mathematics, but also the skill to use this knowledge effectively in everyday life situations. Using the knowledge effectively means to be able to know and use mathematical processes, problem-solving, reasoning, communication, connections, representations as well as aids as tools to understand and engage with the real-life situation.

### 3.2.3 The importance of mathematical literacy

The National Council of Teachers of Mathematics<sup>3</sup> (NCTM) describes the importance of mathematical literacy in their guide Principles and Standards for School Mathematics (NCTM, 2000:4) in the following manner:

*The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase.*

Table 3.4 provides a summary of the different authors’ views regarding the importance of mathematical literacy:

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<sup>3</sup> The National Council of Teachers of Mathematics is a professional organization based in the USA committed to excellence in mathematics teaching and learning for all students.

**TABLE 3.4 DIFFERENT AUTHORS' VIEWS ON THE IMPORTANCE OF MATHEMATICAL LITERACY**

AUTHOR	VIEW ON IMPORTANCE OF MATHEMATICAL LITERACY
MoE, 2004:10	<i>Mathematical literacy is as important as proficiency in reading and writing. Mathematics is so entwined with today's way of life that we cannot fully comprehend the information that surrounds us without a basic understanding of mathematical ideas.</i>
Jablonka, 2003:75	<p>Mathematical literacy is always facilitated in order to achieve something, viz. mathematical literacy for developing human capital, mathematical literacy for cultural identity, mathematical literacy for social change, mathematical literacy for environmental awareness or lastly mathematical literacy for evaluating mathematics.</p> <p><i>It is impossible to promote a conception of mathematical literacy without promoting a particular social practise.</i></p>
Christiansen, 2006:6	<i>Mathematical Literacy curriculum justifies itself in the following two ways; one is through claims of utility and the second claim is through the provision of an awareness and understanding of the role of Mathematics in the world.</i>

From Table 3.4 it seems that mathematical literacy does have a pivotal role to play in our technologically-drenched world. It is not a given that a person who has mathematical knowledge is mathematical literate. Martin (2007:29) makes a very significant statement when he asserts that:

*Knowing the definitions of words does not make a person literate. The same is true for mathematical literacy: just knowing the rules and algorithms to solve mathematics problems does not make a person mathematical literate.*

This brings us, at this point in the discussion, to the importance of mathematical literacy in Canada and in South Africa.

### 3.2.3.1 The importance of mathematical literacy in Canada

Canadian society places a high economic value on mathematical literacy, as shown by Ontario's requirements for secondary school graduation and entry into post-secondary institutions and apprenticeship programs:

*Parents, teachers, and all adults must recognize and affirm the importance of mathematical literacy for all (MoE, 2004:24).*

The general opinion in Canada is that mathematical literacy is increasingly an imperative for employment. According to the Ministry of Education report (MoE, 2004:24) all teachers, regardless of whether they teach mathematics or not, should take advantage of the abundant

opportunities that exist for fostering mathematical literacy across the curriculum as can be gleaned from some of the principles contained in the curriculum document (MoE, 2004:11):

- 1. Mathematical literacy is fundamental. It enables students to make life choices and participate productively in society.*
- 2. All students can learn and be confident in mathematics, given appropriate support and time.*
- 3. All students have the right to quality support in learning mathematics to enable them to reach their potential.*
- 6. Effective mathematics instruction must address the needs of the adolescent learner.*
- 7. Connections to mathematical literacy should be made where they occur naturally across the curriculum.*
- 10. All teachers can and should support the development of mathematical literacy.*
- 11. Collaborative professional learning communities are essential to increasing student success.*
- 12. Effective district and school leadership is crucial to improving student learning.*

### 3.2.3.2 The importance of mathematical literacy in South Africa

In South Africa the Department of Education acknowledges the role of mathematical literacy in society to such an extent that a new subject named Mathematical Literacy was implemented in South African schools in the FET band in 2006.

*The inclusion of Mathematical Literacy as a fundamental subject in the Further Education and Training curriculum will ensure that our citizens of the future are highly numerate consumers of mathematics (DoE, 2003:9).*

Only a few countries in the world offer a subject at school level that focuses explicitly on developing this ability in learners as illustrated in Table 3.5:

**TABLE 3.5 COUNTRIES AROUND THE WORLD**

<b>COUNTRY</b>	<b>SUBJECT/COURSE</b>
England	Functional Mathematics
Canada	Applied Mathematics; Mathematics for Work and Everyday Life
South Africa	Mathematical Literacy

The subject “Functional Mathematics” and the course “Mathematics for Work and Everyday Life” most closely resemble Mathematical Literacy in South Africa.

According to the National Curriculum Statement of South Africa (DoE, 2003:10) Mathematical Literacy as subject has the important role to turn our learners into self-managing persons, contributing workers and also participating citizens.

The next part of the discussion will revolve around the concept of ‘a mathematical literate person.’

### **3.2.4 The mathematical literate person**

The question regarding what the attributes of a mathematical literate person are becomes important when the training of the Mathematical Literacy teacher is at stake: According to the National Curriculum Statement (DoE, 2006a:4) it is the mandate of a Mathematical Literacy teacher to develop these attributes in the learners:

*The challenge for you as the teacher is to use situations or contexts to reveal the underlying mathematics while simultaneously using the mathematics to make sense of the situations or contexts, and in so doing develop in your students the habits or attributes of a mathematically literate person (DoE, 2006a:4).*

The focus here is on identifying what a person must be able to do in order to be called a mathematical literate person. Table 3.6 illustrates the attributes of a mathematical literate person.

**TABLE 3.6 THE ATTRIBUTES OF A MATHEMATICAL LITERATE PERSON**

AUTHOR/S	ATTRIBUTES OF A MATHEMATICAL LITERATE PERSON
NCTM, 2000:4	<p><b>A mathematical literate person is:</b>  <i>able to <b>make purchasing decisions</b>;</i>  <i>able to <b>choose insurance and/or health plans</b></i>  <i>able to <b>vote knowledgeable</b>.</i></p>
MoE, 2004:10	<p><i>A mathematically literate person can:</i>  <i>estimate; interpret data; solve day-to-day problems; reason in numerical, graphical, and geometric situations; and communicate using mathematics.</i></p>
AMESA, 2003:2	<p><i>While the mathematically literate person may draw on mathematical algorithms or knowledge, their mathematical literacy is reflected in <b>habits and behaviours</b> and ways of engaging with problems and situations.</i></p>
Martin, 2007:29	<p>A mathematically literate individual is a <b>person who is able to reason, analyse, formulate, and solve problems in a real-world setting</b>.            Mathematically literate individuals are <b>informed citizens and intelligent consumers</b>.  <i>They have the ability to <b>interpret and analyze the vast amount of information</b> they are inundated with daily in newspapers, on television, and on the Internet.</i></p>
DoE, 2003:9	<p>A mathematical literate person is a <b>self-managing person</b> who can:            handle with confidence financial issues such as hire-purchase, mortgage bonds and investments;            read a map, follow timetables, estimate and calculate areas and volumes;            understand house plans and sewing patterns; and            use ratio and proportion efficiently in situations such as cooking and the use of medicine.            A mathematical literate person is a <b>contributing worker</b> who can: <i>deal with work-related formulae and schedules;</i>  <i>read statistical charts;</i>  <i>understand instructions involving numerical components.</i>            A mathematical literate person is a <b>participating citizen</b> who: engages responsibly with quantitative arguments relating to local, national and global issues; is sensitive to the aesthetic value of mathematics.</p>
Thornton and Hogan, 2004:313	<p>Thornton and Hogan (2004:313) maintain that the Numeracy Framework suggests that being, or becoming, numerate involves being able to, or learning to, take on three roles:</p> <ol style="list-style-type: none"> <li>1. <i>The fluent operator - Being (becoming) a fluent user of mathematics in familiar settings;</i></li> <li>2. <i>The learner - Having (developing) a capacity for the deliberate use of mathematics, to learn; and</i></li> <li>3. <i>The critical mathematician - Having (developing) a capacity to be critical of the mathematics chosen and used.</i></li> </ol>

From Table 3.6 it is clear that the attributes of a mathematical literate person is a self-managing person, contributing worker and a participating citizen who can estimate, interpret data, vote knowledgeable, problem solve, make purchasing decisions, reason in numerical, graphical and geometric terms about global, national and local issues, reflect, connect, represent and communicate using mathematics, but also appreciate the beauty of mathematics. One can conclude that to be called a mathematical literate person means that one has to acquire not only mathematical knowledge but also some mathematical

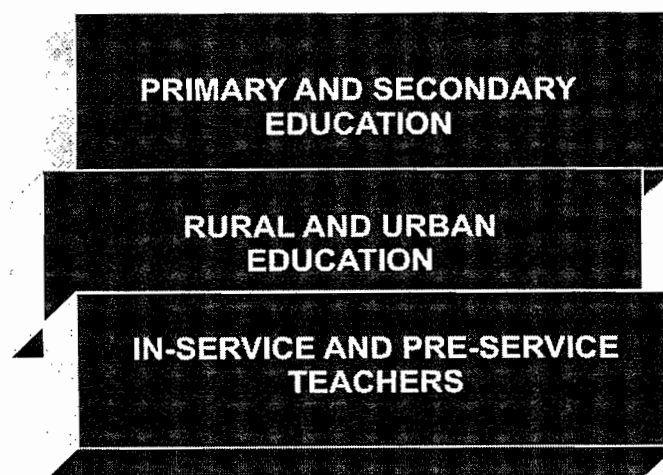
competencies like reasoning skills, analysing skills, reflecting skills, communication skills and the skill that encompasses all other skills - problem solving skills.

Now that different definitions and views of mathematical literacy and its importance, as well as the attributes of a mathematical literate person have been discussed, I will continue with a discussion on the landscape of mathematics and mathematical literacy teacher training and how the particular nature of the subject Mathematical Literacy influences the training of teachers.

### **3.3 THE LANDSCAPE OF MATHEMATICS AND MATHEMATICAL LITERACY TEACHER EDUCATION**

#### **3.3.1 Introduction to Mathematics and Mathematical Literacy teacher education**

There are numerous studies involving Mathematics teacher education but relatively few studies relating to Mathematical Literacy teacher education. One could argue that Mathematical Literacy teacher education purports the teaching and learning of mathematics and as such Mathematical Literacy teacher education is located in the much broader scope of Mathematics teacher education. Adler (2005:1) asserts that mathematics education is a layered domain of practise. One of these layers, in-service and pre-service teachers, is cited in this study as one of the limitations and also one of the differences between the programmes at the two universities. Figure 3.1 illustrates these layers.



Source: Adler, 2005:1

**FIGURE 3.1: DIAGRAMMATICAL REPRESENTATION OF MATHEMATICS EDUCATION AS A LAYERED DOMAIN OF PRACTISE.**

### 3.3.1.1 The complex nature of Mathematics education

In Chapter 1 (p.1), I mentioned the fact that many researchers agree on the complexity of Mathematics teacher education. The distinctive nature between the mathematics knowledge of teachers themselves and the mathematics-for-teaching knowledge that teachers need to acquire further contributes to this complexity (Bass & Ball, 2003:3). According to Bass and Ball (2003:3) these two kinds of knowledge differ. Bass and Ball (2003:3) focus on the working assumption that how well teachers can teach depends on how well they know their subject. In their outline of what a good education in mathematics for prospective teachers would entail, Askew (2008:13) classify the knowledge of prospective teachers into four parts:

1. Knowledge of the content of mathematics;
2. Experiences of doing mathematics;
3. Knowledge of mathematics as a discipline; and
4. Knowing how to learn mathematics.

In South Africa the socio-cultural and political context makes mathematics teacher education even more complex. Adler (2002:2) describes how we, because of apartheid, have to redress, repair and reform mathematics education. The level of competence of the teachers varies considerably as a result of the different education departments. Adler *et al.* (2005:260) claims that quality instruction depends on teachers and therefore the preparation and continuous professional development of these teachers are crucial.

The next section deals with Mathematical Literacy teacher training which lies at the core of this study and is unique to the South African context.

### 3.3.1.2 Initial problems experienced in Mathematical Literacy teacher training in South Africa

South African teachers in Mathematical Literacy teacher education programmes were not initially trained as Mathematics teachers and as such were not involved in formal mathematics teacher education programmes. This situation is worsened by the fact that not all of these educators received initial equal training opportunities due to the apartheid system. Teachers in these programmes also did not have a solid mathematics background because they did not take the subject in the senior grades when they attended school. Within this context Mathematical Literacy teacher training was introduced when the subject was implemented in the school curriculum of South African schools in 2006.

How might this context influence the mathematical literacy teacher training currently offered at universities in South Africa? One might be tempted to answer this question by

investigating assumptions and assertions about knowledge, but maybe one should rather concentrate on the realities of the classroom. Davis *et al.* (2008:10) assert that in their ongoing work with practising teachers these teachers welcomed ideas learned in training programmes when better fitted to the realities of their classrooms. A focus on the reality of the classroom will bring to the fore the issues that teachers are now struggling with in the classroom.

### 3.3.1.3 Approaches to Mathematical Literacy teacher training in South Africa as reflected in existing studies

Although Mathematical Literacy is quite new as subject in the South African school curriculum, several studies have been done to pilot effective approaches in the training programmes. Existing literature regarding approaches in the teacher training programmes for Mathematical Literacy are listed in Table 3.7.

**TABLE 3.7 DIFFERENT AUTHORS' APPROACHES TO MATHEMATICAL LITERACY TEACHER TRAINING**

<b>AUTHOR</b>	<b>STUDIES INVOLVING APPROACHES IN TRAINING PROGRAMMES FOR MATHEMATICAL LITERACY TEACHERS</b>	<b>FINDINGS OF THE STUDY</b>
<b>Brown &amp; Schäfer, 2006:50</b>	A study that adopted an activity- and investigation-based approach using mathematical modelling in order for teachers in the programme to understand the mathematics in context.	It was found that the modelling approach worked well for the skilled teachers but not very well for the teachers with weaker mathematical skills.  Teachers of Mathematical Literacy should first be mathematically literate themselves before they can attempt to teach Mathematical Literacy to learners.
<b>Frith &amp; Prince, 2006:53</b>	A study in which the various roles played by an in-service teacher learning to teach Mathematical Literacy through data handling as research task, were examined.	<i>In designing a curriculum for "Mathematical Literacy" teacher training, it is useful to frame mathematical literacy as contextualised social practice. Some of the implications of this framework for the curriculum are that mathematical and statistical content should be taught through learners' engagement with realistic, relevant contexts: that critical thinking and communication are important elements and that collaborative work should be encouraged (p.59).</i>

<b>D'Armento, 2003:5</b>	An evaluative study done with both in-service and pre-service teachers using a hands-on approach.	The participant teachers changed their teaching practises to include more hands-on interactive activities linked to real-life context.
<b>Graven &amp; Venkat, 2007: 3</b>	A longitudinal case study in which the experiences of educators and learners taking Mathematical Literacy were traced.	Identified a spectrum of agendas. Data from the interviews with these teachers and questionnaires completed by the teachers enabled them to create a tool to analyse mathematical literacy practises.

From Table 3.7 it can be deduced that although existing literature suggests these various approaches to facilitating Mathematical Literacy training sessions, not one of the mentioned authors provides a framework to guide higher institutions as to how an effective Mathematical Literacy teacher training programme should be structured. Although the Mathematical Literacy teacher guide (DoE, 2006a:3) is intended to give teachers a sense of what it means to teach Mathematical Literacy by providing detailed plans for a range of learning units to be taught, it can never substitute the much needed training for the teachers to enable them to teach the subject.

It stands to reason that in order to train effectively to teach a subject, one needs a thorough idea of what the subject entails. The next section will focus on what the training of Mathematical Literacy teachers entails.

### 3.3.1.4 Training to teach the subject Mathematical Literacy

One way of answering the question: 'What is Mathematical Literacy as subject?' might be to find answers to the question of what Mathematical Literacy as a subject is not: Mathematical Literacy is not:

- a "watered down" version of academic Mathematics (AMESA, 2003:1);
- the alternative subject to be taken by those learners who cannot do "real mathematics" (Lott, 2004: 175);
- Standard Grade Mathematics (AMESA, 2003:1; Snyders, 2005:1);
- "easy" or "soft" Mathematics (DoE, 2005:53);
- trivial Mathematics (AMESA, 2003:1).

Already in the early stages of implementation of this new subject in 2006, Vithal and Bishop (2006:2) asked the question whether Mathematical Literacy is a new form of literacy or a new mathematics. AMESA, the Association for Mathematics Education of South Africa, also

indicated that they were *concerned* that the country has not yet properly conceptualised what Mathematical Literacy as a subject entails (AMESA, 2003:1):

*This lack of understanding of what constitutes Mathematical Literacy is reflected in the subject statement at both a definitional and assessment standard level.*

This concern resonates with the serious concern of the Ministerial Committee in the Report of the Ministerial Committee for Mathematics and Mathematical Literacy (DoE, 2005:21) regarding the opening sentence of the definition for Mathematical Literacy in the National Curriculum Statement (2003). (See 2.6.2).

Another interesting point is that Madongo (2007:106) identified three main views amongst the participants in his study regarding Mathematical Literacy as a subject.

*Functional view: Mathematical literacy is a more contextualized applied type of Mathematics, more relevant to one's own life.*

*Status view: Mathematical Literacy is an easier version of Mathematics for learners who are not good at Mathematics.*

*Inter-disciplinarily view: Mathematical Literacy is a subject as well as a competency.*

These views will be confirmed or challenged in Chapter 5 when empirical data from the study is analysed.

### 3.3.1.5 Mathematical Literacy versus Mathematics

There is general agreement in the mathematical literacy community (AMESA, 2003:1; DoE, 2005:21) that Mathematical Literacy differs from Mathematics. Table 3.8 indicates the main difference:

**TABLE 3.8 THE MAIN DIFFERENCE BETWEEN MATHEMATICS AND MATHEMATICAL LITERACY**

CRITERIA	MATHEMATICS	MATHEMATICAL LITERACY
Aim of the subject	Mathematics aims to prepare learners of Mathematics for study fields in Higher Institutions with a strong mathematical base.	Mathematical Literacy aims to provide Mathematical Literacy learners with the basic numerical skills that are needed in everyday life.

Source: AMESA, 2003:4

From Table 3.8 it is clear that Mathematics and Mathematical Literacy are different subjects that cannot be compared to each other as versions of the same subject. Mathematical Literacy and Mathematics are not even different levels of the same subject (AMESA, 2003:1; Snyders, 2005:1). However, for Bowie and Frith (2006:31) Mathematical Literacy looks very much like Mathematics.

Although Mathematical Literacy as subject has as its purpose to help learners to become mathematically literate, it will also prepare learners for study fields at higher institutions that do not require a strong Mathematics base:

*Students proceeding to Higher Education institutions will have acquired a mathematical literacy that will enable them to deal effectively with mathematically-related requirements in disciplines such as the social and life sciences (DoE, 2003:11).*

There is a warning though, that those students who wish to study in Mathematics-based disciplines should not take Mathematical Literacy:

*Mathematical Literacy should not be taken by those learners who intend to study disciplines which are mathematically based, such as the natural sciences or engineering (DoE, 2003:11).*

### **3.3.2 The role of literacy in Mathematical Literacy teacher training**

The role of literacy in Mathematical Literacy is becoming critical considering that the subject Mathematical Literacy contains much more text than Mathematics. This shift towards 'wordier' mathematics creates challenges especially since the majority of learners and teachers must learn and/or teach Mathematical Literacy in their second language. Table 3.9 indicates the different inputs from the authors regarding the level of literacy required in Mathematical Literacy.

**TABLE 3.9 MATHEMATICAL LITERACY STUDIES THAT FOCUS ON LANGUAGE VERSUS STUDIES THAT FOCUS ON TEXT**

STUDIES IN WHICH FOCUS ARE ON LANGUAGE AND AUTHOR/S	STUDIES IN WHICH FOCUS ARE ON TEXT AND AUTHOR/S
<p>A study done with a multilingual grade 11 class in which authors assert that the use of language should facilitate the mathematics learning and not distract their attention from the mathematical task under discussion (Setati <i>et al.</i>, 2008:14)</p>	<p>A study done with nine students to examine their reasons for stating that they do, or do not understand mathematics text. It was found that some students continuously claimed to in principle understand everything they read, but clearly had some difficulties to grasp the contents of the texts. The teaching of Mathematical Literacy also involves understanding various forms that have to be completed or interpreted in real-life situations (Osterholm, 2006:289)</p>
<p>A study in which the following was recommended:</p> <p><i>Attention should be paid to the topic of mathematical language when training Mathematics teachers in South Africa. Teachers should be trained in such a way that they would consciously use and teach educational and educated mathematical language (Vorster, 2006:65).</i></p>	<p><i>Document literacy refers to the ability of comprehending various forms:</i></p> <p><b>Forms:</b> tax forms, immigration forms, visa forms, application forms, questionnaires;</p> <p><b>Information sheets:</b> timetables, price lists, catalogues, programs;</p> <p><b>Vouchers:</b> tickets, invoices, etc.;</p> <p><b>Certificates:</b> diplomas, contracts, etc.;</p> <p><b>Calls and advertisements;</b></p> <p><b>Charts and graphs:</b> iconic representations of data;</p> <p><b>Diagrams;</b></p> <p><b>Tables and matrices;</b></p> <p><b>Lists and Maps</b> (De Lange, 2001:15).</p>
<p>In this study Setati (2005:95) asserts that the teacher as a “discourse guide” requires moving the learners from a stage where they can talk informally about mathematics in their main language(s) to a stage where they can use the formal language of mathematics in the language of learning and teaching (English), and can engage in procedural and conceptual mathematics discourses:</p> <p><i>In a multilingual mathematics classroom of additional language learners, the role of the teacher as a ‘discourse guide’ is even more crucial (Setati, 2005:96).</i></p>	

<p>A study in which the following was recommended:  <i>Mathematics and language teaching should be integrated to provide experiences to the learners that bridge gaps in their mathematics knowledge and expand their competence in English</i> (Buchanan &amp; Helman, 1997:1).</p>	<p>The Department of Education (DoE, 2006a:20) focuses on text when it claims that the following written media are listed as part of resources needed to teach Mathematical Literacy:</p> <p><i>Text books, articles and advertisements; graphs and tables; sales brochures; nutritional panels from food packages; municipality account statements, municipal tariff tables; banking brochures, recipe books, tournament logs and results, timetables for trains, busses, aeroplanes, etc. and national, regional and local road maps.</i></p>
<p>Study in which it was found that the street language does not always map directly or correctly onto mathematical syntax when using real-life examples in attempts to engage students (Kenney, 2005:3).</p>	
<p>A study in which Whitin <i>et al.</i> (1990:10) regard Mathematics as a language:  <i>It is a communication system that we use to explore and expand our knowledge of the world</i></p> <p>Whitin <i>et al.</i> maintains further that learners become mathematically literate the same way they become literate in reading.</p>	

From Table 3.9 it is clear that the ability to read, write and speak using mathematical terms and concepts is an integral part of Mathematical Literacy as subject. Reading and comprehending the text used to depict real life-situations, whether it forms part of class work, homework or during examination, forms an important aspect of the teaching and learning of Mathematical Literacy. Reading provides both context and motivation for learners and also provides learners with a shared basis for receiving and sharing information.

English second language (ESL) learners have the added disadvantage of learning mathematics in a linguistically and culturally unfamiliar environment. From Table 3.9 it seems that it is advisable for the Mathematical Literacy teacher to work with the learners on their informal mathematics language (in English) so that they can acquire the formal language of mathematics (in English) and can thus understand and be understood by other members of the wider school mathematics community. Therefore, Mathematical Literacy training programmes should prepare prospective teachers for this task.

### **3.3.3 The role of Mathematics in Mathematical Literacy teacher training**

Although the Mathematics to be taught to learners in the Mathematical Literacy classroom is basic (grade 8 -12 school mathematics), it is a significant part of Mathematical Literacy as subject and a point to keep in mind when preparing teachers to teach Mathematical Literacy in schools. This notion is also accentuated in the Ministerial Report (DoE, 2005:54):

*Preparing teachers to teach Mathematical Literacy is a medium to long term project that begins in the courses such teachers take as part of their initial pre-service training. In terms of the immediate (short term) needs, in addition to already qualified teachers (ideally with some or other degree) who have a desire to do so and who have a reasonably strong Senior Certificate background in Mathematics can be trained via an immersion in an extended Mathematical Literacy programme – a programme that ensures that they first become mathematically literate themselves.*

In the South African context of this study the following question becomes important: How should Mathematics be taught to a group of registered teachers with different levels of mathematical knowledge? A mathematical knowledge base that can range from the low level of only having grade 9 Mathematics, to a level of having passed grade 12 Mathematics (see Table 4.4). Answering this question becomes more daunting if one has to keep in mind the time since these teachers' last involvement with Mathematics learning. If one does the mathematics correctly, taking the average age of the teachers (Table 4.4) at enrolment into the programme and subtracting the expected age of a grade 9 learner ( $\pm 15$  years), one can estimate that some teachers were involved in mathematics learning 20 ( $35-15 = 20$ ) years ago. In this respect Lott (2004:176, own addition) asserts that:

*Many primary school teachers may not be comfortable with the necessary mathematics because of their own backgrounds, middle school teachers have mixed mathematics backgrounds and secondary teachers are typically more comfortable with traditional mathematics than with the mathematics presented in a quantitative (**mathematical**) literacy programme.*

Lott (2004:176) further argues that it is unrealistic to expect that teachers, other than mathematics teachers, know or understand what might be considered quantitative literacy.

The foregone situation is compounded by the following considerations:

- It is possible that high school learners come into the Mathematical Literacy classroom with a history of previous failure in Mathematics and a general dislike for any subject that is related to Mathematics.
- It is possible that if Mathematical Literacy is selected by learners because it is the only alternative subject to Mathematics, then such learners might experience their “choice” of taking Mathematical Literacy as being forced upon them.

Let us now look at the different inputs of researchers regarding the role mathematics play in Mathematical Literacy.

**TABLE 3.10 DIFFERENT AUTHORS' INPUTS REGARDING THE ROLE OF MATHEMATICS IN MATHEMATICAL LITERACY**

<b>AUTHOR</b>	<b>INPUT</b>
DoE, 2005:21	<i>To teach Mathematical Literacy a teacher must first and foremost have a robust understanding of mathematics, secondly they must be able to "see" the mathematics that underpins the contexts that characterise a Mathematical Literacy curriculum and thirdly, they must be able to extract the mathematical generalisations from those contexts.</i>
DoE, 2003:38	<p><i>Content must serve the learning outcomes and not be an end in itself.</i></p> <p>In this document the mathematics that should be taught is referred to as content.</p>
Whitin <i>et al.</i> , 1990:6	<i>As learners engaged in mathematical experiences, there is the potential for them to learn mathematics, learn through mathematics and learn about mathematics.</i>
Lott, 2004:176	<p>Lott suggests an understanding of how algebra is applied outside the classroom as part of the algebra strand.</p> <p>Any mathematical literacy curriculum must be coherent and focussed on important mathematics and not be a mere collection of activities.</p>

From the foregone it is clear that prospective Mathematical Literacy teachers need to have mastered mathematical content to such a level where they are able to **understand** the mathematics, **identify** the mathematics in the contexts and **extract** the mathematics from the contexts and then be able to **convey** this mathematical knowledge and skills to possibly negative learners. From Table 3.10 it is evident that the Mathematics embedded in Mathematical Literacy can not be a simple collection of activities as stated by Lott (2004:176), but must be focussed on important mathematics. The Mathematical Literacy curriculum must be a coherent and integrated whole.

The list of mathematics or the content that is involved in Mathematical Literacy as subject in South African schools is listed per grade for each learning outcome in the National Curriculum Document (DoE, 2003:38).

### **3.3.4 The competencies or mathematical processes embedded in Mathematical Literacy**

The question “Where is the reasoning and problem solving?” (Venkat, 2009:1) is a significant and thought-provoking question. Taking a closer look at the National Curriculum Statement (DoE, 2003) and the PISA Assessment Framework (OECD, 2003) one discovers that these two documents have much in common. In fact, the assessment taxonomy for the assessment of Mathematical Literacy was based on the PISA (2003) report as well as the TIMSS report (2003):

*Drawing on these two very similar frameworks the following taxonomy for Mathematical Literacy is proposed:*

- *Level 1: Knowing*
- *Level 2: Applying routine procedures in familiar contexts*
- *Level 3: Applying multistep procedures in a variety of contexts*
- *Level 4: Reasoning and reflecting (DoE, 2008:8)*

Another two terms that are often used in the above-mentioned two documents is the concepts of ‘content’ and ‘context’, but what about the competencies? In this respect Table 3.11 indicates the various inputs from different authors regarding ‘competencies’ embedded in Mathematical Literacy teaching and learning.

**TABLE 3.11 DIFFERENT AUTHORS' INPUTS REGARDING THE COMPETENCIES EMBEDDED IN MATHEMATICAL LITERACY**

AUTHOR	INPUT
Niss, 2004:91	<i>If the objective of mathematics education were organized around competencies such as reasoning, modelling and communicating mathematically - rather than, for example, around content such as algebra, geometry, and calculus - school graduates would be far better able to navigate thoughtfully the turbulent waters of democratic debate and decision making.</i>
Van der Walt, 2006:183	In a study with both in-and pre-service teachers it was found that problem-solving was indeed being implemented, but that the strategies and steps that are usually followed by problem-solving were not directly facilitated or explicitly focussed on by the in-service teachers.
DoE, 2003:42	<i>The approach that needs to be adopted in developing Mathematical Literacy is to engage with contexts rather than applying Mathematics already learned to the context.</i>
Bowie & Frith, 2006:30	<p><i>Bowie and Frith distinguish three elements in Mathematical Literacy, viz. the content (the mathematics), the context (the real-life related applications and everyday situations) and the abilities and behaviours of the mathematical literate person (confidence, thinking, interpreting, etc.).</i></p> <p><i>Bowie and Frith found that:</i></p> <p><i>If we want to provide a responsible and meaningful learning experience then the contexts used within Mathematical Literacy need to be addressed from both mathematical and non-mathematical points of view. As we rethink the curriculum we need to address the issue of the integration of Mathematical Literacy with other subjects more seriously (p.34).</i></p>

4 Sentences in Italics are direct quotes from the authors.

Pugalee, 1999:20	<i><b>The ability to use mathematics to solve problems is a primary goal of becoming mathematically literate. The mathematically literate individual possesses those skills that allow him or her to successfully understand a problem, design solution paths that will yield results, and effectively assess the appropriateness of those results. Mathematical literacy is a complex interaction of these processes. Though there are varying levels of proficiency, the development of each of the processes is necessary.</b></i>
Pugalee et al., s.a.:303	<i><b>Authentic tasks are a critical tool in developing the level of mathematical understanding and conceptualizing indicative of mathematical literacy. Authentic tasks can be characterized by in-depth analysis along four dimensions: thinking and reasoning, discourse, mathematical tools, and attitudes and dispositions.</b></i>
DoE, 2008:8	The taxonomy framework that is prescribed in the Subject Assessment Guidelines for Mathematical Literacy to be used by Mathematical Literacy teachers in the assessment of Mathematical Literacy, requires that teachers include questions in which <b>representation, reasoning, reflecting and problem-solving</b> abilities in learners can be assessed.
De Lange, 2004: 77	De Lange argues for an explicit emphasis on the competencies embedded in mathematical literacy:  <i>ML also focuses more attention and emphasis on reasoning, thinking, and interpreting as well as on other very mathematical competencies.</i>
Thompson, 2007:195	Thompson agrees that communication and representation are essential ingredients for the development of mathematical literacy.
Moodley, 2008:70	In a comparative study, assessing the reasoning ability of grade 10 Mathematical Literacy learners on the one end and grade 10 Mathematics learners on the other, Moodley found, to his surprise, that the Mathematics learners outperformed the Mathematical Literacy learners when the results from the tests which were administered in his study indicated that the Mathematics learners were better able to reason with numbers than their Mathematical Literacy counterparts.  Moodley concluded that Mathematical Literacy learners generally are learning mathematics without understanding it although they are expected to apply their knowledge to solving problems.

As can be seen in Table 3.11, there is an emphasis on teachers being able to solve problems because the very nature of Mathematical Literacy implies a strong claim on problem-solving as the subject is focussed on the solving of problems in real-life situations as well as simulations of real-life situations. It must be noted that a competency, like problem-solving, includes most other competencies like communication, representation, connections, use of aids and tools, argumentation as well as reflection (DoE, 2008:8).

The question must be asked as to what extent Mathematical Literacy teachers are being prepared to facilitate problem-solving in Mathematical Literacy teacher education programmes. This leads to the question whether problem-solving is implemented in practise. Van der Walt (2006:172) answered this question when she found that both the pre-service teachers and the in-service teachers do implement problem-solving but the in-service teachers failed to focus explicitly on the steps and strategies for this important mathematical process.

The question 'How do prospective teachers in Mathematical Literacy teacher education programmes experience the wordier problems?' becomes increasingly important if one takes into consideration the fact that Mathematical Literacy is all about mathematics in context according to the National Curriculum Statement (DoE, 2008:7):

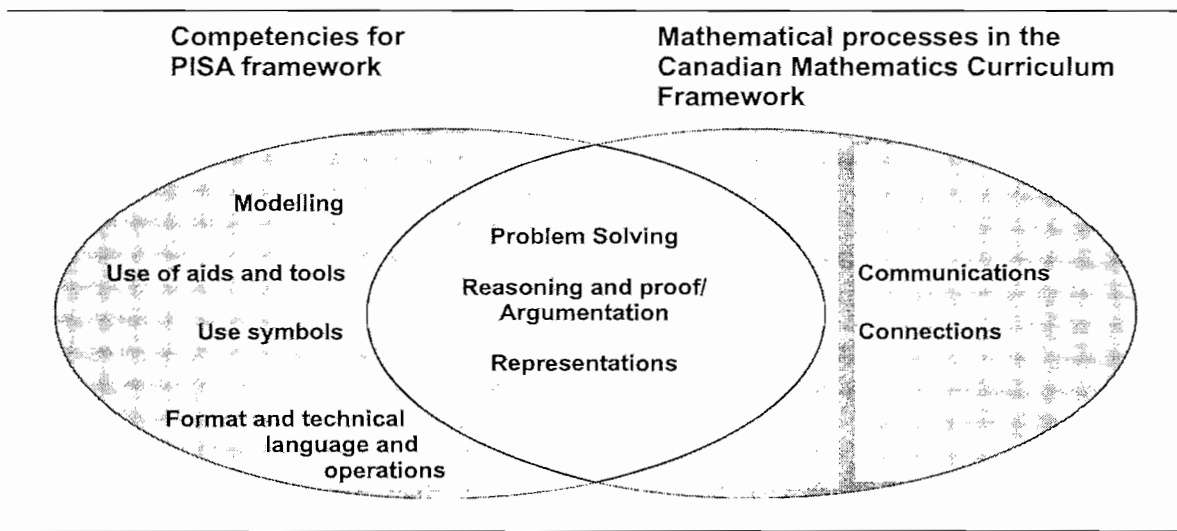
*When teaching and assessing Mathematical Literacy, teachers should avoid teaching and assessing mathematical content in the absence of context.*

Bowie and Frith's findings (2006:34) have real implications for an effective Mathematical Literacy teacher education programme: Prospective teachers in an effective mathematical literacy teacher programme should pay attention to the integration of Mathematical Literacy with other subjects as well as the development of all the important skills and mathematical processes that come into play when Mathematical Literacy is taught to learners.

In South Africa, this task is compounded by the fact that the teachers involved generally had no prior mathematics teacher education which could have provided these teachers with opportunities to learn how the mathematical processes or skills should be focussed on in the curriculum.

What Moodley (2008:70) found in his study is indeed surprising as Mathematical Literacy learners are supposed to outperform Mathematics learners when it comes to reasoning, as they are reasoning (or are supposed to reason) when solving problems in real-life or simulated real-life situations. The question must be asked to what degree the teacher in the study was aware of the fact that reasoning as skills should be focused on explicitly when Mathematical Literacy is taught? Could it be that the mathematical processes are not sufficiently emphasised in the National Curriculum Statement for Mathematical Literacy (DoE, 2003)?

A comparison of the PISA competencies and the mathematical processes listed by the Canadian Mathematics Curriculum Framework yielded the following intersection of competencies:



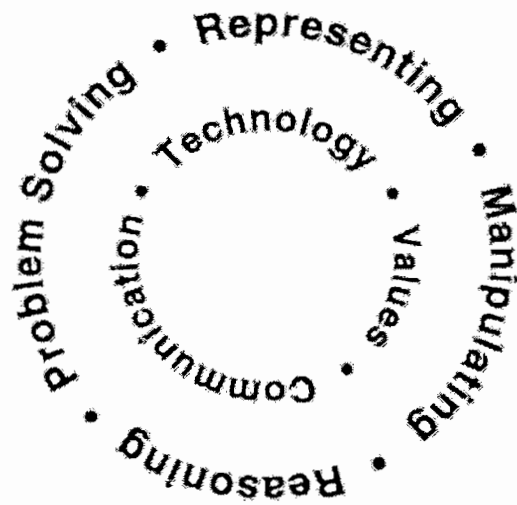
Sources: OECD, 2003:47 and MoE, 2004:10

**FIGURE 3.2 INTERSECTION OF PISA COMPETENCIES AND THE MATHEMATICAL PROCESSES LISTED BY THE CANADIAN MATHEMATICS CURRICULUM FRAMEWORK**

It is evident from Figure 3.2 that Problem Solving, Reasoning/Argumentation and Representations are focussed on by both the PISA framework and the Canadian Mathematics Curriculum Framework and as such they are very important in the teaching and learning of Mathematical Literacy.

Pugalee (1999:20) suggests a model of mathematical literacy (see Figure 3.3) in which he emphasises problem-solving, representing, manipulating and reasoning in the outer circle, forming the boundaries within which communication, technology and values should be embedded. According to Pugalee *et al.* (s.a.:306) the processes in the outer circle are the processes of being mathematical literate while communication, technology and values are crucial and central in enabling the “doing of mathematics”.

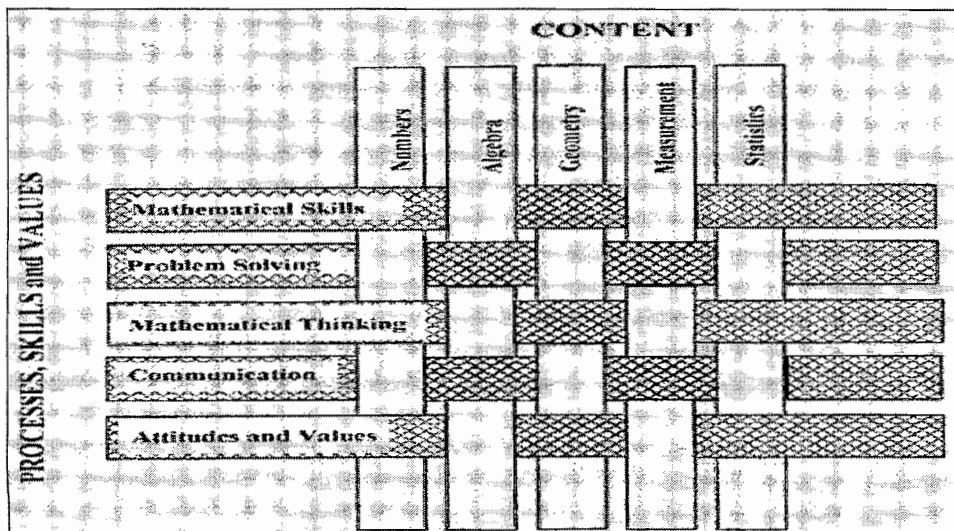
## Model of Mathematical Literacy



Source: Pugalee, 1999:20

**FIGURE 3.3 A MODEL OF MATHEMATICAL LITERACY**

The Mathematics Curriculum Framework of Brunei Darussalam (Figure 3.4) shows how the content (Numbers, Algebra, Geometry, Measurement and Statistics) is interwoven in the processes, skills and values (Mathematical Skills, Problem Solving, Mathematical Thinking, Communication, Attitudes and Values).



Source: Wong *et al*, 2007:447

**FIGURE 3.4 MATHEMATICS CURRICULUM FRAMEWORK OF BRUNEI DARUSSALAM**

Figure 3.3 and Figure 3.4 illustrate the interconnectedness of the mathematical processes, skills and values with the mathematics in the curriculum. These frameworks in Mathematics curriculum documents (Canada and Brunei Darussalam) keep teachers aware of the processes that they need to emphasise and **teach** in order to reach the achievement of helping the learners to become mathematically literate.

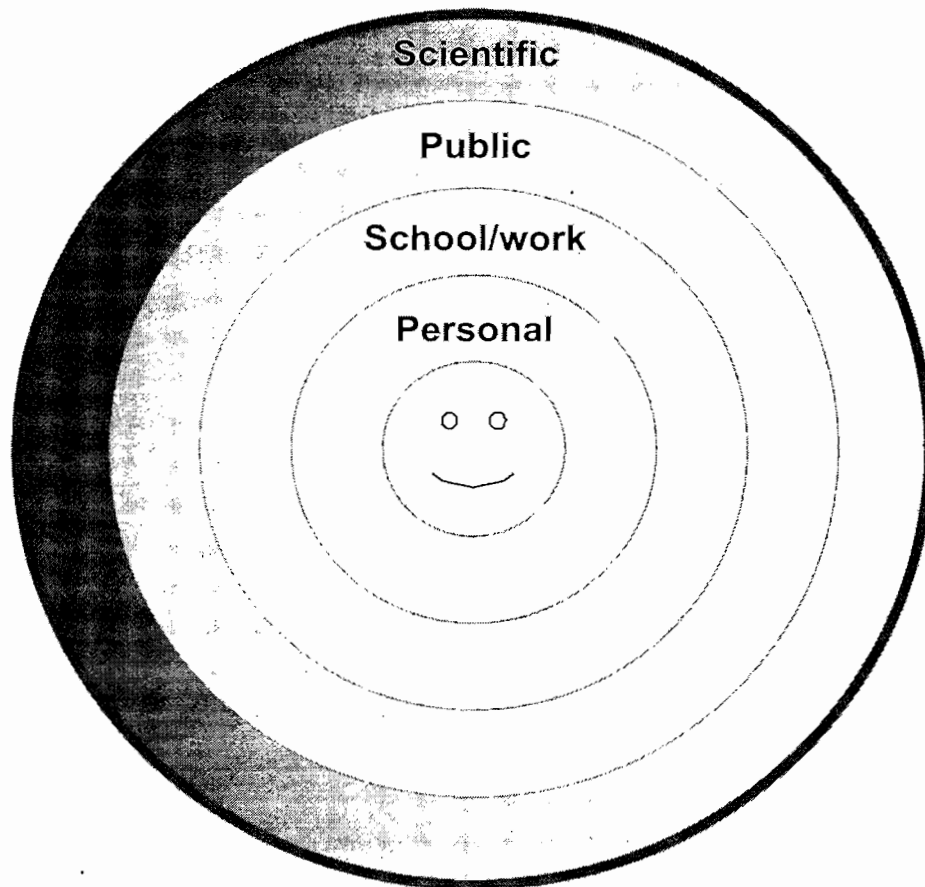
The next section deals with some pedagogical matters regarding mathematical literacy subjects and courses.

### **3.4 THE TEACHING OF MATHEMATICAL LITERACY SUBJECTS AND COURSES**

Bowie and Frith (2006:54) argue that Mathematical Literacy can be thought of as a practice within a social context, which places a strong focus on the teacher's sense of identity and the possible changes that the teacher education programme brings about in this identity. According to Graven (2004:209) the confidence of the learner-teacher has a central role to play when forming this identity. Adding to this new identity as Mathematical Literacy teacher, is the interplay between the context and content that teachers of Mathematical Literacy subjects and courses have to keep in mind and therefore this discussion will now continue with a discourse on context and content.

#### **3.4.1 Context and content**

A distinguishing component of Mathematical Literacy, as new subject in the FET band (grade 10-12) of the South African School curriculum, is the great deal of emphasis that is placed on context. But what is context? The PISA framework (OECD, 2003:32) contains three components *viz.* context, content and competencies. In OECD/PISA documents context refer to situations that are categorised according to their distance from the learner. The closest situation is the personal life of the learner, followed by the learner's school life, work life or leisure, next is public life and furthest is scientific situations. The PISA framework suggests that these contexts can then change from personal to educational/occupational, to public and lastly to scientific, with an accompanying increase in complexity (OECD, 2003:32). These increasing distances can be represented as follow in Figure 3.5:



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Source: OECD, 2003:32

**FIGURE 3.5**      **DIAGRAMMATICAL PRESENTATION OF CONTEXTS FOR OECD/PISA**

Hence, Table 3.12 indicates the centrality of context in the teaching and learning of Mathematical Literacy, based on the inputs by different authors:

**TABLE 3.12 DIFFERENT AUTHORS' INPUTS REGARDING THE CENTRALITY OF CONTEXT IN THE TEACHING AND LEARNING OF MATHEMATICAL LITERACY**

AUTHOR	INPUT
DoE, 2003:42	<i>Contexts are central to the development of mathematical literacy in learners. Mathematical Literacy, by its very nature, requires that the subject be rooted in the lives of the learners.</i>
DoE, 2007:7	Learners need to engage with the contexts rather than applying Mathematics already learned to the context.
Julie, 2006:12	Which contexts to use in Mathematical Literacy is a complex issue. Teachers value those situations from the background of the learners as well as those contexts that are not contradictory to the personal ideology of the teachers, as the most important contexts according to his analysis of the preferred contexts that teachers want to engage in when teaching Mathematical Literacy.
Hendricks, 2006:7	Categorised, among others, culture and sport, entrepreneurship, construction and social responsibility in his study on the motivations of learners for their preferred contexts in which they want to do mathematics.
Kramarski & Mizrachi,s.a.:	<i>Real-life problems are very messy: Real-life tasks are employing real data that are often neither complete nor consistent. The other reasons that make real-life tasks challenging can be listed as follows:</i> <i>It includes complex mathematical data;</i> <i>Provides rich information;</i> <i>Can be approached from different angles;</i> <i>Are based on a wide range of mathematical knowledge and skills;</i> <i>Often requires different representations of the solutions.</i>

Cohen, 2001:	In order to respond to issues there has been an attempt to contextualise school mathematics using contexts which appear to be relevant to the students.
Willis, 1992:	It was hoped that contexts would help students to see the purpose and usefulness of the mathematics they were learning and that the mathematics would make sense. However, despite teachers' best efforts many of the 'real-world problems' appeared contrived rather than real.
Graven and Venkat, 2007:342	Contexts are useful insofar as they provide access to, and/or motivation for learning mathematics and thus in the learning area 'Mathematics', contexts can be contrived in order to meet this purpose.

From Table 3.12 it is clear that context should drive the content and that the everyday numerical situations experienced by the learners should now form the contexts in which learners develop the ability called mathematical literacy. It stands to reason that contexts should be derived from the real-life situations of the learners who are taught Mathematical Literacy. Based on these findings, it is evident that a Mathematical Literacy curriculum is needed that balances the contextual interests preferred by learners with the interests of the relevant curriculum stakeholders.

As can be seen in Table 3.12 there is an emphasis that teachers should try to choose context relevant to the learner's environment, but there is also an acknowledgement that real-life problems are often messy which could cloud the mathematics to be learned or used in the situation.

In a longitudinal study Graven and Venkat (2007:342) designed the following spectrum of agendas that were used by teachers:

**TABLE 3.13 A SPECTRUM OF AGENDAS**

<b>CONTEXT DRIVEN (BY LEARNER NEEDS)</b>	<b>CONTENT AND CONTEXT DRIVEN</b>	<b>MAINLY CONTENT DRIVEN</b>	<b>CONTENT DRIVEN</b>
<p><b>Driving agenda:</b> To explore contexts that learners need in their lives (current and future), work and for critical citizenship.</p>	<p><b>Driving agenda:</b> To explore contexts that learners need in their lives (current and future), work and for critical citizenship.  To deepen math understanding, to learn maths (new or GET) and to deepen understanding of that context.</p>	<p><b>Driving agenda:</b> To learn maths and then to apply it to various contexts.</p>	<p><b>Driving agenda:</b> To give learners a 2<sup>nd</sup> chance to learn the Maths in GET.</p>

Source: Graven & Venkat, 2007:342

Table 3.13 was applied to the empirical data generated in this study to confirm these agendas but also to identify further agendas if and when they existed. Chapter 6 provides more information on the agendas that were identified in the study.

The question arises of how teachers should decide on the contexts that should be used? The following factors complicate this question:

- The language of learning and teaching (LOLT) is English which is the second language of the majority of learners as well as teachers in South African multilingual classrooms (Setati, 2005:75).

- South Africa has come from a past in which imbalances in the previous education system resulted in serious knowledge gaps in many of its citizens (DoE, 2003:9).

### 3.4.2 The distinction between mathematics-for-oneself and mathematics-for-teaching

There is a difference between one's knowledge and skills that constitutes the mathematics-for-oneself and the mathematics-for-teaching. Mathematics-for-oneself refers to the mathematics that a person know and can do while mathematics-for-teaching is about how to compress and detangle mathematics and make it more understandable to the learners.

Davis and Simmt (2006:293) identified four intertwining aspects of teachers' mathematics-for-teaching in a study with 24 in-service teachers. These aspects were discussed using complexity science as framework for their interpretations. The four aspects:

- (i) *mathematical objects;*
- (ii) *curriculum structures;*
- (iii) *classroom collectivity and*
- (iv) *subjective understanding* (Davis & Simmt, 2006:293).

were used in their study to test their second conjecture that:

*these aspects might serve as appropriate emphasis for courses in mathematics intended for teaching* (Davis & Simmt, 2006:293).

Davis and Simmt (2006:316) further caution that "a fluid mastery of how to organise and mobilize social grouping must be accompanied by a strong background in the subject matter". A short summary of what is meant by Davis and Simmt (2006:308) with each of these aspects is provided below:

#### 3.4.2.1 Mathematical Objects

Teachers must have the skills to pry apart concepts, make sense of the similarities, metaphors, images and logical constructs that give shape to a mathematical construct.

#### 3.4.2.2 Curriculum Structures

This involved discussion of the mathematics curriculum with as many as possible teachers across the grades. Davis and Simmt (2006:308) offer the process of recursive elaboration as a more useful way to describe the manner in which mathematical concepts are developed through the curriculum.

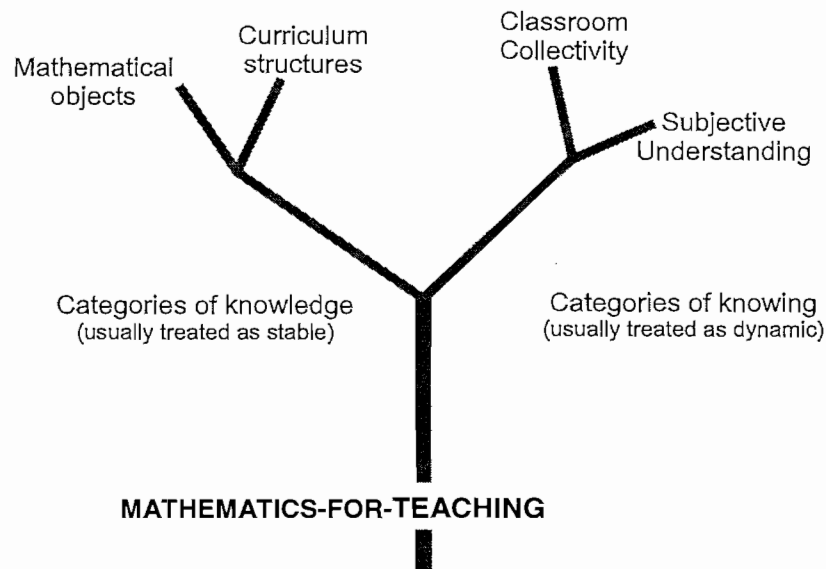
### 3.4.2.3 Classroom Collectivity

Davis and Simmt (2006:309) assert that mathematics-for-teaching cannot be considered a domain of knowledge to be mastered by individuals. It seems to always occur in contexts that involves others.

### 3.4.2.4 Subjective Understanding

This was not an issue that Davis and Simmt (2006:312) focussed on in this stage of their investigation because the explicit emphasis is on the character and production of collective mathematics knowledge.

Figure 3.6 indicates the perceived relationships among the four aspects of teachers' mathematics-for-teaching knowledge:



Source: Davis & Simmt, 2006:298

**FIGURE 3.6 PERCEIVED RELATIONSHIPS AMONG SOME ASPECTS OF TEACHERS' MATHEMATICS-FOR-TEACHING**

### 3.4.3 The relationship between identity and learning mathematics

Solomon (2009) asks a very important question on the back cover of his book, *Mathematical Literacy*: "Why do so many learners, even those who are successful, feel that they are outsiders in the world of mathematics?" For some reason many learners cannot identify themselves with mathematics. In fact, people have the tendency to admit quite readily that Mathematics was never their "strong point".

According to Solomon (2009:86) the development of learner identities reaches a new level of complexity when it comes to entering into university mathematics. The Student Experiences of University Mathematics (SEUM) project (Brown & Macrae, 2005:53) tracked undergraduate mathematics students for three years in two British universities and listed the following aspects as possible factors contributing to this new complexity level which consequently influence the development of an identity:

- Attitude towards mathematics;
- Student adaptation to university life;
- Social and economic background; and lastly
- Educational background.

If, as Sfard (2006:162) suggests, learning mathematics may be defined as “individualizing mathematical discourse, that is, as the process of becoming able to have mathematical communication not only with others, but also with oneself”, we may see learning mathematics as a crucial building block in developing the identity of a mathematical literacy teacher.

### **3.5 SUMMARY AND CONCLUSION**

In conclusion, it is acknowledged that the aspects included and discussed in this chapter are not exhaustive in any way and that much more can be discussed regarding the training of prospective Mathematical Literacy teachers. I must also note that I came across two similar studies (Madongo, 2007; Moodley, 2008); Madongo’s dissertation for the MEd qualification and Moodley’s PhD thesis. What really amazed me were the many similar aspects addressed by us in our studies. Not only did these two studies give me the opportunity to gain a reflective view of my own study but also the opportunity to confirm or challenge their findings, this is done in Chapter 6. Next I will discuss the research methodology and the reasons why I chose this particular type of research methodology.

CHAPTER 4:  
**RESEARCH DESIGN AND  
METHODOLOGY**

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## **4.1 INTRODUCTION**

In Chapter 3, I reviewed the literature pertinent to the study in which I discussed the definitions and views on mathematical literacy as ability and Mathematical Literacy as subject, as well as key areas regarding Mathematical Literacy teacher education in the relevant extant literature.

In this chapter I will portray the design, methods and instruments, as well as motivating the methodologies that were employed in this inquiry. First, I will discuss the primary and philosophical assumptions which framed the theory in this inquiry. Next, I will outline the research approach as a multiple case study, explaining the particular duality of my study in terms of population and sample. Then I will move on to the data collection and how I made use of a computer-aided programme, ATLAS.ti 5.0, to assist me in analysing the data that was collected. Following this, I will offer a preliminary processing of the biographical data and provide a profile of both the South African and the Canadian participants involved in this study. This brings me to a description of the measures I took in an attempt to ensure that this inquiry is trustworthy. Lastly, I will provide the limitations of this study.

## **4.2 THE THEORETICAL FRAMEWORK**

### **4.2.1 Assumptions of the researcher**

According to Borgatti (1999:1), it is impossible for human beings not to have preconceived notions. These notions are fundamental beliefs which make us biased and affect how we look at things. This also forms the theoretical framework and guides us in what we notice, because we do not notice things that do not fit into our framework (Borgatti, 1999:1). With the following assumptions I hope to make my implicit framework explicit, as part of the measures to reduce biasness in this study.

#### **4.2.1.1 Primary assumption**

My primary assumption in this inquiry is based on my perspective of a developed country: I do believe that developed countries have well-researched and established methods of training teachers and, therefore, I assume that South Africa as developing country can benefit from studying how teachers are trained in a developed country like Canada.

#### 4.2.1.2 Philosophical assumptions

As already mentioned in Chapter 1, this study is situated within an interpretive orientation and as such it opens up the opportunity to explore the practises of the participants in terms of their views and experiences in the training programmes in which they were enrolled. My philosophical assumptions, therefore, relate to the epistemology that knowledge can be obtained from the sense-making of the South African and Canadian participants in the study. This sense-making became clear through the written text obtained from questionnaires, transcriptions of focus group discussions and individual interviews, as well as field notes from lesson observations. Boland (1991:18) asserts that the philosophical base of interpretive research is hermeneutics and phenomenology. Interpretive research focuses on the full complexity of human sense-making as the situation emerges (Kaplan & Maxwell, 1994:32).

As researcher I assume that reality can be interpreted in various ways and our understanding depends on subjective interpretations. From the perspective of this theoretical framework I will proceed with the inquiry.

#### 4.2.2 My role as researcher and participant

According to Nieuwenhuis (2007a:79) the *researcher's involvement and immersion in the changing, real-world situation is essential*, because the qualitative researcher have to record those changes in the real-life context. I was both participant and researcher in Canada when I was allowed to attend, along with the students, the course in the teacher training programme which I studied in this inquiry. This allowed me to establish a rapport with the students in Canada, while in South Africa my role as facilitator and coordinator of the programme allowed me to observe certain phenomena pertaining to the study. However, I acknowledge that because I was the lecturer and developer of one of the programmes in this study it might have influenced this inquiry.

### 4.3 THE RESEARCH APPROACH

As a result of my position as interpretivist in this study I aligned myself with the qualitative research approach, because this approach enabled me to establish how participants are making sense of the training programme by analysing the data that was generated from the collection instruments in terms of their experiences, perceptions, attitudes, knowledge, feelings and values. Cresswell (2008:30) is of the opinion that qualitative research methodology is suitable for research questioning that requires the researcher to explore, while Henning *et al.*, (2004:3) explain that a qualitative approach emphasises verbal description and explanations of human behaviour. These statements strengthened my

decision to make use of the qualitative research methodology as opposed to quantitative research methodologies where the data is more rigid. My decision to choose a qualitative rather than a quantitative approach was further inspired by Nieuwenhuis (2007b:99) who asserts that:

*Qualitative data analysis is usually based on an interpretive philosophy that is aimed at examining meaningful and symbolic content of qualitative data.*

#### **4.3.1 The multiple case study**

Within the qualitative research approach I decided on the multiple case study research design, because of the **dual contexts of the study**: This study comprised of two contexts because it occurred at two universities in two countries, namely the Canadian context (registered pre-service teachers at Brock University in Canada) and the South African context (registered in-service teachers at the North-West University in South Africa). According to Leedy and Crmrod (2005:78), in the multiple or collective case study two or more cases are studied in order to make comparisons, build theory or propose generalisations.

According to Merriam (1998:215) the case study design focuses on one phenomenon which the researcher selects to understand in-depth, regardless of the number of sites or participants in the study. I have selected this particular design in order to gain greater insight into, and a deeper understanding of the dynamics of mathematical literacy training programmes as phenomenon. A case study allows researchers to investigate this in-depth understanding of a phenomenon from different perspectives (Merriam, 1998:215; Cohen *et al.*, 2000:181). The case study as research approach in this study enabled me to provide a multi-perspective analysis of mathematical literacy programmes at the universities in South Africa and Canada through an in-depth investigation of small distinct groups at these universities. This was further enhanced by selecting to interview experienced practising teachers whom could shed more light on how mathematical literacy courses are taught in practise in Canada.

#### **4.4 POPULATION AND SAMPLE OF PARTICIPANTS**

The Canadian context comprises of all teacher candidates enrolled in EDUC 8P81, a course in the Mathematics Intermediate/Senior Teacher Education Programme at Brock University in Canada as well as the two practising teachers at two different Canadian schools, while the South African context consists of the in-service teachers who enrolled for the ACE (Mathematical Literacy) Teacher Education Programme in 2008. It is important to note that the classes for the training programme in Canada were offered at Brock University in St.

Catherines as well as at the satellite campus in Hamilton (about 60 kilometres from St. Catherines), while the classes at the North-West University were offered at various centres in the North-West Province in South Africa.

Purposive sampling was employed in this study in line with Nieuwenhuis (2007a:79) who asserts that qualitative research is generally based on non-probability and purposive sampling. It makes perfect sense that purposive sampling should be used for qualitative research studies as the data to be collected must be rich and therefore the participants who provide this rich data should be hand-picked. According to a communication by Merriam (2008), purposive sampling happens when participants are selected because of their knowledge of a certain phenomenon. As researcher I have selected those teachers that were most likely to be knowledgeable and informative about the programme for the focus group discussions and the individual interviews. It must be mentioned, however, that the sample for the questionnaire depended upon which student teachers elected to respond to the questionnaire as it was handed out to all the pre-service and in-service teachers who were registered in the two teacher education programmes involved.

#### **4.4.1 The Canadian population and sample**

The Canadian population consisted of the eight teacher students at Brock University and the twenty-two teacher students at Hamilton Campus who were registered for the training programme. For the Canadian sample I invited those student teachers who were placed in the Applied Mathematics classes or the Mathematics for Work and Everyday Life course during their teaching block, and selected four of them for the individual interviews. During the first focus group discussion I included all eight student participants at Brock Campus and purposively selected eight student teachers from the twenty-two student teachers at Hamilton Campus for the second focus group discussion in Canada. The main criterion for this purposive sampling was the ability to speak up easily. The researcher made sure, however, that there was proportional gender representation in both groups: It must be noted that there were more women than men in the Canadian population for this study. Choosing participants with varied experiences increases the possibility of shedding light on the research question from a variety of perspectives (Patton, 1987:25; Adler & Adler, 1988:33). For this purposes two practising experienced Canadian teachers with sound mathematical knowledge bases were also recruited to take part in the study. These experienced teachers did not complete the training programme and the main aim with these interviews was to obtain a view on what is currently happening in the Applied and the Mathematics for Work and Everyday Life classes in Canadian schools.

#### 4.4.2 The South African population and sample

The population in South Africa was the 186 in-service teachers who registered for the ACE in Mathematical Literacy at the North-West University in 2008. I informed these teachers about the study at the beginning of the programme in 2008 and subsequently contacted and informed the teachers about an information session that would be held at the university. The teachers were invited to this information session during which the study was explained and an opportunity for questions about the study was provided. Four volunteers were purposefully selected for the focus group discussions. The criteria for selection were twofold:

- (i) A good attendance rate of the contact sessions; and
- (ii) Teaching Mathematical Literacy at the time of the study.

Not all the teachers who completed the programme successfully were teaching the subject in schools.

### 4.5 DATA COLLECTION IN SOUTH AFRICA AND CANADA

#### 4.5.1 The phases of data collection

As mentioned previously (see 4.3.1), this is a multiple case study and therefore I made use of multiple data collection instruments to explore the practices of the teachers. This includes attending the classes at Brock University and the facilitation at the North-West University in South Africa in order to spend more time on-site with the participants. Leedy and Ormrod (2001:150) assert that:

*In many instances, the researcher may spend an extended period of time on-site and interact regularly with the people who are being studied.*

I related to the following five phases which Macmillan and Schumacher (2006:212) identified as the qualitative phases of data collection and analyses:

**Phase 1: Planning:** This phase took place when I travelled to Canada and met with the students and their instructor in the training programme. During this stage I was introduced to the students as part of the class and I applied for ethics clearance for my study at the Research Ethics Board (REB) of Brock University.

**Phase 2: Beginning data collection:** This stage marked my first days of attending class in which I build a rapport with the students. I became aware of the fact that getting participants for my study might not be as easy as the students were very busy. It therefore became increasingly important that I establish relationships with the students and gain their trust so that I could ensure participants for my study. In order to achieve this I had to be seen as a

member of the class group and, just like the rest of the class, presented a lesson utilising some form of technology.

**Phase 3: Basic data collection:** During this third stage I started to make preliminary observations during the classes and continually made new decisions and adjusted existing ones regarding instrumentation for the study. One example of this was that I decided to also include experienced practicing teachers in the study in order to gain a deeper insight of what actually occurs in the class room.

**Phase 4: Closing data collection:** This stage occurred during the last days of my four month visit to Canada. The last interview was conducted on the 15<sup>th</sup> of December 2008 with one key informant. I gave more attention to possible interpretations and could verify these during my last interview.

**Phase 5: Completion:** This stage occurred in South Africa during which I constructed meaningful ways to present the data. I had to adjust the questions in all the instruments because of the differences that existed between the programmes and participants in the two countries. Data collection in South Africa was much easier because I am familiar with the country, the procedures of ethics applications and the research processes that need to take place. Table 4.1 indicates the different instruments that were used for data collection in the South African and Canadian context of this study.

**TABLE 4.1 DATA COLLECTION INSTRUMENTS USED IN SOUTH AFRICA AND CANADA**

<b>INSTRUMENTATION</b>	<b>SOUTH AFRICA</b>	<b>CANADA</b>
Questionnaires	X	X
Lesson Observation		X
Individual Interviews		X
Focus group discussions	X	X
Participatory Observation	X	X
Field notes	X	X
Interviews with practising teachers		X

#### **4.5.2 Questionnaires**

Although the questionnaire is an instrument usually employed in quantitative studies, it was employed in this qualitative study to provide initial information to inform the questions that were used in the interviews and focus group discussions. The questions for the questionnaire were set up in three sections viz. (i) background information - in order to obtain some biographical data on the participants, (ii) mathematics content - that portrays the

mathematics competency level of the participants and (iii) didactics - which shed more light on teaching preferences and the implementation of the curriculum by the participants. These questions were further informed by the existing literature about mathematical literacy training programmes in South Africa, but also mathematics teacher education programmes globally. The questions were designed to probe participants' perceptions and experiences in the training programme.

#### 4.5.2.1 Completion of the questionnaires in Canada

At Brock University all the volunteers who agreed to participate by only completing the questionnaire filled out a detailed (one-hour open-ended) questionnaire regarding their perspectives of mathematical literacy and their views on the training programmes, as well as their learning both in terms of mathematics and mathematics didactics. After informing the students about the study, inviting them to take part and giving them the consent forms, the questionnaires were e-mailed to the volunteer student participants. The student participants could then voluntarily answer the questionnaire in their own time. Completed questionnaires could be e-mailed back to me or handed to me in hard copy format in an envelope that was placed in a box which was made available to the student participants. During class or via e-mail I continuously reminded the student participants about the questionnaire.

#### 4.5.2.2 Completion of the questionnaires in South Africa

I initiated the process with an information session held with the current teacher students enrolled in the programme during the holiday school which were part of the face-to-face contact time in the programme. I altered the original population, which would have been teacher students who already finished the programme, to teacher students currently enrolled in the programme because of practical reasons and accessibility to the students. The new population was the 2008 intake who already had completed one year of the required two years of the qualification. I informed the teacher students about the study and invited them to take part. I also explained that the data will be anonymous. On completion of the consent forms I gave all the teacher students the questionnaires to complete during the holiday contact session. They had one hour to complete the questionnaire on their own and then hand it in.

### 4.5.3 Focus group discussions

#### 4.5.3.1 Introduction

The use of focus group discussions and the possibilities for application thereof in academic research gained popularity in the late 1960's and is a popular data collection instrument

employed by qualitative researchers (Bloor *et al.*, 2001:124). Researchers (Kitzinger, 1994:103; Nieuwenhuis, 2007a:90) agree that the focus group is a technique that involves the use of in-depth group interviews in which the participants are selected because they are a purposive sample, and not necessarily representative of a specific population. One of the disadvantages of focus group discussions is that the sample is typically small and not representative (Nieuwenhuis, 2007a:91).

I selected the five focus groups that took part in this study based on the criteria that they would have something to say on the topic, are within a certain age range (for example the group of students in Canada within the age group 20 – 24 were grouped together) and have similar socio-characteristics (for example in the one focus group in South Africa white teachers were grouped together so that they would be comfortable talking to the interviewer and to each other).

A focus group interview can easily be confused with a group interview. Nieuwenhuis (2007a:90) differentiates between the two by asserting that a group interview takes place when a group of participants are asked a set of questions without debating and arguing about the responses being generated, while in the focus group interview debate and even conflict are encouraged and group dynamics form part of the data that is generated while focussing on a particular topic. The opportunity to build on each other's ideas and comments is one characteristic that cannot be obtained with individual interviews and as such it is a big advantage of the focus group interview. All the discussions were audio-taped by me, but transcribed by a research assistant to reduce biasness. A copy of the transcription was sent to each focus group discussion participant by e-mail to member-check.

#### 4.5.3.2 Conducting focus group discussions in Canada

As researcher I met with two groups of eight student teacher participants each in Canada for one-hour focus group discussions to get their views on the curriculum. Initially these focus group discussions seemed impossible to arrange due to the students being involved in examinations at the time. According to Nieuwenhuis (2007a:90) conducting only one focus group discussion is not advisable because you are seeking alternative perspectives. A total of five focus group discussions were held in the two countries. Two focus group discussions were held in Canada, one at each of the two campuses where the programme is offered. The first focus group discussion with eight student teacher participants was conducted during a cancelled class session at Brock University while the second focus group discussion, also with the eight student teacher participants, was conducted at the Hamilton campus in Canada.

#### 4.5.3.3 Conducting focus group discussions in South Africa

At the North-West University I made arrangements with three groups of students to take part in the focus group discussions. The first group was made up of all the Afrikaans teacher students of the 2008 intake who were teaching Mathematical Literacy and consisted of three teachers, this discussion lasted for about 40 minutes. The second group consisted of six teachers with the third and last group made up by only five teachers. All the participants that took part in the focus group discussions in South Africa had to be teachers in the programme who were teaching Mathematical Literacy at the time in their schools.

#### 4.5.4 Interviews

A total of six individual interviews were conducted in Canada. All the interviews were audio-taped and transcribed by me and were sent for member-checking to the participants who were involved in the interviews in an attempt to enhance the trustworthiness of the study.

##### 4.5.4.1 Interviewing participants in Canada:

- (i) Interviews with participants: Individual interviews with four participants were conducted to mirror some reflections on the teaching of Applied Mathematics and Mathematics for Work and Everyday Life. In Canada I arranged via e-mail to meet with the participants who I selected for the interviews, either before or after class. The Canadian participants for the individual interviews were selected based on the criteria that they had to give a lesson in Applied Mathematics or Mathematics for Work and Everyday life during their teaching block. The individual interviews lasted approximately half an hour each.
- (ii) Interviews with practising teachers: Interviews with two practicing teachers who were teaching the courses in Canada were included to gain an expert view on the teaching of these courses. The input from one of these teachers was especially valuable to this study as she was seconded to work for the Ontario Ministry of Education for two years which enabled her to gain a deeper understanding of policy documents and structures within the Ministry.

##### 4.5.4.2 Interviews in South Africa:

I cancelled the individual interviews with the teachers because when I started to analyse the data, I realised that it was already saturated.

## **4.5.5 Lesson observation**

### 4.5.5.1 Canada

Three lesson observations were done while I was in Canada. I could, however, only manage one lesson observation of the student teacher participants in Canada. This was due to the fact that the teaching block for the students was almost over by the time I received ethical clearance from the Brock University Ethics Committee. To increase the amount of data obtained from lesson observations two lessons by the two experienced practising teachers were also observed at another school.

### 4.5.5.2 South Africa

In South Africa there were no lesson observations done because I decided that the data collected was already saturated. Another reason was that I am familiar with the South African situation and data (taken down as field notes) could be obtained from the participants who were also the students during contact classes held as part of the Advanced Certificate in Education (Mathematical Literacy) programme.

## **4.5.6 Participatory observation**

### 4.5.6.1 Canada

I attended class sessions in Canada to gain in-depth knowledge of study material and methods applied in the training programme with a particular focus on the mentioned courses. The instructor of the education programme in Canada granted me permission to attend the classes. I was able to gain deeper insight into the classes as well as build a rapport with the students.

### 4.5.6.2 South Africa

As mentioned earlier in this study, I am also a facilitator in the Advanced Certificate in Education in Mathematical Literacy programme which allowed me to observe the classes on a continuous basis. These observations were written down in the form of field notes.

**TABLE 4.2 INDICATION OF HOW THE QUESTIONS THAT WERE USED IN THE STUDY ADDRESSED THE RESEARCH QUESTIONS**

QUESTION-NAIRE	WHAT IT ADDRESSED	INDIVIDUAL INTERVIEWS	WHAT IT ADDRESSED	FOCUS GROUPS	WHAT IT ADDRESSED	INTERVIEWS PRACTISING TEACHERS	WHAT IT ADDRESSED
3, 4	Concept of mathematical literacy and mathematical literate person	1	Experiences form lessons taught by student teachers	1	Similarities and differences between Mathematics and ML (SA) and Math for Work and Everyday Life and Academic Maths(Can)	1	Attitude of learners toward Applied/Math for Work and Everyday life
5	Motivation to enrol in programme	2	Context that was used	2	SA: Examples of times in teaching when deficiencies in the training programme was experienced; Can: Need for programme with specific focus on Applied/Math for Work and Everyday Life	2	Similarities and differences in teaching between Mathematics and ML (SA) and Math for Work and Everyday Life and Academic Maths(Can)
6, 7	Expectations for the programme	3	Reason for using particular context	3	Opportunities for learning experienced during the course/programme	3	What teaching approaches are employed in teaching ML(SA) and Applied/Math for Work and Everyday Life(Can)
8	Mathematical background/other teachable subject(Canada)	4	Use of study material in preparing lesson	4	Challenges experienced during course/programme	4	Choice of context in teaching ML(SA) and Applied/Math for Work and Everyday Life(Can)
9	Impact of Mathematics component in programme	5	Mathematics in context			5	Content drive context or visa versa
10	Impact of Didactics component/other teachable subject(Canada) in programme	6	Evidence to assess success of lesson			6	Use of curriculum documents in preparing lessons

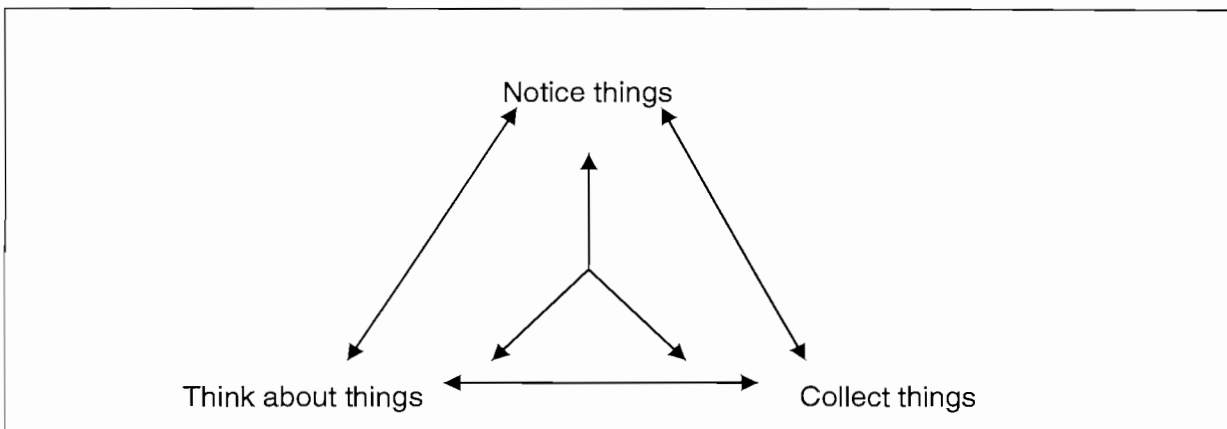
**TABLE 4.2 INDICATION OF HOW THE QUESTIONS THAT WERE USED IN THE STUDY ADDRESSED THE RESEARCH QUESTIONS  
(CONTINUED)**

QUESTI ON- NAIRE	WHAT IT ADDRESSED	INDIVID UAL INTERVI EWS	WHAT IT ADDRESSED	FOCUS GROUPS	WHAT IT ADDRESS ED	INTERVIEWS PRACTISING TEACHERS	WHAT IT ADDRESSED
11	Experience in teaching Mathematics/Mathematical Literacy. Canada: experience of course and mathematics in different faculties	7	Teaching approaches employed in lesson			7	Importance of solid Math background
12	Impact of programme on teaching Mathematical Literacy	8	Reason for using this particular teaching approach			8	Need for programme with specific focus on Applied/Mathematics for work and Everyday Life
13, 14	Experiences in programme that informed teaching	9	Covering of expectations in lesson			9	Teaching and learning resource material used in teaching Mathematical Literacy(SA) and Applied/Mathematics for Work and Everyday Life(Can)
15	How Curriculum documents informed teaching	10	Content driving context or visa versa in lesson			10	Opportunities for learning experienced during teaching Mathematical Literacy(SA) and Applied/Math for Work and Everyday Life(Can)
16	Other resources in the teaching of Mathematical Literacy	11	Focussing explicitly on math processes in lesson or not			11	Challenges experienced in teaching Mathematical Literacy(SA) and Applied/Math for Work and Everyday Life(Can)
17	Impact of study material/references in programme on teaching Mathematical Literacy	12	Opportunities for learning experienced in lesson teaching Mathematical Literacy(SA) and Applied/Math for Work and Everyday Life(Can)			12	Components of an effective Mathematical Literacy teacher training programme
18	Experiences regarding mathematical processes in programme	13	Challenges experienced in lesson teaching Mathematical Literacy(SA) and Applied/Mathematics for Work and Everyday Life(Can)				
19	Comments on English as teaching language for Mathematical Literacy						
20	Other questions regarding programme						

## 4.6 THE DATA ANALYSIS PROCESS

In qualitative research the danger that the researcher's own belief systems or bias can cloud the analysis of the data becomes very real. This danger could not be more pertinent than in this particular study because of my dual roles as both researcher and facilitator in the ACE programme at the North-West University in South Africa. It was therefore imperative that this study should be conducted by following a structured data analysis process.

I made use of what Nieuwenhuis (2007b:99) refers to as an "iterative" (non-linear) process. According to Nieuwenhuis (2007b:99) this process implies that data collection, processing, analysis and reporting are intertwined. Figure 4.1 shows the model that illustrates this process:



Source: Nieuwenhuis, 2007b:100

### FIGURE 4.1 THE DATA ANALYSIS PROCESS

The model in Figure 4.1 consists of three very important elements: noticing, collecting and reflecting. My aim was always to interpret and make sense of what I have heard, seen and read in terms of commonly used words, phrases, themes or patterns, both in the Canadian context and in the South African context.

#### 4.6.1 Processing the data

Before I could start with any analysis of the data, the raw data had to be converted into a form which I could then make sense of. I started this process during the last days of my visit in Canada by transcribing the six individual interviews. The reasons for transcribing these interviews myself were two-fold: Firstly, I wanted to gain some experience in transcribing and secondly, I wanted to get as well-acquainted with the data as possible. The only disadvantage to transcribing the interviews myself is that I could have been biased in the

transcribing process. This was combated by e-mailing the transcribed interviews to the participants who were involved to member-check the transcriptions. All the participants indicated that they were satisfied the transcripts were a true reflection of the interviews. The transcription of the five focus group discussions was done *verbatim* in order to reduce biasness and enhance the trustworthiness of the study. I asked an independent person, a research assistant who was trained in research activities, to assist with this task. After the focus group discussions were transcribed, I went through it in order to verify its accuracy.

I then typed up the responses to the questions from all 61 questionnaires that I received back from the South African participants. This resulted in a MS Word document of 33 pages. Thereafter, I studied the 12 questionnaires sent back to me by the Canadian participants via e-mail and arranged the responses to the questions also as a 29-page MS Word document.

Lastly, I edited the field notes taken down by me during the two lesson observations in the schools I visited in Canada and the two lesson observations of the course in the Mathematics teacher education programme at Brock University which I was allowed to attend. At this stage I had 17 sets of data and realised that I needed some assistance with the analysis of this large amount of data. I decided to employ ATLAS.ti 5.0, a computer-based system that is used to analyse qualitative data.

Attending two workshops on ATLAS.ti 5.0 for four afternoons enabled me to utilise the system in order to structure the data into a coherent whole. According to Muhr and Friese (2004:3), not only does the ATLAS.ti 5.0 system offer a variety of tools to manage, extract, compare, explore, and reassemble meaningful pieces with immediate search and retrieval functions from large amounts of unstructured data, but it also has a network feature that displays the arrangement of meaningful data. This was also my experience because initially I had no clue as to how to go about the analysis of the large amount of data I collected for this inquiry.

All 17 MS Word documents were then loaded into the Hermeneutic Unit of the ATLAS.ti 5.0 system which I labelled: *Final analysis of exploring the practises of teachers in South Africa and Canada*. Muhr and Friese (2004:3) appropriately refer to the Hermeneutic Unit as the “container of meaning”.

#### **4.6.2 Content analysis**

According to Nieuwenhuis (2007b:101) this strategy is used in the analysis of such things as books, brochures, written documents, transcripts, news reports and also qualitative responses to open-ended questions in surveys, interviews or focus groups. *In this study I was able to utilise this strategy when I studied curriculum documents from South Africa and*

Canada, transcriptions of interviews, focus group discussions and responses to the open-ended questions from the questionnaire.

### 4.6.3 Analysing with ATLAS.ti 5.0

Next I will give explanations of those concepts used in my study to enhance the understanding of how ATLAS.ti 5.0 has been applied to the analysis of the data in this study.

#### (i) Terminology

**Hermeneutic Unit (HU):** This can be called the 'heart' of ATLAS.ti 5.0. From here all the functions of the ATLAS.ti 5.0 system can be accessed. Primary documents are stored in the HU by assigning text, graphical, audio, and/or video materials to the HU. I made use of only text in this inquiry.

**Category:** A category is an answer to the question "What?" which can be seen as a thread throughout certain codes (Krippendorff, 1980:17).

**Sub-category:** A cluster of codes with a common thread that runs through them. It has the same function as the code family.

**Code:** Codes are used as classification devices at different levels of abstraction in order to create sets of related information units for the purpose of comparison. A standard code is directly linked to the quotations with which it is associated. (Muhr & Friese, 2004:32).

**Super Code:** *A Super Code is a query that typically consists of several combined codes.* (Muhr & Friese, 2004:32.)

**Memos:** *Memos capture thoughts regarding the text and are an important device for creating theory. A 'memo' is similar to a code, but usually contains longer passages of text.* (Muhr & Friese, 2004:32.)

**Families:** *Families are a way to form clusters of PDs, codes, and memos for easier handling of groups of codes, memos, and PDs.* (Muhr & Friese, 2004:33.)

**Primary document:** Primary Documents (PDs) are the interface between a Hermeneutic Unit (HU) and the data and provide access to data

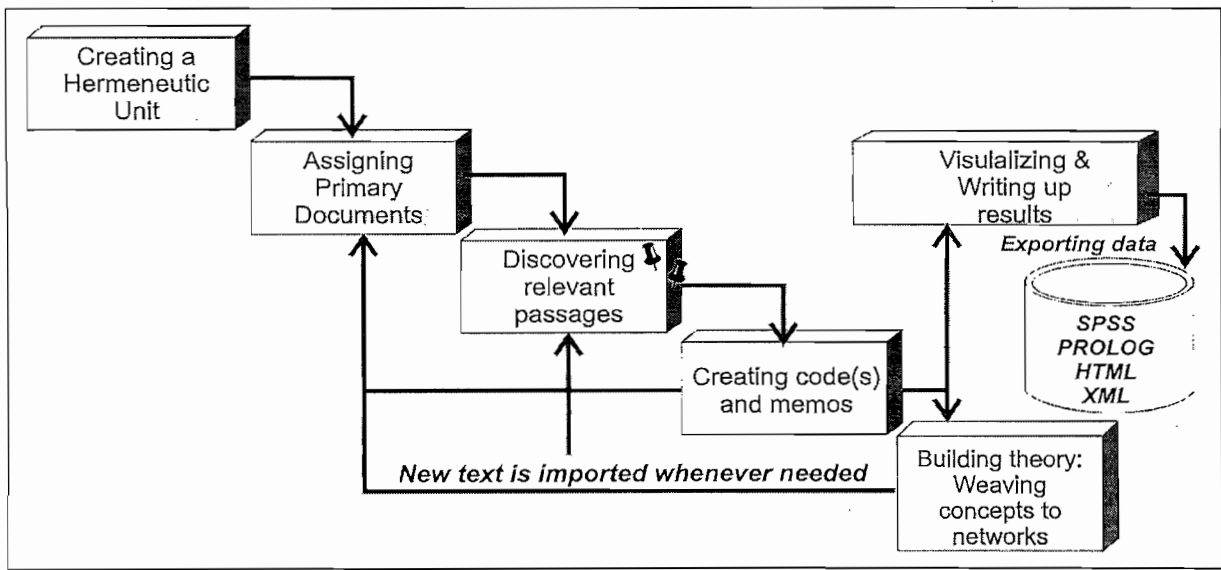
sources, which are usually for example, word files of transcribed interviews, focus group discussions and field notes of lesson observations. PDs represent the text, graphical, audio, and/or video materials that must be analysed. The content of PDs is usually stored in data files on the computer. This study only made use of text.

Quotation: *A quotation is a segment from a PD that is interesting or important to the user. (Muhr & Friese, 2004:30.)*

Network view: A visual diagram that connects sets of similar elements together in which relationships between codes, quotations, and memos are displayed (Muhr & Friese, 2004:30).

**(ii) Outline of the ATLAS.ti 5.0 analysis process in this inquiry**

Figure 4.2 illustrates the steps that might be followed for successful data analysis with ATLAS.ti 5.0.



Source: Muhr & Friese, 2004:25.

**FIGURE 4.2 THE ATLAS.TI 5.0 WORKFLOW**

**Step 1: Open new Hermeneutic Unit (HU):** I started this process by opening up a Hermeneutic Unit (HU) and named it: *Analysis of exploring the practises of teachers in South Africa and Canada.*

**Step 2: Assigning Primary Documents (PDs):** I then assigned each of the transcriptions of the five focus group discussions as well as the transcribed

individual interviews as word documents to the new HU, as well as the two word documents that consisted of the responses from the South African participants and the responses from the Canadian participants.

- Step 3: Discovering relevant passages:** After I read through the transcriptions three times I highlighted all the passages that contained meaning for me and were relevant to my study.
- Step 4: Creating codes and memos for the relevant passages:** The key areas that were discussed in Chapter 3 (Table 3.1) guided my selection of codes and memos. I developed 279 codes and created 14 memos in total for this inquiry.
- Step 5: Building theory: Weaving concepts to networks:** Next I used the codes and memos to first create family codes (sub-categories), which I could then use to extract the categories and which in turn were used to create the emerging themes and represented these with relations to carefully weave each network.
- Step 6: Visualising and writing up results:** The networks were then exported as graphic files and saved in a folder in order to insert it in Chapter 5 where the data was reported and relations were explained. In Chapter 6 these networks were used to display the themes, which could be supported by data from the questionnaires and field notes. These networks and themes were then discussed using triangulation and written up as the final findings of the inquiry. Table 4.3 illustrates how I constructed one of the themes that emerged from analysis by ATLAS.ti 5.0.

**TABLE 4.3 EXAMPLE OF THEME-CONSTRUCTION FROM GENERATED DATA OF THE FOCUS GROUP DISCUSSIONS**

<b>THEME</b>						
<b>DEVELOPING A 'NEW STATUS IDENTITY' AS MATHEMATICAL LITERACY TEACHER</b>						
<b>Category</b>	Changes relating to the teachers themselves			Changes relating to subject Mathematical Literacy		
<b>Subcategory</b>	Programme boosted confidence	Programme enhanced understanding of Mathematics	Programme helped participant to help himself	Programme enhanced teaching approach	Problem-solving skills of Mathematics teacher improved by programme	Change in teaching perception
<b>Codes</b>	Confidence Positive Real life situation Good Programme enable teacher to overcome fear	Enhanced Mathematics knowledge Enrichment Mathematics competencies	Acknowledgment knowledge gaps Skills gaps Helped with context to content	Enhanced Teaching approach Approaching ML was challenging before programme	Problem solving More meaningful	Change Teaching perception Pedagogical knowledge Used to focus more on Mathematics

## 4.7 BIOGRAPHICAL DATA

In order to provide a picture of the kind of participant involved in this study descriptive statistics was employed in an attempt to represent the biographical data that was collected. According to Pietersen and Maree (2007:183) the term “descriptive statistics is a collective name for a number of statistical methods that are used to organise and summarise data in a meaningful way”. Although numerical methods of presenting data is usually associated with quantitative studies, Pietersen and Maree (2007:183) claim that it is also a method in which qualitative or categorical data can be described. In this data-reporting and data-analysis endeavour I utilised descriptive statistics mainly to paint a clear picture of the Canadian and South African participants in this study in order to bring about greater understanding of the inquiry as a whole.

**South Africa:** I received 61 completed questionnaires back from 93 teachers who attended the ACE programme. The response rate was therefore a satisfactory 65,6%.

**Canada:** I received 12 completed questionnaires back out of a total of 30 registered pre-service teachers via e-mail. This makes the response rate only 46,67% but can be understood in the light of the fact that these students were busy preparing for their end of term tests.

The answers from the close-answer type of questions were used as biographical data to form profiles of both the South African participant and the Canadian participant in the study.

### 4.7.1 The profile of the South African participants

#### 4.7.1.1 Age of the South African participants

The biographical data collected through the questionnaires indicated that the South African participants in this study fell mostly within the 30 – 39 age group (38 out of 61). This close-question was not answered in two of the questionnaires. Table 4.4 provides a numerical way of summarising the situation regarding the age of the South African participant by way of a frequency distribution.

**TABLE 4.4 AGE OF SOUTH AFRICAN PARTICIPANTS**

CATEGORY	FREQUENCY	PERCENTAGE
20-29 years of age	0	0
30-39 years of age	38	62,2
40-49 years of age	19	31,1
40-49 years of age	1	1,5
No response	2	5,2
<b>Total</b>	<b>61</b>	<b>100,0</b>

#### 4.7.1.2 Gender of the South African participants

Responses on the gender of the participants in the questionnaire support the tendency in distance education (see 2.2.4) that more women than men enrol in training programmes. This phenomenon is clearly illustrated in Table 4.5: the majority of the in-service teachers (51 out of 61) in the Advanced Certificate in Education (Mathematical Literacy) teacher education programme who participated in the study, was female.

**TABLE 4.5 GENDER OF THE SOUTH AFRICAN PARTICIPANTS**

GENDER	MALE	FEMALE	TOTAL
<b>NUMBER OF PARTICIPANTS</b>	10	51	61

#### 4.7.1.3 The language proficiency of the South African participants

The frequency distribution in Table 4.6 indicates that the South African teachers in the Advanced Certificate in Education (Mathematical Literacy) teacher education programme who participated in this study were mostly multilingual as 68,8% (19,6% + 49,2%) speaks at least three languages *viz.* Setswana, English, Afrikaans, with Setswana as their mother tongue.

**TABLE 4.6 THE LANGUAGE PROFICIENCY OF THE SOUTH AFRICAN PARTICIPANTS**

<b>CATEGORY</b>	<b>FREQUENCY</b>	<b>PERCENTAGE</b>
Setswana, English, Afrikaans and other	12	19,6
Setswana, English and Afrikaans	30	49,2
Setswana and English or Afrikaans and English or Setswana and Afrikaans	15	24,6
Setswana only or English only or Afrikaans only	4	6,6
<b>TOTAL</b>	<b>61</b>	<b>100,0</b>

4.7.1.4 The mathematical background of the South African participants

Responses on the close-question concerning the school level Mathematics education of the South African participants are represented in Table 4.7.

**TABLE 4.7 SCHOOL MATHEMATICS EDUCATION OF THE SOUTH AFRICAN PARTICIPANTS**

<b>CATEGORY</b>	<b>FREQUENCY</b>	<b>PERCENTAGE</b>
Mathematics up to grade 12 and have passed it	23	37,7
Mathematics up to grade 12 and have failed it	17	27,9
Mathematics up to grade 10 only	7	11,5
Mathematics up to grade 9 only	10	16,4
Did not answer question	4	6,5
<b>TOTAL</b>	<b>61</b>	<b>100,0</b>

Four of the South African participants in the study did not select any one of the options that was given in this question. It might be that each of these participants did not want to disclose the fact that he/she did not have grade 12 Mathematics on his/her Senior Certificate. As Table 4.7 indicates, only 37,7% of the South African participants took Mathematics until grade 12 and passed it. This means that 55,8% (excluding the four participants who did not respond to this question) of the in-service teachers who took part in this study do not have grade 12 Mathematics on their Senior Certificate.

#### 4.7.1.5 Teaching Mathematical Literacy or/and Mathematics at school

The responses from the questionnaire whether the participants are teaching Mathematical Literacy at school or not, revealed some interesting cases. It seems as if the majority of the participants (60,7%) did not teach Mathematical Literacy at the school where they were working. The data collected yielded Table 4.8:

**TABLE 4.8      TEACHING OR NOT TEACHING MATHEMATICAL LITERACY AT SCHOOL**

<b>CATEGORY</b>	<b>FREQUENCY</b>	<b>PERCENTAGE</b>
Teaching Mathematical Literacy at school	14	22,9
Teaching Mathematical Literacy and Mathematics at school	10	16,4
Not teaching Mathematical Literacy or Mathematics at school	33	54,1
Teaching Mathematics at school	4	6,6
<b>TOTAL</b>	<b>61</b>	<b>100,0</b>

#### 4.7.1.6 Portrait of the South African participant in the study

An analysis of the biographical data collected from the close-questions in the questionnaires painted the following portrait of the South African participant:

The typical South African participant in this study is a woman aged between 30 and 39 years who is trilingual with Setswana as mother tongue, who did not pass grade 12 Mathematics at school and was trained as pedagogical generalists with some other-than-Mathematics subject as specialisation. She has a general orientation of teaching and no methodological knowledge of Mathematics, but does have a broad background in general education and

pedagogy. Lastly, this participant was not teaching Mathematical Literacy at the time of the study.

#### 4.7.2 The profile of the Canadian participants in the study

##### 4.7.2.1 Age of the Canadian participants

Table 4.9 shows that the Canadian participants were mostly in their twenties, with only one participant in his/her thirties:

**TABLE 4.9 AGE OF THE CANADIAN PARTICIPANTS**

CATEGORY	FREQUENCY	PERCENTAGE
22 years of age	4	25,0
23 years of age	3	33,4
24 years of age	1	8,3
25 years of age	2	16,7
28 years of age	1	8,3
35 years of age	1	8,3
<b>TOTAL</b>	<b>12</b>	<b>100,0</b>

##### 4.7.2.2 Gender of the Canadian participants

Responses from the completed questionnaires indicated that two thirds of the Canadian participants in the study were female. This is the same tendency as in the South African context *viz.* that more women than men are involved in training programmes (4.2.2). Table 4.10 illustrates this tendency:

**TABLE 4.10 GENDER OF THE CANADIAN PARTICIPANTS**

GENDER	MALE	FEMALE	TOTAL
No of participants	4	8	12

#### 4.7.2.3 The language proficiency of the Canadian participants

The frequency distribution in Table 4.11 indicates that the Canadian pre-service teachers in the Mathematics teacher education programme who participated in this study were mostly bilingual with English as the dominant language.

**TABLE 4.11 THE LANGUAGE PROFICIENCY OF THE CANADIAN PARTICIPANTS**

<b>CATEGORY</b>	<b>FREQUENCY</b>	<b>PERCENTAGE</b>
English only	5	41,7
French only	0	0
English and French	5	41,7
English and Other (Polish)	2	16,6
<b>TOTAL</b>	<b>12</b>	<b>100,0</b>

#### 4.7.2.4 The mathematical background of the Canadian participants

The mathematical backgrounds of the Canadian participants were fairly good as these teachers all have grade 12 Mathematics. The National Council of Teachers of Mathematics in Canada (2000:288) asserts that:

*All students are expected to study mathematics each of the four years that they are enrolled in high school, whether they plan to pursue the further study of mathematics, to enter the workforce, or to pursue other post-secondary education.*

Different courses that were offered as part of Mathematics teaching (Table 2.4) could be taken depending on the future plans of students. The close-question regarding Mathematics as first or second teachable yielded responses from the Canadian participants that are represented in Table 4.12:

**TABLE 4.12 TEACHABLES OF THE CANADIAN PARTICIPANTS**

<b>CRITERIA</b>	<b>FREQUENCY</b>	<b>PERCENTAGE</b>
Mathematics as major (first) teachable subject	8	66,7
Mathematics as minor (second) teachable subject	3	25,0
No response	1	8,3
<b>TOTAL</b>	<b>12</b>	<b>100</b>

The majority (66,7%) of the participants indicated Mathematics as their first teachable subject. This means that Mathematics is one of the two subjects of specialisation.

4.7.2.5 Preferences of teaching Mathematics school courses by Canadian participants

The question instructing Canadian participants to indicate their preferences in regards to teaching the different types of school courses (see 2.5) on a five-point Lickert scale using numbers 1 (most likable course) to 5 (least likable course), yielded an interesting spread of preferences. It must be noted that five participants did not respond to this question. As can be seen in Table 4.13 only 1 participant indicated the Applied Mathematics course (grade 9 and 10) as most likable course, while only 2 participants indicated the Mathematics for Work and Everyday Life course (grade 11 and 12) as most likable course.

**TABLE 4.13 PREFERENCES OF THE CANADIAN PARTICIPANTS**

<b>CRITERIA</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Applied Mathematics courses</b>	1	1		3	3
<b>Academic Mathematics courses</b>	2	4	1		2
<b>Mathematics for Work and Everyday Life courses</b>	2	1		2	3
<b>University bound Mathematics courses</b>	2	2	1	1	2
<b>College Mathematics courses</b>		1	5		

#### 4.7.2.6 Portrait of the Canadian participant in the study

The biographical data collected from the close-questions in the questionnaires paints the following portrait of the Canadian participant:

The typical Canadian participant in this study is a bilingual (English and French) female in her early twenties who mostly speaks English, has a good mathematical background, is well trained in Mathematics as subject, but does not prefer to teach the Applied Mathematics course or the Mathematics for Work and Everyday Life course.

## 4.8 TRUSTWORTHINESS

### 4.8.1 Aspects of trustworthiness

A review of the literature led me to understand that the description of trustworthiness differs in the quantitative and the qualitative research traditions. It seems as if the concepts **validity, reliability and generalisability** are more appropriate in regards to quantitative studies. These concepts change to **credibility, dependability and transferability** in the case of qualitative studies (for example Lincoln & Guba, 1985:299; Patton, 1987:24). Graneheim and Lundman (2004:109) assert that these aspects of trustworthiness are interrelated. Table 4.14 indicates the measures that were taken to ensure the trustworthiness of this study.

**TABLE 4.14 ASPECTS OF TRUSTWORTHINESS AND HOW IT WAS ENSURED IN THIS INQUIRY**

<b>ASPECT</b>	<b>DEFINITION</b>	<b>ACTION IMPLIED BY DEFINITION</b>	<b>DESCRIPTION OF ACTION BY RESEARCHER</b>
Credibility	<p><i>Credibility deals with the focus of the research and refers to the confidence in how well data and processes of analysis address the intended focus.</i> (Graneheim &amp; Lundman, 2004:109.)</p>	<p>This implies selecting the most:</p> <ul style="list-style-type: none"> <li>(i) appropriate method for data collection and amount of data;</li> <li>(ii) suitable meaning unit;</li> </ul> <p>It also deals with how well categories and themes cover data and how similarities within and differences between categories were judged.</p>	<p>I am confident that I have made the correct decisions in terms of the selection of participants, approach and design, as well as the methods for data collection and analysis to address the focus which is the exploration of the practises of teachers in mathematical literacy training programmes in South Africa and Canada.</p> <p>The questions for the different data collection instruments were given to a colleague in the Mathematics department of our faculty to give her inputs.</p> <p>I also requested another knowledgeable person in the same field, but who was not involved in the study, to read through my selection of meaningful units, coding and networks used in the data analysis to determine whether he agrees.</p>

Dependability	<i>Dependability seeks means for taking into account both factors of instability and factors of phenomenal or design induced changes. (Lincoln &amp; Guba, 1985:299.)</i>	This refers to the degree to which data change over time and adaptations are made in the decisions of the researcher during the analysis process.	I have altered several decisions since I started this inquiry in 2008. An example is the adjustments I made in terms of the questions which I developed at the start of the study and the questions which I ended up using. I, as person and researcher has also changed. I also used follow-up questions to narrow the focus of the interviews and focus group discussions.
Transferability	<i>Transferability refers to the extent to which the findings can be transferred to other settings or groups. (Graneheim &amp; Lundman, 2004:109.)</i>	Transferability is facilitated when a clear and distinctive description of the culture, context, selection and characteristics of participants, data collection and process of analysis, as well as a rich presentation of the data together with appropriate quotations are provided	I have ensured this aspect of trustworthiness by: <ul style="list-style-type: none"> <li>(i) providing a clear portray of both the South African and the Canadian participants in this study (see 4.7).</li> <li>(ii) outlining the data collection and analysis processes that were embarked upon in this inquiry in as much detail as possible (see 4.5 &amp; 4.6).</li> <li>(iii) presenting the themes in diagrammatical form (see Figures 5.1-5.11) and the findings in tabular form (see Table 6.1) as well as providing a synopsis of the key findings (see 6.3).</li> </ul>

#### **4.8.2 Trustworthiness of interpretation**

According to Graneheim and Lundman (2004:110) trustworthiness regarding interpretations in qualitative research deals with arguments for the most probable interpretations and, therefore, trustworthiness will be enhanced if the findings are presented in a way that allows for alternative interpretations.

*A text always involves multiple meanings and there is always some degree of interpretation when approaching a text. This is an essential issue when discussing trustworthiness of findings in qualitative content analysis. (Graneheim & Lundman, 2004:106.)*

#### **4.8.3 Triangulation and crystallisation**

According to Leedy and Ormrod (2005:99) triangulation refers to the converging of themes by employing different methods of data-collection to support a hypothesis (in the case of quantitative studies) or a theory (for qualitative studies). Richardson (1997:23) views triangulation slightly different by asserting that triangulation is too rigid to use in qualitative studies because the concept is anchored in the rigid two-dimensional idea of reference points on a triangle. In a crystal, symmetry and content combine in an endless variety of forms, changes, dimensions and angles of approach. Nieuwenhuis (2007a:81) agrees that crystallisation provides a complex and deeper understanding of the phenomenon and as such enhance trustworthiness.

All these viewpoints were taken in consideration and I concluded that although crystallisation is the preferred concept to be used in qualitative studies as was seen from the foregoing discussion, I used triangulation to enhance the trustworthiness in this study as to my opinion the meaning of concepts (their interpretations) is subjective and therefore should be thoroughly analysed in order to find the same idea in the different sets of data that were collected. In Table 6.1 the different colours indicate how triangulation was used in the study in which reported data of similar colour but from different sources, shows the same theme.

### **4.9 ETHICAL CONSIDERATIONS**

Two applications for ethical approval were completed and submitted due to the dual context of this inquiry, one in Canada and one in South Africa. Both applications were approved by the respective ethical boards of the two universities

A letter was written to the Regional Directorate of the North-West Department of Education to request permission to involve the teachers in the research. I handed out consent forms to all the participants to complete and collected the completed consent forms from each participant

before the data collection commenced. The participation activities in this inquiry also varied for the participants and therefore consent forms were specifically developed to address ethical considerations for each particular participant, for example, there were participants who only completed the questionnaire, others participated in all four research activities in Canada, *viz.* questionnaires, focus group discussions, individual interviews and lesson observations.

I held an information session in which I outlined the process and different activities involved. I also provided opportunities for questions to clarify uncertainties.

Lastly, I assured participants of anonymity and informed them that they may withdraw from the study at any time.

## **4.10 LIMITATIONS**

### **4.10.1 The large difference in number of completed questionnaires between South African and Canadian participants**

The fact that only 12 of the Canadian pre-service teachers responded to the questionnaires can be a limitation of this study as these few responses were put up against the 61 questionnaires completed by the South African in-service teachers.

### **4.10.2 South African participants not teaching Mathematical Literacy**

It was envisaged that all participants would be teaching the subject/course. In fact, several teachers were not teaching Mathematical Literacy at their schools. This limited the number of South African participants that could provide rich information based on current issues in the Mathematical Literacy classroom.

### **4.10.3 The language of the data collection instruments**

South African participants had to complete the questionnaire in English which was not their home-language. Although one focus group discussion was conducted in Afrikaans, the home-language of the participants of one of the focus groups, there were still two other focus group discussions that were conducted in English. This might have limited the responses and resulted in short responses. It might also have caused some teachers to misunderstand the questions.

#### **4.10.4 No mathematics teacher training programme focussing specifically on Mathematics for Work and Everyday Life in the Canadian context of this study.**

The situation surrounding the reasons why the Canadian participants enrolled for the programme can be seen as another limitation of the research, as there is no specialised teacher education programme for only Mathematics for Work and Everyday Life. This made it difficult to pinpoint reasons for enrolling to teach Mathematics for Work and Everyday Life, because the course was only one of the many courses in the Mathematics teacher education programme at Brock University (see Table 2.3). It can, therefore, be assumed that the Canadian participants might have had the course in mind, or they might **not** have had the course in mind, when they listed their motivations for enrolling in answering this question.

#### **4.10.5 Canadian participants not teaching Mathematics for Work and Everyday Life during their teaching practicum**

Several questions in the questionnaire and one question in the focus group discussions involved the contribution of the programmes to the teaching practises of participants, and as such, could not be answered as expected because of the fact that not all the Canadian participants were teaching Applied Mathematics or Mathematics for Work and Everyday Life during their teaching practicum in their final year (Table 4.13).

#### **4.10.6 Authoritative position of course facilitators in Canada and South Africa**

The Canadian students were initially a bit reluctant to talk about the programme. One of them asked whether this data will be made available to their course facilitator. After ensuring him that the data can only be accessed by the facilitator after their grades have been assigned, the group seemed more comfortable.

My authoritative position as facilitator of the ACE programme for Mathematical Literacy, but also conductor of the focus group discussions, might have influenced the discussions with the South African participants and subsequently the views they expressed. To minimise biasness, the focus group discussions were transcribed by an impartial person and were member-checked by participants after the transcriptions were completed.

#### **4.10.7 Teacher inhibitions in focus group discussions**

South African participants come from a past where teacher education programmes varied considerably and were also very unequal in standard (Adler, 2002:2). These programmes

were not all structured in a way that ensures sufficient self-confidence. Conversation analysis as well as discourse analysis enabled me to note that the South African participants were somewhat reluctant to take part in the discussions. This might be due to the inhibitions of the teachers. Responses were often short and sometimes confusing.

#### **4.11 CONCLUSION**

As novice researcher I do acknowledge that the planning and execution of this inquiry could have been done in various other ways, following a multitude of other research methods, strategies and tools. This chapter outlined the one method that I chose to pursue in this study. As such, it is but one of the many methods that exist and I acknowledge that it is by no means necessarily the most effective method. However, this study must be seen as a contribution to a debate rather than an endeavour to find consensus.

In the next chapter, the findings generated by the methods of data analysis utilised, as described in this chapter, will be reported.

CHAPTER 5:  
**DATA REPORTING AND  
ANALYSIS**

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## 5.1 INTRODUCTION

In Chapter 4, I described the research design used in this study as well as the motivation for the decisions I have made with respect to the research methodology employed in this study. This chapter offers an interpretive and analytical account of the data that was generated and collected during the study.

### 5.1.1 Structure of the data reporting and analysis with reference to the research questions

Table 5.1 provides an outline of the research questions with an indication of where each research question is addressed in this chapter.

**TABLE 5.1 REFERENCES TO SUB-SECTIONS THAT ADDRESS THE RESEARCH QUESTIONS**

<b>PRIMARY RESEARCH QUESTION</b>			
Can we as developers of teacher training programmes for Mathematical Literacy teachers in South Africa learn from the teacher training programmes for similar subjects in Canada in order to improve our own programmes?			
<b>SECONDARY RESEARCH QUESTIONS</b>	<b>QUESTION-NAIRE</b>	<b>FOCUS GROUP DISCUSSIONS</b>	<b>INDIVIDUAL INTERVIEWS</b>
1. How do teachers in an in-service Mathematical Literacy training programme view the Mathematical Literacy training and how did they experience the programme?	5.2 Tables 5.2 - 5.11	5.3 Figures 5.1 - 5.7	
2. How do teachers in a pre-service mathematical literacy training programme view the training for Applied Mathematics (grade 10) and Mathematics for Work and Everyday Life (grade 11-12) and how did they experience the programme?	5.2 Tables 5.3 - 5.11	5.3 Figures 5.1 - 5.7	5.4 Figures 5.8 - 5.11
3. What are the similarities and differences in the mentioned training programmes offered at the two universities?	5.5 Table 5.13		

The generated data was analysed and will be reported as follows:

Firstly, the analysed data regarding the views and experiences of the participants obtained from the questionnaires will be reported in tables, followed by a discussion of the table. These tables give readers an instantaneous view on the categorisation of the responses in

both the South African and the Canadian context. The notation at the end of the responses in the tables indicates where the data can be found. The notation (E1:6:58) should be understood as follows: The first letter and number refers to the relevant addendum (E1 for the responses from the South African participants and E2 for the responses from the Canadian participants), the number which follows represents the page number and the last number represents the response number. Therefore (E1:6:58) means Addendum E1, page 6, response 58.

Secondly, the views and experiences of the participants, which were extracted from the data generated by the five focus group discussions, as well as data from the six individual interviews, will be reported. The themes that emerged from these discussions and interviews were organised into networks with the help of ATLAS. ti.

The third secondary question involves a synthesis of the answers to the first two secondary questions in order to identify the similarities and differences between the practises of the participants in the two teacher training programmes.

The Afrikaans speaking participants in South Africa completed the questionnaires in Afrikaans and one of the focus group discussions was also conducted in Afrikaans. Hence, the Afrikaans quotes that have been used in this study have been translated into English.

This study was initially planned with questionnaires, focus group discussions and individual interviews as the main instruments for data collection. However, I have been privileged to be the lecturer and developer of the South African training programme involved in this study for five years. During the five years I made several notes of my observations regarding the development of prospective Mathematical Literacy teachers during the period from entering the Mathematical Literacy teacher programme until, two years later, graduating from the programme as qualified Mathematical Literacy teachers. In regards to the Canadian context, field notes were taken at two lesson observations for Applied Mathematics and Mathematics for Work and Everyday Life at a high school in Canada, as well as two lesson observations during classes for the methods course which forms part of the Mathematics teacher education programme at Brock University. These field notes are also included in this study as it resonate with themes which emerged from the analysis of the other data generated during this study.

## **5.2 VIEWS AND EXPERIENCES BY ALL PARTICIPANTS**

This section provides reporting and a content analysis of the open-ended questions in the questionnaire that dealt with the views and experiences of the participants. Table 5.2 indicates the tables in which the generated data was categorised.

**TABLE 5.2      TABLES REPRESENTING GENERATED DATA FROM THE QUESTIONNAIRES**

<b>TABLE</b>	<b>CATEGORY</b>
Table 5.3	Perceptions of mathematical literacy
Table 5.4	Motivators for enrolling in the training programme
Table 5.5	Expectations of the participants
Table 5.6	Implementation of the curriculum documents
Table 5.7	The role of other resources
Table 5.8	The contributions of the mathematics modules and courses
Table 5.9	The influence of the teacher education programme
Table 5.10	Specific times participants could draw on experiences in the programme
Table 5.11	The role of mathematical processes

### **5.2.1      Views of all the participants**

This section provides an analytical view, presented in tables, of the perceptions and the motivators of the participants. This manner of presentation will enable readers to have an instantaneous view regarding the aspects which were similarly perceived by the South African and Canadian participants, as well as the aspects that were perceived differently.

#### **5.2.1.1      Perceptions of mathematical literacy**

All the Canadian participants responded to the question regarding their perceptions of mathematical literacy, while this question was left unanswered by three South African respondents. The reason for not responding to the question might be that these participants were not sure what mathematical literacy is. The perceptions of the remaining 58 respondents are represented in Table 5.3.

**TABLE 5.3 PERCEPTIONS OF MATHEMATICAL LITERARY**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. Defining mathematical literacy as the ability to apply knowledge of mathematics in real-life situations	<b>22 of 58 respondents or 37.93%</b> <i>Ability to apply the knowledge and understanding of mathematics in the real life situation. (E1:6:58)</i>	<b>9 of 12 respondents or 75%</b> <i>Mathematical Literacy means being able to use mathematics in life situations, to know how much extra tax you'll have to pay for an item, ...and other situations people would really use math. (E2:3:12)</i>
2. Highlighting a basic knowledge of mathematics as integral part of mathematical literacy without the application of the mathematical knowledge.	<b>4 of 58 or 6.90%</b> <i>Having the basic knowledge of Maths. (E1:6:50)</i>	
3. Indicating mathematical literacy as a lower level mathematics subject.	<b>2 of 58 or 3.45%</b> <i>Literate people with mathematic/numbers give opportunity to people who does not /not good in Mathematics. (E1:5:19)</i>	
4. Focussing on the ability to function in real-life without mentioning mathematics as part of the definition.	<b>5 of 58 or 8.62%</b> <i>Relating to real life situation. (E1:6:39)</i>	<b>3 of 12 or 25%</b> <i>Mathematical literacy is the ability to perform mathematical functions, explain and write mathematically. (E2:1:6)</i>
5. Perceiving mathematical literacy as the subject seeking to prepare learners to work with elementary mathematics and solve problems they come across in daily life.	<b>17 of 58 or 29.31%</b> <i>Subject seeking to prepare learners to be able to work with daily simple mathematical solution/problems they come across every day in life. (E1:5:15)</i>	

Table 5.3 indicates that less than half of the South African participants (**37.93%**) have a clear idea of what mathematical literacy as concept entails, while it seems as if the majority of the Canadian participants (**75%**) know what mathematical literacy is. South African participants either left out the word “mathematics” or the words “real-life” in their definitions. It should also be noted that 8 of the responses from the South African participants defined mathematical literacy with the same words as the definition from the PISA 2003 report, while another 5 responses defined mathematical literacy using the definition in the National Curriculum statement. This might point to a rote-learned definition of the concept which can indicate that these teachers, although the correct definition was given, still do not understand what mathematical literacy is all about. All the Canadian participants mentioned mathematics in their perceptions of mathematical literacy.

**Synthesis: From the foregone it can be deducted that mathematical literacy as concept and as subject is not yet fully conceptualised by the South African participants.**

#### 5.2.1.2 Motivators for enrolling in the training programme

Four of the 61 questionnaires completed by the South African participants did not indicate any answer to this question, while the question was answered by all the Canadian participants who completed questionnaires. The remaining 57 responses elicit the following reasons as motivators for enrolment in the programmes (Table 5.4).

**TABLE 5.4 MOTIVATORS FOR ENROLLING IN THE TRAINING PROGRAMME**

FOR THE SUBJECT		
MOTIVATORS	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. The challenging nature of the subject	<i>The unlimited world of numbers and perspective which the subject is being approached is far more open and have so many challenges. (E1:7:6)</i>	<i>I was always good at figuring out math from high school and enjoyed the challenge of it. I just carried it on into taking math in university to break up having subjective classes and wanted to be able to make math interesting for my future students. (E2:5:10).</i>
2. Passion/love for Mathematics and enjoyment of Mathematics	<i>I like Maths and interested in increasing my knowledge as I am teaching.. (E1:8:30)</i>	<i>I always enjoyed math. (E2:4:4).</i>
3. Desire to understand and teach Mathematical Literacy	<i>Om meer kennis en begrip van die vak ML te kry.(E1:9:61)</i> Translation: To gain more knowledge and understanding of the subject ML.	
4. Needed to make Mathematics teaching more relevant in order to erase rural learners' fear of Mathematics	<i>...I needed to get a way of making my maths teaching more relevant and more day-to-day related to my learners. I'm teaching in a rural area where more learners are afraid to do maths. (E1:9:48)</i>	
5. Good and interesting alternative to Mathematics	<i>... Math Literacy was a good and interesting alternative. (E1:9:45)</i>	
6. The newness and popularity of Mathematical Literacy as subject	<i>It is the new compulsory subject that will help us to practice in our lives. It is the most wanted subject in school... (E1:8:44)</i>	

**Table 5.4 Motivators for enrolling in the training programme (continue)**

<b>FOR ONE-SELF</b>		
<b>MOTIVATORS</b>	<b>SOUTH AFRICAN PARTICIPANTS</b>	<b>CANADIAN PARTICIPANTS</b>
1. Self-development, self-empowerment and better qualifications	<i>To make sense of the world around me by empowering myself. To upgrade myself. (E1:8:37)</i>	
2. Wanting to be mathematical competent	<i>I wanted to be mathematical competent and be able to enlighten those who in need of mathematical knowledge. (E1:6:1)</i>	
3. Enhancing Mathematics knowledge and interpretation	<i>To have knowledge on the Maths content. (E1:8:31)</i>	
4. Becoming mathematical literate themselves	<i>I want to be mathematically literacy so that I can also contribute toward mathematics to others. (E1:8:38)</i>	
5. Improving life-style	<i>To helps me to manage my life well as it comes to money matters, solving problems and contribute to society by helping them to interpret life. (E1:8:26)</i>	
6. Being able to help one's own children with Mathematical Literacy	<i>Om my eie Wiskundige vaardigede en kennis te verbeter. Om nog 'n kwalifikasie by te kry. Om my eie kinders te kan help. (E1:9:56)</i> [Translation: To improve my own Mathematics skills and knowledge. To gain another qualification. To be able to help my own children.]	

**TABLE 5.4 MOTIVATORS FOR ENROLLING IN THE TRAINING PROGRAMME (CONTINUE)**

<b>FOR THE JOB</b>		
<b>MOTIVATORS</b>	<b>SOUTH AFRICAN PARTICIPANTS</b>	<b>CANADIAN PARTICIPANTS</b>
1. Helping Heads of departments to better understand the subject in order to control educators' work	<i>As an HOD, I wanted to know what is happening in the subject and how to control the educator's work. (E1:7:14)</i>	
2. Making up for lost opportunity to teach Mathematics	<i>I am interested in Mathematics and previously did not have opportunity so I like to teach learners Mathematical literacy. (E1:19:7)</i>	
3. Advised by Subject Specialist / previous Mathematics teachers to do the course	<i>...my subject advisor advised us to do the course. (E1:20:7)</i>	<i>Some of my previous mathematics teachers have motivated me to become a math teacher myself. . (E2:4:7)</i>
4. Shortage of Mathematical Literacy (ML) educators	<i>Shortages of Maths Literacy teachers and the subject is also challenging as it teaches you about practical things. (E1:9:53)</i>	
5. Easy access to job opportunities		<i>I am a physical education major, and that is my passion. However, Phys Ed jobs are not needed right now. Math will get me in the door. (E2:5:11).</i>

**TABLE 5.4 MOTIVATORS FOR ENROLLING IN THE TRAINING PROGRAMME (CONTINUE)**

<b>FOR THE LEARNERS</b>		
<b>MOTIVATORS</b>	<b>SOUTH AFRICAN PARTICIPANTS</b>	<b>CANADIAN PARTICIPANTS</b>
1. Bringing understanding to those who struggle with Mathematics	I would like to help the learners who are struggling with Mathematics who can at least do Maths Lit to help them in their everyday life to also help their parents who might not have the knowledge e.g. budgeting, rates, Bond, hire-purchase etc. (E1:7:9)	...I also want to help other students who struggle with math, and give them someone they can look to and say, "If she did it, then I can too! (E2:4:6)
2. Changing negative attitude of Black/African learners towards Maths	Seeing most Black/African learners having a negative attitude towards Maths & thus not performing to the best of their ability. (E1:7:18)	
3. Wanting learners to be mathematical literate	It is an interesting learning area which is all about things or real life situation. I would like to see our learners being mathematically literate. (E1:8:38)	

As can be seen from Table 5.4 it seems as if the participants had their own agendas when they enrolled for the programme. These agendas can be categorised in four main groups, namely:

- (i) The participants who are in the programme for the subject;
- (ii) Participants who enrolled for self-development and empowerment;
- (iii) The participants who want to help the learners; and
- (iv) The participants who are there to secure a job for themselves.

However, the main motivator that runs like a golden thread through all the agendas is to be able to teach the subject, whether it is Mathematical Literacy or Mathematics.

In the South African context it seems as if the prospect of learning mathematics in the training programme was a very big motivator. It is also noteworthy that one South African participant viewed the training programme as a chance to make up for some previously lost opportunity to teach the subject Mathematics (Table 5.4).

#### 5.2.1.3 The expectations of the participants.

Three South African participants did not complete this question that explores what the expectations of these participants were at the start of the programme, while all the Canadian participants answered this question. These responses can be grouped into the categories that are indicated in Table 5.5

**TABLE 5.5 EXPECTATIONS OF PARTICIPANTS**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. Expected to be taught how to teach Mathematical Literacy or Mathematics to the learners	<p><b>14 of 58 or 24.14%</b>  <i>Know how to teach ML, write lesson plan ML, how to selecting the content for the lesson topic, how to select appropriate material. (E1:9:2)</i></p>	<p><b>1 of 12 or 8.33%</b>  <i>I was expecting how to get math across to students. I didn't want to talk about WHAT math to teach so much as effective ways of conveying material. Other classes deal with classroom management, so this course should be about teaching math and that is basically it. (E2:6:4)</i></p>
2. Expected to be taught Mathematics or to cover difficult topics and problem areas in Mathematics and to be taught many ways of presenting it	<p><b>10 of 58 or 17.24%</b>  <i>Since I had no mathematics in grade 12, I thought people like myself who had no mathematics will be given extra lessons to know more about mathematical concepts. (E1:10:17)</i></p>	<p><b>2 of 12 or 16.67%</b>  <i>I was hoping that we could learn methods of teaching students, that we could cover difficult topics in mathematics, the ones that students tend to have problems with, like factoring, negative numbers, fractions, etc. I want more ways of seeing a concept and therefore have many different ways to present the ideas to my students. (E2:7:12)</i></p>
3. Expected to become more confident and competent as teacher	<p><b>10 of 58 or 17.24%</b>  <i>To gain confidence in the teaching of the subject and at the same time improve my education. (E1:11:52)</i></p>	<p><b>1 of 12 or 8.33%</b>  <i>I expected to learn some strategies for being a successful math teacher, build my confidence in teaching math (pacing my lessons), and gathering some useful resources that I could use in the classroom. (E2:7:10)</i></p>
4. Expected to become Mathematical literate themselves	<p><b>5 of 58 or 6.62%</b>  <i>Be mathematically literate. (E1:11:35)</i></p>	

**TABLE 5.5 EXPECTATIONS OF PARTICIPANTS (CONTINUE)**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
5. Expected to be taught how to explain Mathematics and how to motivate learners		<b>2 of 12 or 16.67%</b> <i>I am really hoping that I can gain a lot of tips and hints of how to explain mathematics to students and how to motivate them. (E2:6:5)</i>
6. Expected the module content in the course to be difficult	<b>2 of 58 or 3.45%</b> <i>I thought that it was going to be difficult because I didn't have basic Maths but I wanted to understand the subject. (E1:11:38)</i>	
7. Expected to learn more about applying mathematics problems to real-life scenarios		<b>1 of 12 or 8.33%</b> <i>I expected the mathematics teacher education program to teach me how to reach all of my students in the classroom and how to apply mathematics problems to real life scenarios. (E2:7:7)</i>
8. Expected to learn how to move from the context to the content	<b>8 of 58 or 13.79%</b> <i>To start from the concrete then to abstract as most of registered don't understand most of the mathematical content and context. (E1:10:12)</i>	
9. Expected to be taught strategies to use in classroom		<b>3 of 12 or 25%</b> <i>... I expected to learn strategies that are particularly good for teaching certain topics. I expected to learn activities that will allow students to self-discover math information that is in the curriculum... (E2:7:11)</i>
10. Expected the module content in the course to be easy	<b>4 of 58 or 6.90%</b> <i>I expected that Mathematical Literacy is an easy subject but it was so difficult. (E1:11:54)</i>	

From Table 5.5 it seems that the expectations from the two countries were quite diverse because, except for the first three categories, there were no other categories which were in common. It is noteworthy that to be taught how to teach the subject and how to teach it confidently were part of the expectations of both the Canadian and the South African participants.

**(i) Expectations by South African participants:**

**To be helped with context and content**

The expectations from the South African participants indicated that 8 out of 58 expected to be helped with context and content. This confirms existing literature which claims that context is a complex issue (Julie, 2006:66).

**To be taught Mathematics**

South African participants seemed to be well aware of the inadequacies in their own mathematical knowledge. At least two of the categories indicated that they expected to be taught Mathematics knowledge.

**(ii) Expectations by Canadian participants**

In contrast with the South African participants, the Canadian participants seem to be very confident of their own mathematics knowledge and indicated that they expected to be taught mathematics-for-teaching knowledge instead.

**5.2.2 The experiences and practices in the teacher education programmes obtained from the questionnaire**

A content analysis was done on the section in the questionnaire that deals with exploring how the participants **experienced** the programme and what some of the practises are which they embarked on during the time they were engaged in the programmes involved.

**5.2.2.1 Implementation of the curriculum documents**

All the Canadian participants responded to the question regarding the use of curriculum documents except for one of the participants who indicated that the question did not make sense to him/her. A total of 18 out of the 61 South African participants did not answer this question, while 7 participants indicated that the question is not applicable to them. This leaves only 36 responses that were, together with the responses of the Canadian participants, categorised in Table 5.6.

**TABLE 5.6 IMPLEMENTATION OF THE CURRICULUM DOCUMENTS**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. Curriculum documents are used for information and guidance of what should be taught	<p><b>31 of 36 or 86.11%</b>  <i>It informs about Assessment Standard, learning outcomes, critical, assessment task, weightings.</i>            (E1:24:30)</p>	<p><b>9 of 12 or 75%</b>  <i>The documents would inform me of what information needed to be covered.</i> (E2:20:1)</p>
2. Curriculum documents are used to keep track of which expectations were covered and which still need to be addressed		<p><b>1 of 12 or 8.33%</b>  <i>The curriculum documents played a large role in my everyday lesson planning and what we were going to learn. The Brock lesson plan template includes a section for including the overall and specific expectations and so I completed this daily and could keep track of which expectations I covered and which still needed to be addressed.</i> (E1:20:6)</p>
3. Curriculum documents are used as a foundation to build on		<p><b>1 of 12 or 8.33%</b>  <i>I planned my entire lessons around them. They were my foundation to build upon and create interesting and relevant experiences and activities for the students. Of course, they are only the foundation – the starting point.</i> (E2:20:8)</p>
4. Curriculum documents did not inform participant's teaching		<p><b>1 of 12 or 8.33%</b>  <i>They didn't.</i> (E2:20:12)</p>

From Table 5.6 the following points can be extracted:

**(i) The use of curriculum documents mainly to inform and guide**

Only two categories were found to be in common between the participants from the two countries, *viz.* informing and guiding. 86.11% of the South African participants and 75% of the Canadian participants indicated that they use the curriculum documents to inform and guide them with respect to assessment standards, outcomes, assessment types, contexts as well as time frames and the general teaching of the subject or courses.

**(ii) Other uses of the curriculum documents by the Canadian participants**

Other uses for the curriculum documents by the Canadian participants included using the curriculum documents as his/her foundation to understand what is required for the teaching of each course, for every-day lesson planning and to keep track of the expectations that were mastered and those that still need to be mastered.

Only one of the twelve responses by the Canadian participants indicated that the curriculum documents did not inform his/her teaching of the Applied Mathematics/Mathematics for Work and Everyday Life courses. A possible explanation for this response could be that the participant did not yet teach the course and therefore the curriculum document did not yet inform his/her teaching of Applied Mathematics/Mathematics for Work and Everyday Life. The South African participants also indicated that they did gain knowledge from the curriculum documents but still need more knowledge in order for them to teach the subject.

#### 5.2.2.2 The role of other resources

All the Canadian participants responded to this question that deals with the use of other resources while only 31 of the 61 South African participants responded to this question. These responses are presented in Table 5.7.

**TABLE 5.7 THE ROLE OF OTHER RESOURCES**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. Participants who value people as their primary resource		<p><b>9 of 12 or 75%</b>  <i>... The biggest resource for me, though, were the people that surrounded me, not only in the department of mathematics at the secondary school I was at, but from my friends at Teachers' College – and not only in the mathematics subject. So many people have so many creative ideas that I can build upon and shape to meet my needs, and that is why I value people as my primary resource. (E2:22:8)</i></p>
2. Utilise the internet	<p><b>7 of 31 or 22.58%</b>  <i>I used the Internet a lot, and came across very interesting learning material. (E1:26:56)</i></p>	<p><b>8 of 12 or 66.67%</b>  <i>Internet is my main source to find ideas on how to teach a concept. I google everything I need to teach and read what other teachers have done. (E2:23:11)</i></p>
3. Utilise written text materials like textbooks, teacher guides and previous examination papers	<p><b>21 of 31 or 67.74%</b>  <i>A lot of different ML textbooks and exam guidelines. (E1:26:45)</i></p>	<p><b>4 of 12 or 33.33%</b>  <i>I Would search out textbooks used for the course, other teachers, and utilize some internet resources as well, in addition to the curriculum documents. (E2:21:4)</i></p>
4. Make use of manipulatives, educational television programmes and computer software	<p><b>4 of 31 or 12.90%</b>  <i>The Encarta and One note programmes in our school computer lab has made my work in the subject become more vibrant and active. (E1:25:6)</i></p>	<p><b>2 of 12 or 16.67%</b>  <i>I would use manipulatives such as geoboards, algebra tiles, frequent examples and word problems taken from workplace and everyday life situations, perhaps smartboard, software such as Geometer's Sketchpad, resources from the internet. (E2:22:9)</i></p>
5. Make use of materials from real-life situations	<p><b>3 of 31 or 9.68%</b>  <i>Geography-Maps. Economics- Interpretation of graphs. Accounting- calculations of tax, hire purchase, etc. (E1:26:39)</i></p>	<p><b>1 of 12 or 8.33%</b>  <i>They I would like to obtain some real problems from construction workers, gym teachers, accountants, physicists, etc to be able to use in the classroom to show the value in mathematical skills. It would also be great to have guest speakers to come in and talk about why mathematical skills were important to them and their careers. (E2:22:7)</i></p>

From the responses in Table 5.7 the following conclusions can be drawn:

**(i) The text book as primary resource**

The responses by the South African participants indicate that the textbook is the most popular resource utilised by them. Other resources include charts, newspapers, television, worksheets, magazines and previous question papers, while a few teachers mentioned computer programmes like Encarta as well as the Internet. It is clear that the Canadian participants make use of technology far more than the South African participants who are still using mainly written text when teaching Mathematical Literacy.

**(ii) People as primary resource**

It is evident that the majority of the Canadian participants (75%) value people as their primary resource: They build on each other's ideas and read up on how other teachers were teaching a particular concept or lesson. This phenomenon could not be found in the South African context.

**(iii) Internet as resource**

The phenomenon that the Canadian participants were using the Internet more than the South African participants (66.67% against 22.58%) was anticipated considering that Canada is a developed country and South Africa is a developing country.

**5.2.2.3 The contributions of the mathematics modules and courses in the programmes**

The responses to the question relating to the contributions of the mathematics modules and courses in the programme varied from it being empowering to not being empowering at all and are categorised and presented in Table 5.8. While all 12 of the Canadian participants responded, 7 of the 61 South African participants did not respond to this question.

**TABLE 5.8 THE CONTRIBUTIONS OF THE MATHEMATICS MODULES AND COURSES IN THE PROGRAMMES**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. Modules contributed to boosting confidence	<b>12 of 54 or 22.22%</b> <i>I am confident to teach to any one and not only to learners. (E1:16:49)</i>	
2. Programme provided theoretical knowledge of Mathematics		<b>2 of 12 or 16.67%</b> <i>By presenting interesting proofs, concepts and properties of Mathematics. (E2:10:3)</i>
3. Modules contributed by empowering participants and motivating them to study further	<b>1 of 54 or 1.85%</b> <i>It guide and lead step by step and increase my knowledge and empowers me. I am really empowered and want to know or study more, eg. Hos of Diploma in ML. (E1:16:41)</i>	
4. Programme enhanced meta-cognitive skills and critical thinking, but did not prepare participants to teach the courses		<b>4 of 12 or 33.33%</b> <i>.... I think I have become more metacognitive through university and this will definitely be a benefit when I become a teacher and need to analyze how I talked myself through a problem so I can explain it to my class. (E2:10:6)</i>
5. Modules contributed by clarifying concepts that participants did not understand during schooling years or concepts that they forgot	<b>11 of 54 or 20.37</b> <i>Prepares me, revive my Maths that I did at my high school. Now I am well prepared to treat ML in any grade I'll come across. (E1:16:58)</i>	

**TABLE 5.8 THE CONTRIBUTIONS OF THE MATHEMATICS MODULES AND COURSES IN THE PROGRAMMES (CONTINUE)**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
6. Programme did not prepare participants to teach applied/workplace streams		<b>4 of 12 or 33.33%</b> <i>University math does not have anything to do with high school math. So it doesn't prepare you to teach. (E2:11:11)</i>
7. Programme hindered participants to teach applied/workplace streams		<b>2 of 12 or 16.67%</b> <i>... In addition, I believe that being exposed to the way mathematics was taught at the post-secondary level might have hindered me as a teacher because it was not very hands on at all, and was very largely based on theory... (E2:10:8)</i>
8. Modules contributed by sparking interest in Mathematics	<b>4 of 54 or 7.41%</b> <i>I am now interested in Maths than before I could register. (E1:16:53)</i>	
9. Modules contributed to certain extend but participants needed more practise with the mathematics modules	<b>13 of 54 or 24.07%</b> <i>I have gained a lot though I still need further training and practice at home or school. (E1:15:28)</i>	
10. Modules did contribute, but prepared participants for Mathematics and not Mathematical Literacy.	<b>2 of 54 or 3.70%</b> <i>They prepare one to teach Maths not Maths Literacy. (E1:15:8)</i>	
11. Modules did not contribute because of difficulty level	<b>1 of 54 or 1.85%</b> <i>Mathematics in it is too difficult and not understandable. (E1:15:17)</i>	

Table 5.8 reveals that South African participants indicated that they really benefited from the mathematics modules to the extent that they gained confidence in themselves to teach Mathematical Literacy, while only 16.67% (category 2) of the responses from the Canadian participants indicated that they were benefiting from the programme. It must however be noted that 33.33% (category 4) was of the opinion that their meta cognitive abilities were enhanced.

Category 9 and 11 indicate that South African participants found the mathematics content knowledge in the modules difficult and needed more practise with it, which is in line with my observation (field notes of researcher) that the South African participants struggled with the mathematics in the programme and need more help with personal mathematics knowledge:

- Teacher-students found the mathematics modules quite daunting and one teacher-student complained that the lecturer did not take cognisance of the fact that they did not do mathematics in grade 12 and that they are sometimes lost when the lecturer explains the mathematics (field notes of researcher as facilitator).
- Teacher-students found the mathematics challenging and were very impressed with themselves when they were able to get the correct answer to the mathematics problems in the two modules (field notes of researcher as facilitator).

**(i) Personal mathematics content knowledge versus mathematics-for-teaching knowledge**

From the responses it seems that the mathematics modules helped South African participants to revive the mathematics done during their schooling years and even clarified some concepts which were never understood by them. On the other hand, the mathematics courses in the university programme for the Canadian participants did provide them with a strong mathematics content knowledge base, but it seems like there was not enough mathematics-for-teaching knowledge in the Canadian programme.

**(ii) No opportunities to teach Mathematical Literacy for South African participants**

Participants want to teach the subject at school but it seems as if principals do not have enough trust in them to give them this opportunity.

**(iii) Contradictory responses**

The responses (category 2) indicated that the mathematics courses in the programme did indeed prepare Canadian participants for teaching Applied/Mathematics for Work and Everyday Life by providing him/her with mathematical knowledge like proofs and properties

of Mathematics. This is contradicted by several responses (category 6) that indicated that participants did not think that the programme prepared them in any way to teach applied/workplace courses or any other course for that matter.

**(iv) Canadian participants have a solid school Mathematics background**

From the responses (category 4) it seems like the Canadian participants already had a good mathematical knowledge base when they entered into the programme. In chapter 2 (Table 2.5), the various courses which can be taken in high schools were listed and include, for example, the university-bound courses which are quite advanced. Learners are only taught how to think critically and become more meta-cognitively aware in these courses. This relates well with the observations (field notes) made by me as participant observer attending the methods course along with the pre-service teachers in Canada. It was apparent that Canadian participants were very confident in their own mathematical competence when they had to present lessons using various technologies, like the smart board and the graphic calculator, while the South African participants did not appear very confident with the mathematics during contact classes (field notes).

**(v) University Mathematics courses is the opposite of the requirements for Applied courses**

Responses did also indicate that the Canadian participants viewed university mathematics courses as exactly the opposite of what the Applied courses and Workplace Preparation courses required of them.

The following two sections (5.2.2.4 and 5.2.2.5) will not report the responses in tabular form and the responses from the two countries are separated due to the large difference in the type of question that was asked in the South African and Canadian questionnaires.

**5.2.2.4 The contributions of the didactics modules (MLED 572 and MLED 574) to the teaching practise of South African participants**

MLED 572 (The didactics of Mathematical Literacy) and MLED 574 (Mathematical Literacy in Context) have, as core aim, the empowerment of prospective Mathematical Literacy teachers and to develop their own teaching and learning strategies (see 2.4.3). Eleven of the 61 participants did not respond to this question. Responses varied from these modules being very useful to not being useful at all, as can be seen in the following categorisation:

**(i) Modules contributed to boosting confidence**

Several respondents (29 of 50) indicated that they have gained more self-confidence to teach Mathematical Literacy, *e.g.*:

*Yes, I am more confident when teaching ML because I have gained knowledge and have background of Maths, I am able to deal with formulae. (E1:17:18)*

**(ii) Modules contributed by empowering participants**

Some responses (9 of 50) indicated that the modules empowered them by giving them knowledge and skills, *e.g.*:

*Yes, because I am well equipped with the skills and more convenient with them. (E1:18:29)*

**(iii) Modules contributed by enhancing knowledge and implementation of the National Curriculum Statement (NCS) in Mathematical Literacy**

From some of the responses (8 of 50) it is clear that these didactics modules helped participants to understand the learning outcomes for Mathematical Literacy as well as how to use them in their lessons, *e.g.*:

*Yes, I can now prepare a portfolio with ease. I know my LO's and how to create a real life situation based on the LO's. (E1:19:48)*

**(iv) Modules contributed by helping teachers with selecting and starting with the contexts from their learners' environment**

A very important part of the teaching of Mathematical Literacy is the issue of context (see Chapter 3). Several respondents (5 of 50) indicated that the modules helped them to choose appropriate contexts from the environment of their learners, *e.g.*:

*Yes. It helped me to use context in my teaching that relates to learners environment. (E1:19:59)*

Some responses (11 of 50) indicated that participants are able to start lessons in Mathematical Literacy with the context (real-life situation), *e.g.*:

*It did! It gave us an idea of how to prepare a lesson and what to keep in mind. It showed us to start with a real life scenario. (E1:19:52)*

**(v) Modules provided different strategies for the teaching of Mathematical Literacy**

Several responses (17 of 50) indicated that the participants benefited from the didactical modules by way of learning a variety of teaching strategies as part of the modules, *e.g.*:

*Yes. I learnt more methods on how to tackle different activities. (E1:17:3)*

## **(vi) The history of Mathematics**

The outcomes for MLED 574 include knowledge of the historical development of Mathematics (see 2.4.3 in Chapter 2), but one of the participants was not impressed with the history of Mathematics which forms part of the Advanced Certificate in Education (Mathematical Literacy), *e.g.*:

*No. I've been a teacher for very long. The history of Mathematics and Mathematicians is interesting, but does not help in presenting a class. (E1:18:45)*

This opinion is supported by my own observations (field notes of researcher as facilitator) during classes for the programme: Teacher students complained about the history of Mathematics in MLED 574 and seemed very bored with the lessons when the contributions of the Egyptians and other ancient civilisations to the development of Mathematics were facilitated with them.

It must be noted that two of the responses contradicted this one response, *e.g.*:

*The History of Maths did help. Didactics is also helping in knowing the learning outcomes. (E1:18:42)*

## **(vii) Modules did not contribute to teaching practise**

Only two of the 50 participants indicated that the modules did not contribute to his/her teaching practise, *e.g.*:

*"Not effectively." (E1:18:36)*

### **5.2.2.5 The impact of the other teachables on the Canadian participants' teaching of Applied Mathematics/Mathematics for Work and Everyday Life courses**

The responses to the question regarding the other teachable required for the teaching certificate in Canada can be divided into the following two categories:

#### **(i) No, it did not help to teach Applied Mathematics/Mathematics for Work and Everyday Life course**

This category of responses (3 of 12) represents the participants who did not think that their other teachable helped them in teaching Applied/Mathematics for Work and Everyday Life.

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<sup>5</sup> One of two teaching subjects of specialisation within the Mathematics teacher education programme at Brock University. See 2.3.

*Not really. Religious Education does not help much. (E2:13:9)*

**(ii) Yes, it did help to teach Applied Mathematics/Mathematics for Work and Everyday Life courses:**

Several participants (9 of 12) claimed that their other teachable helped them with the teaching of Applied Mathematics/Mathematics for Work and Everyday Life courses, e.g.:

*When dealing with physics I believe it does. Physics is the application of mathematics into real-life scenarios. (E2:12:2)*

It seems that whether the other teachable helped in the teaching of Applied Mathematics/Mathematics for Work and Everyday Life course depended largely upon what type of subject the second teachable was.

**5.2.2.6 The impact of the training programmes on the teaching of the South African and Canadian participants**

The question that was used to explore the impact of the programmes on the participants was not well responded to by the South African participants (38 of 61). One reason could be that participants were not teaching Mathematical Literacy yet, and as a result could not answer this question. These responses were divided into the categories as listed in Table 5.9.

**TABLE 5.9      RESPONSES REGARDING THE INFLUENCE OF THE TEACHER EDUCATION PROGRAMME**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. Responses that were positive and favourable regarding the programme	<p><b>20 of 38 or 52.63%</b>  <i>The programme indeed empowered the participants in the following ways:</i>  <b>Eagerness:</b> <i>I am now eager to teach Maths Literacy. (E1:21:53)</i>  <b>Positiveness:</b> <i>I am positive and with a little more experience I would want to teach Math. Lit. (E1:21:56)</i></p>	<p><b>4 of 12 or 33.33%</b>  <i>... We also learn valuable strategies and ideas from our peers in the teacher education program. Some of my peers have had different experiences from me and are able to share some of their knowledge. We are also reminded of technological tools that we can use to enhance learning in the classroom. (E2:17:7)</i></p>
2. Negative responses regarding the influence of the programme		<p><b>2 of 12 or 16.67%</b>  <i>... Before I got into the classroom, everything was just a vague idea that we have discussed over and over again, but now that I have taught I would say that the courses have not influenced me at all compared to how large of an influence that my first associate and first group of students had on me. (E2:17:6)</i></p>
3. Responses indicating that participants' confidence was enhanced	<p><b>4 of 38 or 10.53%</b>  <i>I feel very confident after doing certain relevant topics. I teach with confidence which I never had before enrolling for ACE ML. (E1:20:15)</i></p>	
4. Responses indicating that programme helped with the teaching of subject/course	<p><b>7 of 38 or 18.42%</b>  <i>It improve the way we teach ML and how to prepare a lesson plan, now we know how to use LO's and AS. (E1:19:2)</i></p>	<p><b>4 of 12 or 33.33%</b>  <i>... By learning about these differences and the breadth of these differences, I would be able to engage my students on multiple levels to ensure that they understand the material rather than catering their education to the way that I learned or understand the material. (E2:17:10)</i></p>

Conclusions that can be drawn based on Table 5.9:

### **Conclusions for the South African context:**

It seems that the programme did indeed impact positively on the development of the majority of the South African participants (31 of 38 - the total of category 1, 3 and 4) in becoming Mathematical Literacy teachers with no negative response regarding the influence of the programme: The programme helped (4 of 38) of the participants to teach the subject with confidence. This is important in the South African context because, as was explained in Chapter 3 (see 3.4), these teachers usually have a negative self-image about their own mathematical competence, which then further influences their confidence in teaching Mathematical Literacy. In particular it helped with teaching in context, which is what was envisaged for the teaching of Mathematical Literacy according to the National Curriculum Statement (DoE, 2003:42). This claim is supported by the following quote: "Helped me to teach in context." (E1:21:50). This is also the observation (field notes) I made during the classes: In MLED 572, one of the pedagogical modules in the programme, registered in-service teachers have to develop learning experiences in the form of lessons for a specific grade. Some teacher students found these lessons helpful for their own classes.

### **Conclusions for the Canadian context:**

If one understands that Canadian participants experience Applied/Workplace Mathematics as some unique form of specialised mathematics teaching, one can understand why several responses indicated the contribution of the programme towards this special kind of teaching was not what they expected it to be.

#### **5.2.2.7 Specific times participants could draw on their experiences in the programme when teaching the subject/course**

The question regarding the extent to which the South African participants could draw on their experiences in the programme when they were teaching the subject or course elicited only 21 responses from the 61 respondents. Also, only 8 of these responses can be regarded as meaningful. Only four of the 12 Canadian participants responded to this question. Others indicated with "N/A" that this question was not applicable to them or simply left this space open. The responses were divided into main categories as can be seen in Table 5.10.

**TABLE 5.10 SPECIFIC TIME PARTICIPANTS COULD DRAW ON THEIR EXPERIENCES GAINED FROM THE PROGRAMME.**

<b>CATEGORY</b>	<b>SOUTH AFRICAN PARTICIPANTS</b>	<b>CANADIAN PARTICIPANTS</b>
1. Times when participants were using real-life situations	<b>6 of 8 or 75%</b> <i>When I was teaching Financial Mathematics (E1:22:14)</i>	
2. Times when participants were doing group work/co-operative learning		<b>2 of 3 or 66.67%</b> <i>... What I tried to realize in my classroom was the value of cooperative learning (another big buzzword)...after a few tries, though, the students began to appreciate the fun (if not the value as such) of cooperative learning, and I could see how beneficial it was for them. (E2:17:6)</i>
3. All the time when teaching Mathematical Literacy	<b>2 of 8 or 25%</b> <i>Every time when I teach ML in class I refer/draw on my experiences of ACE in ML. (E1:22:18)</i>	

**South African participants indicated that they could indeed draw on the programme when teaching Mathematical Literacy.**

From Table 5.10 it is evident that six of the meaningful responses (8) by the South African participants indicated that the times when they were using real-life situations when teaching they could think back and draw on their experiences, knowledge and skills acquired during the programme.

**For the Canadian context:**

In two of the three meaningful responses the Canadian participants indicated that they could draw on the programme when they were using co-operative learning in their lessons.

#### 5.2.2.8 Focus on the mathematical processes in the programme

The question regarding the role of mathematical processes in the teacher education programmes was very well responded to by the Canadian participants (11 of 12), while only 27 of the 61 South African participants responded to this question. These responses are categorised in Table 5.11.

**TABLE 5.11 THE ROLE OF MATHEMATICAL PROCESSES IN THE TEACHER EDUCATION PROGRAMMES**

CATEGORY	SOUTH AFRICAN PARTICIPANTS	CANADIAN PARTICIPANTS
1. Sufficient focus on the mathematical processes in programme	<p><b>12 of 27 or 44.44%</b></p> <p><i>They are emphasized a lot. We plan activities with this in mind. (E1:30:52)</i></p>	<p><b>6 of 11 or 54.55%</b></p> <p><i>We experienced these processes by going through simple questions in a step by step format. (E2:25:7)</i></p>
2. Some of the mathematical processes left out in programme	<p><b>4 of 27 or 14.81%</b></p> <p><i>Reasoning and providing has not been brought to my attention. (E1:28:7)</i></p>	<p><b>4 of 11 or 36.36%</b></p> <p><i>The only thing I believe I've seen is representing, which is representing ideas using manipulatives. I wish we could have seen the other topics. (E2:26:12)</i></p>
3. Focus should not be on own learning of processes but how to teach these processes to the learners		<p><b>1 of 11 or 9.09%</b></p> <p><i>Most of these processes have been touched on very briefly. Definitely not enough. What is most important though is not MY using these processes, since I did that for five years in university and have proven that I'm adequate equipped at worst in these areas, but how to get my students to do this. We have not done this latter enough in my estimation. (E2:24:4)</i></p>
4. Could not understand the processes	<p><b>1 of 27 or 3.70%</b></p> <p><i>I could not understand them well. (E1:28:1)</i></p>	
5. Mathematical processes empowered participants	<p><b>4 of 27 or 14.81%</b></p> <p><i>I'm now able to solve math problems, can give reasons and know how to select the tools. (E1:28:12)</i></p>	

**(i) Sufficient emphasis on the mathematical processes in the programme**

From Table 5.11 it is clear that six of the 11 responses by the Canadian participants and 12 of the 27 responses by the South African participants indicated that sufficient emphasis was placed on mathematical processes in the programme, but also that 4 of the 11 responses by the Canadian participants indicated that some of the processes were left out in the programme (category 2). It is noteworthy that one participant indicated that not only should these processes be mastered by the participants, but the strategies of teaching them to the learners should also receive attention (Category 3, Table 5.11). Four of the 27 responses by the South African participants also indicated that they were empowered by the mathematical processes. This supports my own observations (field notes) regarding the mathematical processes in MLED 574: Teacher students struggled with applying the mathematical processes in the class work activities. Of the five processes which are dealt with in MLED 574, *viz.* Problem-solving, Communication, Reasoning and proof, Connections and Representation, problem-solving is the process that the teacher-students are most familiar with. They regard it as the process of finding the answer to a word problem.

This then concludes the analysis and reporting of the questionnaires. The next section deals with the analysis (done with the help of ATLAS. ti) of the focus group discussions.

### **5.3 VIEWS AND EXPERIENCES BY PARTICIPANTS FROM THE FOCUS GROUP DISCUSSIONS.**

As was mentioned previously in Chapter 4, five focus group discussions were held: three of these discussions were conducted in South Africa and two were conducted in Canada.

This section will start firstly with the themes that emerged from the South African context and then move to emerging themes from the Canadian context. Quotations that were used as evidence of claims made are referred to by a notation that should be understood as follows: In the notation (P11:08), P11 refers to primary document 11 in the hermeneutic unit for focus groups and interviews and 08 to the number of the paragraph in primary document 11.

#### **5.3.1 Emerging themes for the South African context**

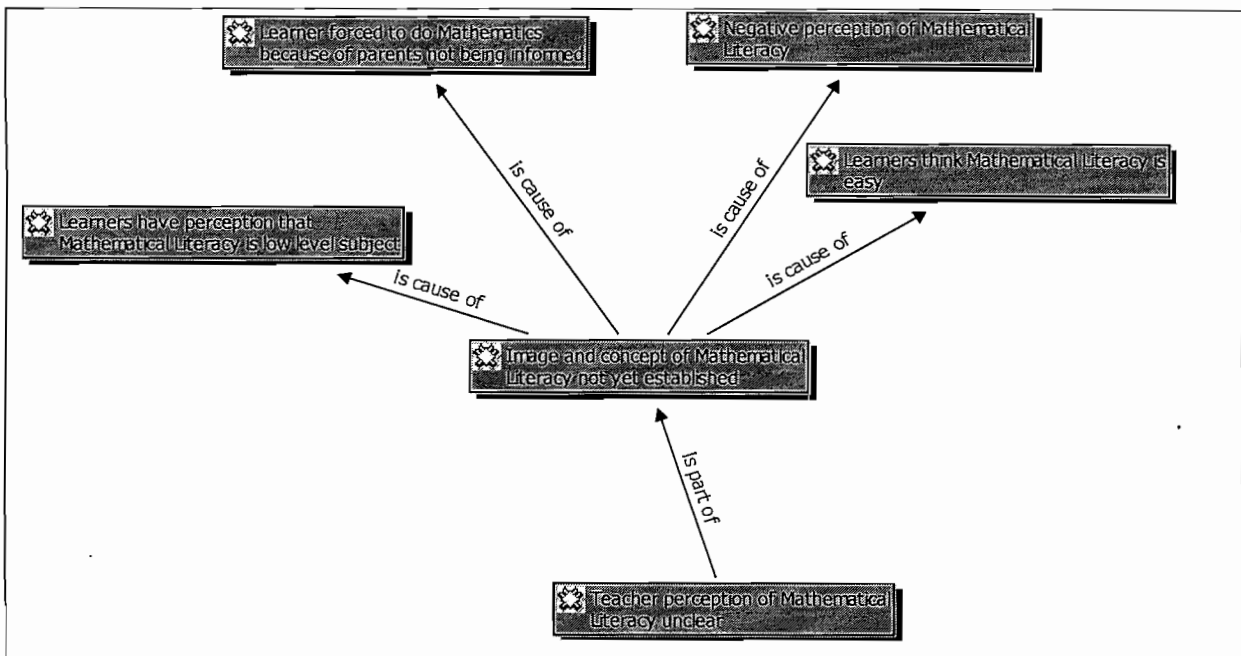
One of the three South African focus group discussions was held with three Afrikaans speaking participants and as such the discussion was conducted in Afrikaans in order for the participants to be as comfortable as possible during the discussion. The analysis of the transcriptions created four emerging themes, *viz.*:

1. Mathematical Literacy (image and concept) as subject is not yet fully established;
2. Addressing the needs in the programme;

3. History of Mathematics is not important in the training of Mathematical Literacy teachers; and
4. Developing a 'new status identity' as Mathematical Literacy teacher.

### 5.3.1.1 Mathematical Literacy as subject is not yet fully established among learners and the greater society

Figure 5.1 illustrates the network that was developed from the three South African focus group discussions and deals with the perceptions of Mathematical Literacy.



**FIGURE 5.1 CONCEPT AND IMAGE OF MATHEMATICAL LITERACY IS NOT YET FULLY ESTABLISHED AMONG LEARNERS AND THE GREATER SOCIETY**

The relationships and concepts contained in Figure 5.1 shape the idea that the learners and society do not really understand what the subject entails, according to participants:

*Hulle verstaan nog nie rerig dat Geletterdheid is rerig 'n praktiese wiskunde wat jy kan gebruik na skool nie. Hulle verstaan dit nie... (P11:08)*

[Translation: They do not really understand that Literacy is really a practical mathematics that you can use after schooling. They do not understand that ...]

It must be noted that the participant is referring to the subject Mathematical Literacy when she uses the word "Literacy" in the quotation. This incomplete or not-fully-comprehended idea of Mathematical Literacy as subject might be the reason why learners view

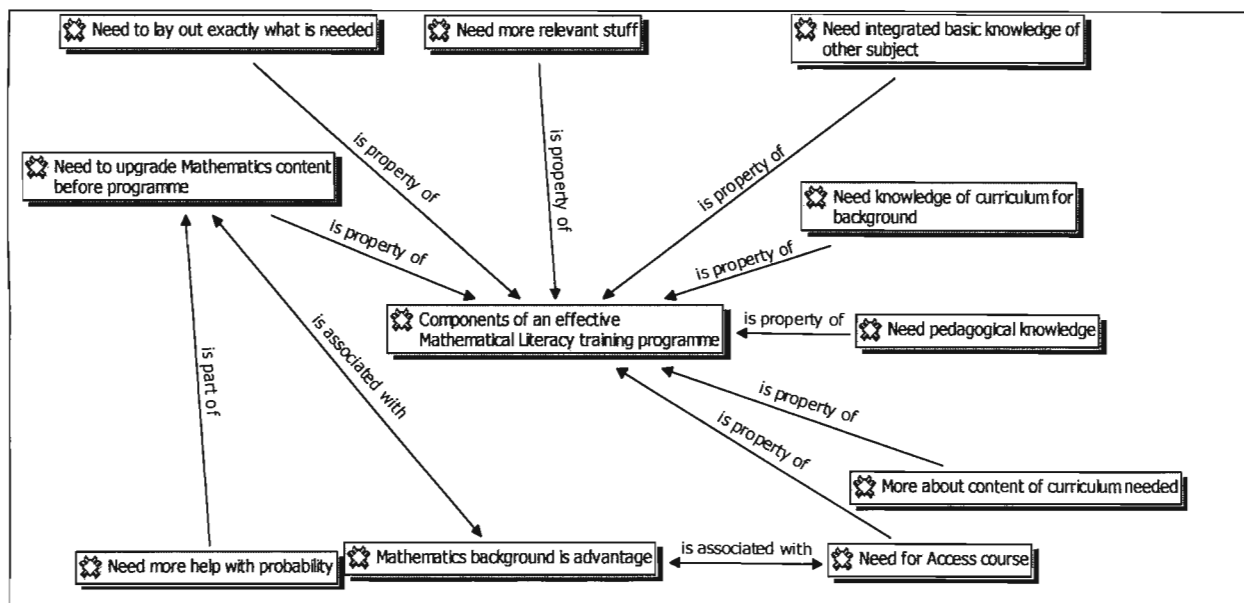
Mathematical Literacy as an easy and low level subject, why there is a negative perception about Mathematical Literacy and why children are being forced to take Mathematics and not Mathematical Literacy:

*Die gemeenskap, die ouers, almal. Die kind word nou basies gedwing om wiskunde te doen, en hulle se hy wil nie wiskunde hê nie, maar hy word nou gedwing om wiskunde te doen, maar hulle verstaan nog nie rerig mooi nie, die gemeenskap...( P11:11)*

[Translation: Society, the parents, every one. The child is now basically forced to do Mathematics and they say he does not want to take Mathematics, but now he is forced to do Mathematics, but they do not understand clearly, society ...]

### 5.3.1.2 Addressing the needs in the programme

Figure 5.2 indicates the various needs identified by the participants to be addressed in the existing Mathematical Literacy training programme.



**FIGURE 5.2 ADDRESSING THE NEEDS IN THE PROGRAMME**

From Figure 5.2 it appears that there is a need for an integrated knowledge base of other relevant subjects, upgraded personal mathematics content knowledge and more guidance with curriculum documents in the training programme. The participants focussed especially on the need for guidance with the curriculum documents as is clear in the following quote:

*...so ek sal voel mens moet meer deur die inhoud gaan lat ons, as ons nou hier uitgaan dat ons die hele kurukulum ken of darem 'n agtergrond het van wat gedoen word en waarheen ons werk.... (P11:22)*

[Translation: ... so I feel that one should go through the content more so that, when we leave here that we know the entire curriculum or at least have a background of what is done and what we are working towards.]

It is evident that this need is crucial as participants are using the curriculum documents to guide and inform them as can be seen earlier in this chapter (5.2.2.1) in the analysis of the questionnaire. Participants also expressed the need to be familiar with the content that should be dealt with in the different grades:

*I've been teaching mathematics and I did ACE in mathematics, so like her, that was a long time ago so I came here because I needed the NCS part...(P13:81)*

This relates well to the following observations (field notes) which I made during the lessons that required knowledge of the curriculum documents: Teacher-students that were not teaching Mathematical Literacy at their respective schools were not very conversant with the curriculum documents as they could not:

- relate a given context to assessment standards in the curriculum documents;
- name the learning outcomes for Mathematical Literacy when asked to write down the four learning outcomes.

This might be due to the fact that they do not use the curriculum documents as frequently as the teachers who do teach Mathematical Literacy at their schools and are using the documents fairly frequently.

According to the participants another area, in which participants need to improve, is their personal mathematics content knowledge as is clear in Figure 5.2. The participants also voiced the importance of the Access Course (2.4.1) as part of the upgrading of personal mathematics content knowledge. One participant acknowledged that he/she needed help with probability as an example of a gap in his/her personal mathematics content knowledge:

*...and the other thing in maths lit. because I'm doing both mats and math lit, in the maths lit there is this probability and we don't even touch that probability. (P12:146)*

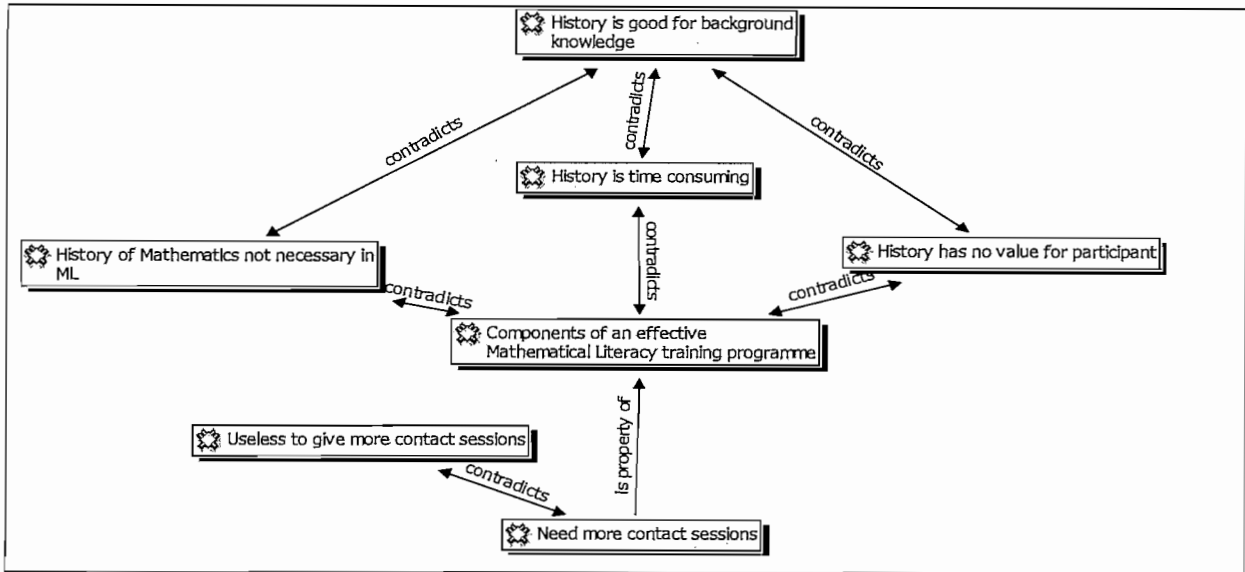
Lastly, the participants also listed the need for an integrated knowledge base of the basics of other relevant subjects, like geography (how to calculate distance on a chart) as important components of an effective Mathematical Literacy training programme:

*Because if you can check maths lit, it involves so many things. It involves even economics, it involves even accounting. If we can just have a touch of the basics of distance. Not necessarily that we should go and... We should just check what is it that is needed for maths literacy generally and then do the basics. (P12:40)*

Interestingly, the South African participants did not mention mathematics-for-teaching-knowledge as a need.

### 5.3.1.3 Participants do not view the history of Mathematics as important in the training of Mathematical Literacy teachers

Figure 5.3 illustrates the network that was drawn up based on the participants' opinions regarding why the history of Mathematics is not important for an effective Mathematical Literacy teacher training programme.



**FIGURE 5.3 THE HISTORY OF MATHEMATICS IS NOT IMPORTANT IN A MATHEMATICAL LITERACY TEACHER EDUCATION PROGRAMME**

As can be seen in Figure 5.3 the South African participants who took part in the focus group discussions experienced the history of Mathematics, which forms part of the content in module MLED 574 (see 2.4.3), as time-consuming.

*But I don't like the history part, this history part of mathematics. I know in some Grade Eight books there's that history of maths, but I don't know how does it impact on the learners' achievements or on the learners' knowledge. (P13:90)*

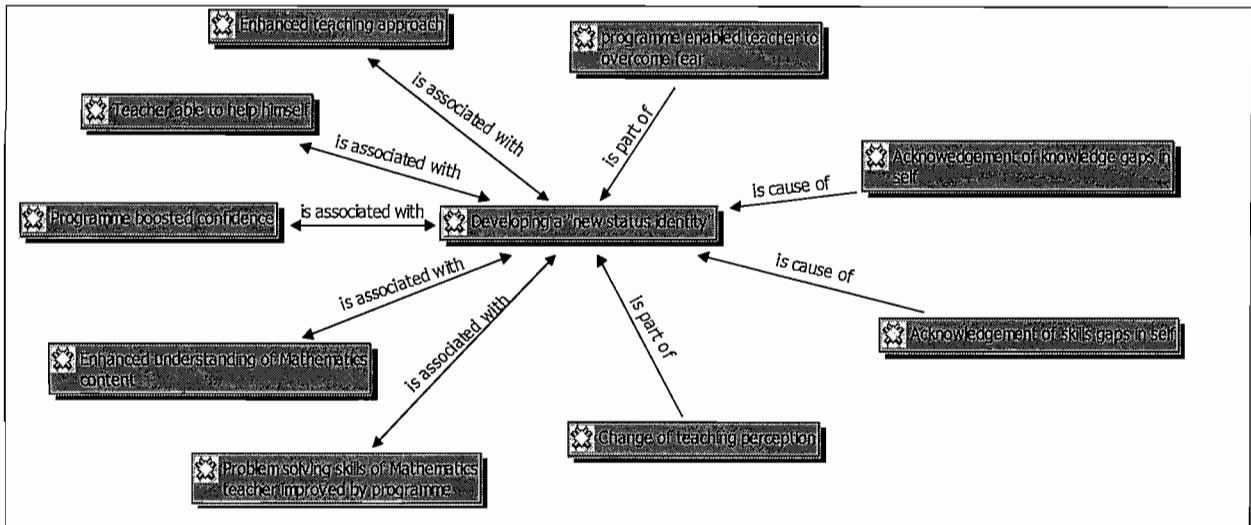
However, this experience was not shared by everyone as one participant acknowledged that the history of Mathematics is good background knowledge as can be seen in the following quote:

*Dit is goed om 'n agtergrond kennis te hê breër as net die suiwer wiskunde. (P3:50)*

[Translation: It is good to have background knowledge broader than only the pure Mathematics.]

### 5.3.1.4 Developing a 'new status identity' as Mathematical Literacy teacher

Figure 5.4 illustrates a network based on the concepts identified that make the participants think of themselves as mathematical literacy teachers.



**FIGURE 5.4 DEVELOPING A 'NEW STATUS IDENTITY' AS MATHEMATICAL LITERACY TEACHER**

From Figure 5.4 it is evident that 'developing a new status identity as Mathematical Literacy teacher' is the theme that manifests itself from the concepts and relationships that could be drawn from the responses. The network (Figure 5.4) shows that the change in teaching perceptions and overcoming fear of mathematics forms part of developing a new identity as a Mathematical Literacy teacher:

*...Okay, since I said that the last time I was in a mathematical class was ten years ago, and after attending this program last year I was able to, to overcome my fears for maths, because at least I'm literate and I have a class, I have been giving the class to get exposure. (P13:30)*

The participants showed the following signs of becoming mathematical literacy teachers:

**Programme boosted confidence:** *I think the ladies have said a lot. What they are actually saying is that this course gave us confidence... (P13:34)*

**Programme enhanced understanding of Mathematics:** *It was an eye opener. Like, I did maths up to Grade Eleven. Even though I didn't write maths in Matric, but I did maths. I majored in Maths at college. So sometimes when you were taught, we were taught to, it was just a teaching for us to get our diploma and all those things. (P12:075)*

**Programme helped participant to help himself:** *Even in real life situations I can be able to project what I save for that, next five years or so. (P13:40)*

**Programme enhanced teaching approach:** *The first thing that I can say is, it gave us light on how to approach the subject matter. (P12:050)*

**Problem-solving skills of Mathematics teacher improved by programme:** *Most of the things we didn't understand as we are doing them now. Now at least you know that if I do this, if I approach a problem, I have to start doing this and then you know how to use the different methods of solving a problem then you are just doing the solving of problems without understanding. (P12:075)*

It must be noted that this analysis was explorative in regard to the unique programme modules of the ACE (Mathematical Literacy) teacher training programme at the North-West University and caution should be used in generalising the results to apply to other teacher training programmes.

The next section provides an analytical account of what transpired during the focus group discussions that were held in Canada.

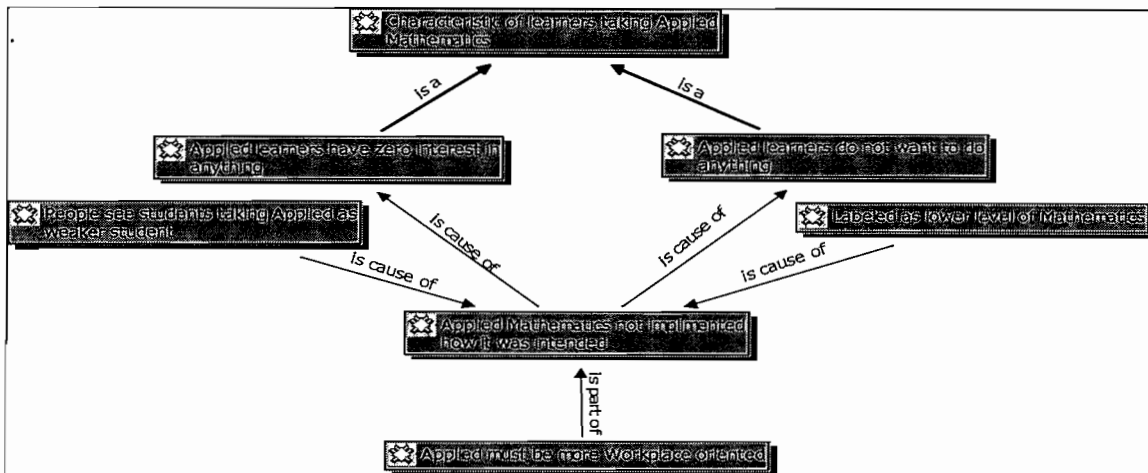
### **5.3.2 Emerging themes for the Canadian context**

In Canada two focus group discussions were held. Both of the discussions were conducted in English. Three emerging themes were identified and are discussed in the following section, *viz.*:

1. Applied Mathematics is not implemented in Canadian schools as was intended by the curriculum document (MoE, 2004);
2. Course repeats content that was learned in previous courses; and
3. Valuable elements in the existing course.

#### **5.3.2.1 Applied Mathematics is not implemented as was intended in Canadian schools**

Figure 5.5 illustrates the network that was developed from the two Canadian focus group discussions about Applied Mathematics, of which Mathematics for Work and Everyday Life forms an integral part. The network was generated from the following question: *“What is your view on the similarities and differences in Applied Mathematics as opposed to Academic Mathematics?”*



**FIGURE 5.5 APPLIED MATHEMATICS IS NOT IMPLEMENTED AS WAS INTENDED IN CANADIAN SCHOOLS**

From Figure 5.5 it seems as if participants want to convey the idea that Applied Mathematics (see Chapter 2), as it is taught in the Canadian schools today, is not taught as it was intended in the curriculum documents (MoE, 2004:6). It seems as if Applied Mathematics, as it is implemented today in Canadian schools, is for learners that have one or more learning impediments and are treated likewise by their teachers:

*I think we all see recreational **instability** that the classes were in and how different the two classes are, like I'm sure we all saw, the instances of the differences between Applied and Academic in our teaching blocks was and how completely different they were. (P10:002, emphasis added)*

*I think in Applied Mathematics students think it is more acceptable to not hand in anything, they don't think as much is expected of them. They just like, o well I'm in applied, I'm just, you know, that's why I'm in applied, because they're **I'm not smart, they can't teach us**, and they don't even try, and then they just, they don't care enough to hand in assignments or anything. (P10:004, emphasis added)*

According to the participants taking part in the focus group discussions, as Figure 5.5 indicates, the learners in the Applied Mathematics courses do not hand in assignments and do not have any interest in anything. They are also viewed as the weaker learners:

*...and then they just, they don't care enough to hand in assignments or anything. (P10:004)*

*...They could be just ... (unclear)... appropriate activities for them, but they had zero interest in anything, still thought, that, oh when are they ever going to use this ... (unclear)... you know like this is interest rates. (P10:017)*

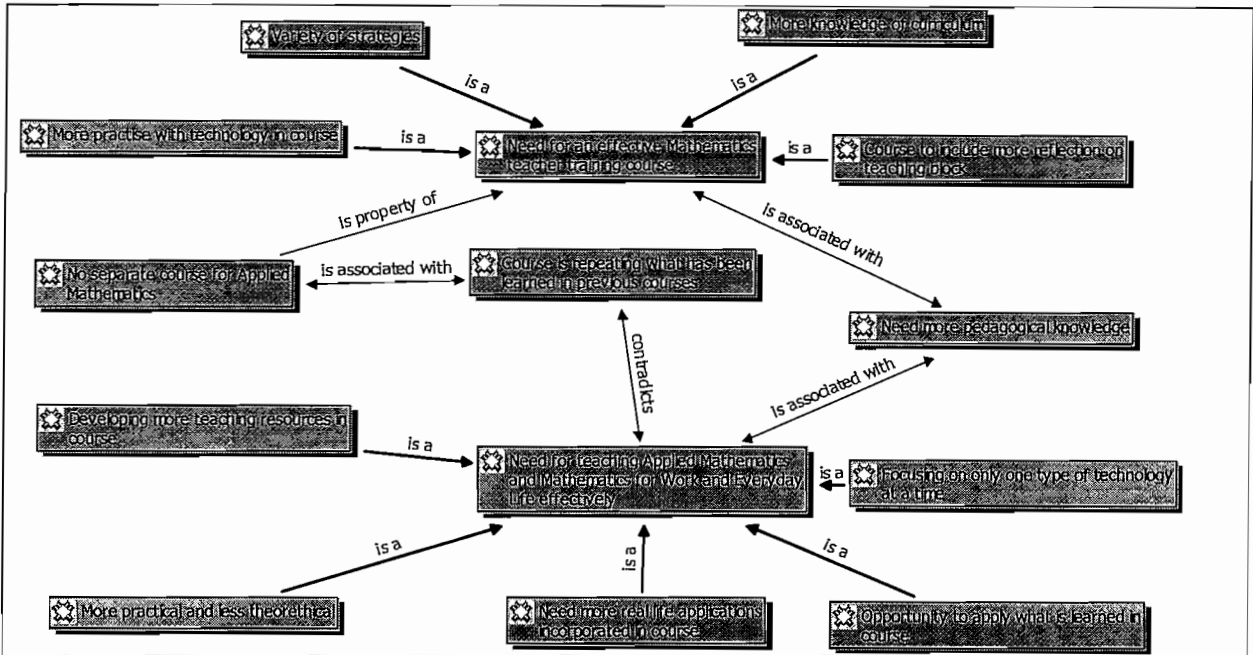
*It's not, it shouldn't mean what it means, it should mean like you're just choosing to blow that chance, but a lot of people see that as you're a weaker student. Like, I had one student even before, before this teaching block, saying that even my mom says I'm dum...so... (P10:008)*

It seems that the foregone behaviour by learners in Applied Mathematics classes might be the inevitable consequence of how Applied Mathematics courses were implemented and that, therefore, the course is not taught in the manner envisioned in the curriculum documents. This is in line with observations (field notes of researcher as participant observer) made during a school visit in Canada:

- The learners in this class seem to have learning disabilities.
- One learner has problems with remembering the work. Another learner does not understand English.
- The teacher is just trying to get the learners to do the task. Biggest challenge is getting learners to remember the work.
- One learner is telling the teacher a story that has nothing to do with the maths, but the teacher listens and seems interested in the story.

#### 5.3.2.2 Course repeats content that was learned in previous courses

Figure 5.6 indicates the views regarding the question whether a separate course in the existing I/S Mathematics Teacher Education Course at Brock University is necessary, a course that would focus specifically on learning how to teach Applied Mathematics or Mathematics for Work and Everyday Life.



**FIGURE 5.6 VIEWS ON THE NEED FOR A MATHEMATICS TEACHER EDUCATION PROGRAMME WITH SPECIFIC FOCUS ON COURSES LIKE APPLIED MATHEMATICS AND MATHEMATICS FOR WORK AND EVERYDAY LIFE**

From Figure 5.6 it is clear that the Canadian participants who took part in the focus group discussions agreed that no separate course is needed which will focus specifically on Applied Mathematics or Mathematics for Work and Everyday Life. Participants indicated that the existing course, the I/S Mathematics teacher training course should focus on the preparation for the teaching of Applied and Mathematics for Work and Everyday Life. One participant commented:

*I think it should be ... I think it should be incorporated into this class. This class is not what I had hoped it to be. (P9:028)*

Participants further indicated that the course was actually repeating content which had been learned in previous courses, as can be seen from the following discourse:

**Respondent 1:** *That's just it. Everything we've learned in this class, I found we've learned better actually in other classes. You guys agree?*

**Respondent 2:** *Mostly.*

**Respondent 1:** *See everything that we've learned in this class, theory wise we've learned better actually in other classes.*

Another participant indicated: *I think it's a waste of time.* (P9:028)

This contradicts the perception that an effective Mathematics teacher training programme should focus on Applied Mathematics or Mathematics for Work and Everyday Life. It must be noted that Figure 5.6 distinguishes between the more general teacher education programme, including all the courses that these pre-service teachers are preparing for, and the specific preparation for Applied Mathematics or Mathematics for Work and Everyday Life. (See chapter 2 of this study, at 2.5). The following four needs can be applied to the general Mathematics teacher education programme:

- **Variety of strategies needed:** *I would just generally to have more strategies sort of ways and activities to deal with kids for specific areas so I don't know, just not talking all the time, I tried to do different things.* (P10:082)
- **More practise with technology:** *And like, you got all those packages for like how to use your graphic calculators, which I found to focus on because I'm not strong with them and it gave me like the buttons to press to get certain things what we had, different things like using the main controls, for mini tab, like whatever it is for smart boards,....* (P10:038)
- **Need to include more reflection on teaching block:** *On the internet there's just mountains and mountains of sometimes crap so, just like, just sometimes it's not good information and so to have something that was more directed that we had learned in class and do something with it with this activity would have been nice and not have to start from scratch every time.* (P10:098)
- **Need more knowledge of the curriculum:** *Why, on the first day when we actually started looking at the curriculum we should probably have gone a bit further with it,...* (P9:044)

Needs that were specifically identified by the participants for learning how to teach Applied Mathematics and Mathematics for Work and Everyday Life are the following:

- **Need skills to teach Applied Mathematics or Mathematics for Work and Everyday Life effectively:** *Specially that I don't feel comfortable enough... but I don't feel like we're giving sort of skills, instead of just like use these manipulatives in the class when I feel like we should be giving skill to be able to have to teach these applied mathematics or workplace mathematics kids.* (P10:031)
- **More practical and less theoretical:** *...like academic is supposed to be sort of more theory and that kind of learning style. Applied is supposed to more hands on, and like fun I guess activities...(P10:023)*
- **Need to focus on only one technology at a time:** *I know it's that kind of thing, spending at least a few lessons on it, or like one period on a specific technology would have been a lot more helpful to me.* (P10:040)
- **Need opportunity to apply knowledge learned in course:** *I don't know if I learned a lot of stuff, I don't know if I could plan the classroom, cause I haven't had the*

*opportunity yet, ...I don't know it's helping me, cause I didn't have time to apply what we talked about in class to know. (P10:104)*

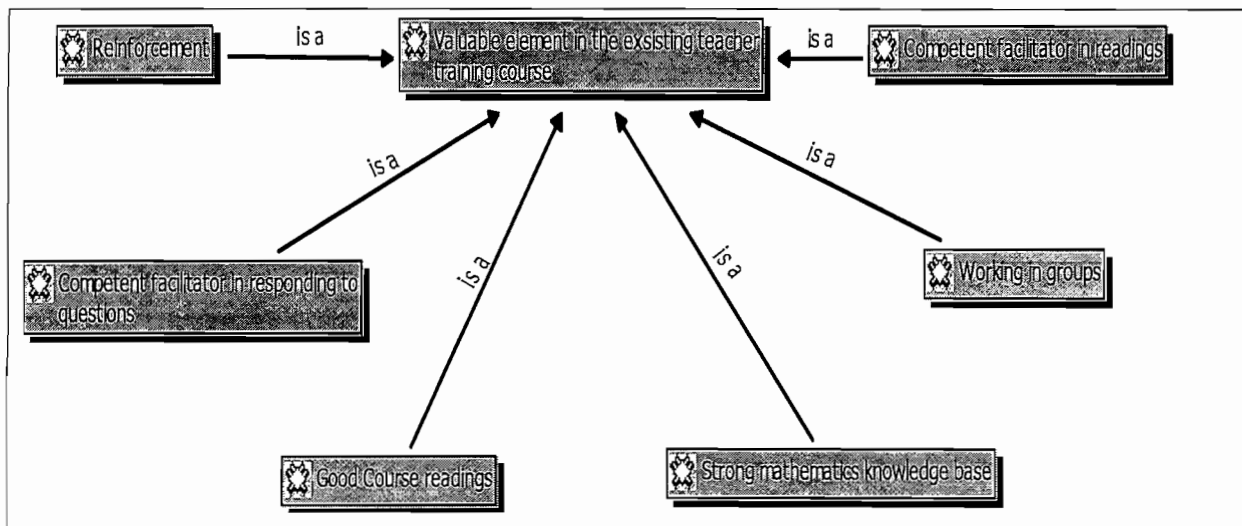
- **Need more real-life situations to be incorporated in course:** *When you are talking about a situation for an applied student where you really don't get it, then you'll break it down and give examples of, like their everyday life is really important. (P9:098)*
- **Need to develop more teaching resources:** *On the internet there's just mountains and mountains of sometimes crap so, just like, just sometimes it's not good information and so to have something that was more directed that we had learned in class and do something with it with this activity would have been nice and not have to start from scratch every time. (P10:082)*

From Figure 5.6 it is evident that the Canadian participants place a lot of emphasis on pedagogical knowledge as part of the content of an effective Mathematics teacher education programme in general, and specifically as part of a course in which they train how to teach Applied Mathematics and Mathematics for Work and Everyday Life. It is clear that these pre-service teachers need confidence to teach these courses effectively as can be seen from the following quote:

*It should be, more using the curriculum documents so that we have concrete stats, or something that we can take and have a little more confidence what we're teaching. (P9:062)*

### 5.3.2.3 Valuable elements in the existing Mathematics teacher training course at Brock University as identified by participants

In order to improve on existing programmes one needs to know what the valuable elements are in the existing programme so that these elements could be enhanced. The following elements were extracted from the responses and are reflected in figure 5.7.



**FIGURE 5.7 VALUABLE ELEMENTS IN THE EXISTING MATHEMATICS TEACHER TRAINING COURSE**

From Figure 5.7 one can deduce that the following components were singled out as valuable elements in the existing Mathematics teacher training course:

**Good course reading:** ... *but the last reading that was really good. How much unpacking of our knowledge we have to do and how we need to consider all the different ways to which students solve problems and if they're correct and if they can be generalized to other problems,...* (P10:102)

**Competent facilitator in theories:** *Joyce is like really good at the theory part, she knows the theories and that's something that I picked up, ...(unclear)...theory aspect of things.* (P10:106)

**Strong Mathematics knowledge base:** *Because you have a knowledge of the subject...So if you have knowledge of the subject then it takes away from the point of this.*

**Working in groups:** *One thing I did like about this course was everything was group based, but I think after, like learning how much I learned from other people in my group I think I will definitely try to incorporate that into the math, ...(unclear)...in high school, that was great.* (P10:046)

**Reinforcement in programme:** *...so coming here and having to do reinforcement as they want us to call it, it is good in some ways, but also boring in others.* (P10:096)

**Competent facilitator in responding to questions:** *If somebody asks a question, she can answer that question.* (P10:108)

It must be mentioned, however, that the participants did not want the course to be cancelled as can be seen from the following encounter:

**Researcher:** *So I'm going to play devil's advocate now. So we can cancel this course then, the methods course. What do you think about that?*

**Respondent 1:** *No.*

**Respondent 2:** *It is important ... if you can change that and actually take into account ... I guess... the things that we want to learn... it should be different.*

(P9:108-111)

This then concludes the analysis of the two Canadian focus group discussions.

The next section provides the analysis of the generated data from the transcribed individual interviews with three Canadian participants. The data is enriched with the inputs from two practising Canadian teachers who were not part of the programme, but who taught the Mathematics for Work and Everyday Life and Applied Mathematics courses in Canadian schools at the time of this study and could shed light on the teaching and learning of these courses.

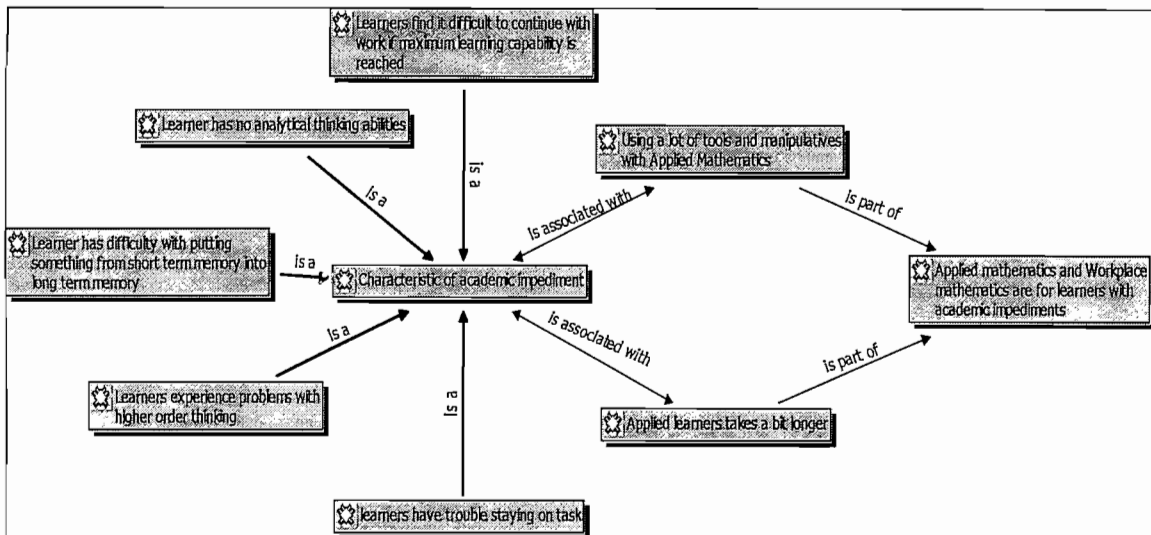
## **5.4 VIEWS AND EXPERIENCES OF CANADIAN PARTICIPANTS FROM THE INDIVIDUAL INTERVIEWS**

It must be noted that this section will contain data for the Canadian context only, as no individual interviews were conducted with the South African participants due to the fact that I decided that the data was already saturated enough for meaningful analysis. The following aspects generated by the data is focussed on:

1. The attitude towards Applied Mathematics and Mathematics for Work and Everyday Life courses;
2. The focus on the mathematical processes;
3. Content versus context; and
4. Reflection on the programme.

### 5.4.1 The attitude towards Applied Mathematics and Mathematics for Work and Everyday Life courses

Figure 5.8 illustrates a network in which relationships and concepts point to the fact that the majority of learners taking Applied Mathematics are learners with learning impediments. It seems as if Applied Mathematics became the Mathematics for the mentally disabled learner.



**FIGURE 5.8 APPLIED MATHEMATICS AND WORKPLACE MATHEMATICS ARE FOR LEARNERS WITH ACADEMIC IMPEDIMENTS**

From Figure 5.8 it is evident that the participants spoke about learners that were academically challenged.

It appears as if the majority of learners taking Applied Mathematics and Workplace Mathematics are learners with learning impediments. Based on the responses it becomes clear that the Canadian participants were talking about learners that were academically challenged in one way or the other. It seems like the Applied and Workplace mathematics classes are taken by learners who do not need an in-depth knowledge of Mathematics, but most of these learners are learners with learning disabilities as can be seen in the following quotes:

**Learners with learning difficulties:** *part of the problem was cause in a class like this a lot of kids were identified and that I was having a problem with because its more kids with learning disabilities. (P3:038)*

**Difficulty with memory:** *I had a student who had uhm...difficulty with putting something from short term memory into long term memory because he had uhm... something happened at birth that caused that and it was a challenge for me to remind him every time...it was multiplication every time when we where doing*

*percentage. He always wanted to just add or subtract. He never wanted to multiply or divide. (P6:037)*

**Learner constantly forgetting:** *...that's that one girl that kept putting her hand up. I show her something, as soon as she go back she forgot. So it's that kind of thing that you deal with. (P3:044)*

**Learners need the lowest level chunk of information:***...what I had to do was really simplify myself in order to try to teach the class...so I had to simplify in ways I actually spoke which is really challenging... then I had to really focus on what the ...the smallest and lowest level chunk of information is I was trying to present. (P5:50)*

**No analytical thinking in the Applied class:** *So, clearly that... that analytic way of thinking was not happening in my Applied class. (P4:10)*

**Applied learners take more time to understand:** *Sometimes with the Applied it takes a little bit longer... (P3:12)*

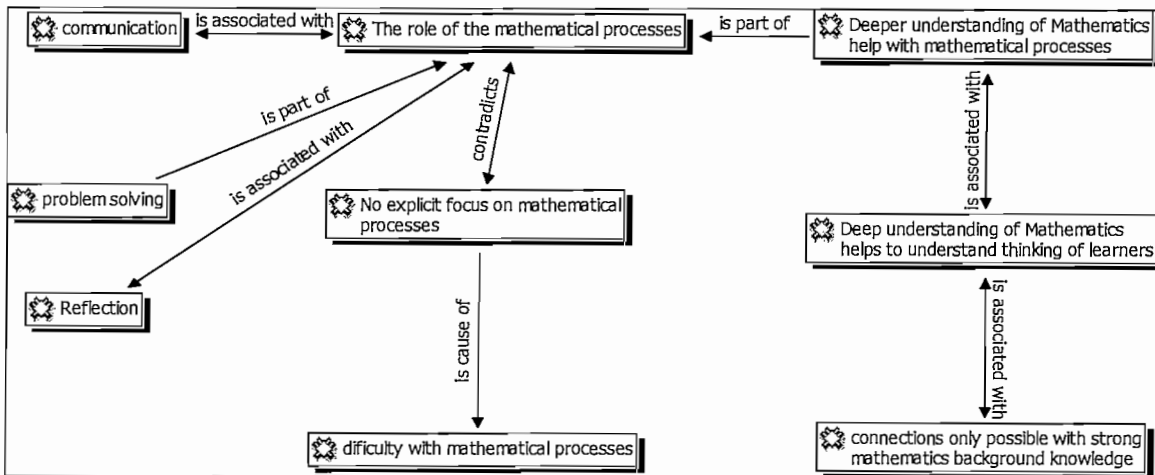
The other side of the coin could also be true: It might be that Canadian learners are more exposed to regular testing by specialists and as a result of the testing Canadian teachers are more aware of learning impediments in their learners.

*We did have couple of people come down that specialize in special education cause there were some kids in my class that I was really worried about so they came in and sort of saw what was going on and suggests okay maybe do this do that. (P3:38)*

It might be the case that in South Africa these kinds of learners are also in the Mathematical Literacy class, but there are no specialists in special education that regularly perform tests on these learners so that the possible learning disabilities amongst these learners may be detected.

#### **5.4.2 The focus on the mathematical processes**

The curriculum document clearly indicates that the mathematical processes must be included in the teaching and learning of Applied Mathematics and Mathematics for Work and Everyday Life.



**FIGURE 5.9 THE ROLE OF THE MATHEMATICAL PROCESSES**

From Figure 5.9 it is evident that Canadian participants were well aware that they had to include the mathematical processes (see Chapter 2) in the teaching of Applied Mathematics and Mathematics for Work and Everyday Life, but did not focus explicitly on these processes when they were teaching the courses during their teaching practicum:

*Uhm..I didn't work at those processes specifically on them but I did have my lesson learning goals were...under like the four broad categories so I was using uhm...communicate...like under communication I had: Communicate a solution to a problem and justify the steps needed and I was in the presentation part and then application,... (P1:52)*

It seems as if the participants found it inappropriate to apply the mathematical processes in their lessons because they think that these learners are not capable of higher order thinking (which they obviously regard as pivotal for applying the mathematics processes) as can be seen from the following quote:

*I think I've tried to cover those but I find a lot of them had a lot of difficulties with they have higher order thinking when it came to problem solving...(P6:065)*

The following mathematical processes were the only mathematical processes that were done in the lessons that were discussed:

**Problem solving:** *We didn't...We obviously did problem solving to some extend...but they're very very elementary problems...(P5:44)*

**Communication:** *The communication ...uhm ..I mean there was obviously ...we had class discussions... (P5:48)*

**Reasoning:** *...and to get how to help them with problem solving, help them with reasoning so I find the best way for me was just questioning. (P2:56)*

The practising teachers, however, think that knowledge of the mathematical processes is important. They also feel that a strong mathematics background can help with the mathematical processes especially when connections have to be made:

*So having a deeper understanding of math helps me to plan better, helps me to see where kids might go wrong and helps me to pull the pieces together and help the kids to make connections cause I see how it all fits. (P6:34)*

According to the practising teachers, reflection by the learners on their likes and dislikes create the opportunity to detect where help is needed as can be seen from the following quote:

*...but I use a lot of reflecting of what do you like, what don't you like, what's difficult. They're pretty forthcoming in telling me what...what it is, cause they know that I'll help them... (P4:16)*

It seems that a deeper understanding of mathematics and the mathematical processes helps the teachers of Applied Mathematics and Mathematics for Work and Everyday Life courses to understand the thinking of their learners.

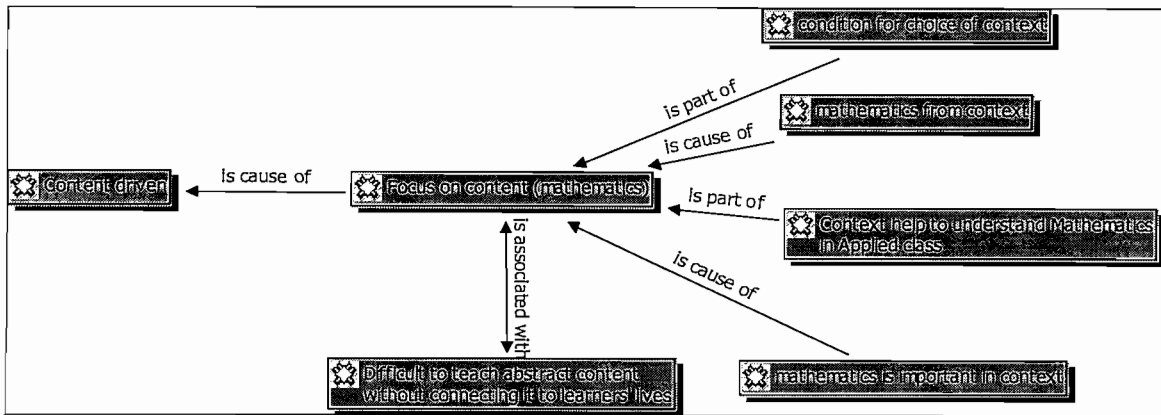
*So I think that having a strong math background has helped me to be a better 9 Applied Math teacher. (P6:34)*

*I think it's really because a deep understanding of the math can help you see what the kids are thinking when they're not...when they're going of the rails... (P4:34)*

It must be mentioned that I observed (field notes of researcher) A3 posters of the 7 mathematical processes hanging on the walls of the class room at the school where lesson observation was done during a Mathematics for Work and Everyday Life lesson.

### **5.4.3 Context versus content**

Whether the teaching of Applied Mathematics and Mathematics for Work and Everyday Life should be context-driven or whether it should be content-driven is debatable.



**FIGURE 5.10 CONTEXT VERSUS CONTENT OR VISA VERSA**

From Figure 5.10 it appears that participants sometimes select the content (mathematics) and then look for a context in which the content would fit, while other times they will take a context (real-life situation) in which the learners are interested and then build a problem around that and make the mathematics happen from there.

However, although there are mixed feelings about whether context should drive content or whether content should drive context, according to the responses Canadian participants valued the mathematics more than they value the real-life situation:

*So I say it happens both ways, but for me my bottom line is if I'm gonna give them a context or if I'm gonna give them a story or if I'm going to give them a manipulative then my question is where's the math? (P4:22)*

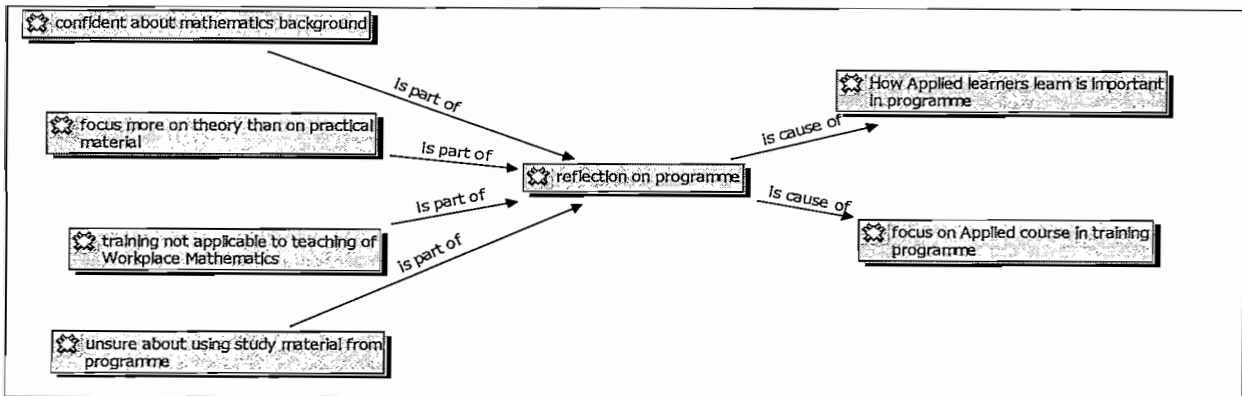
*... I mean the content end is obviously important, but I think we should take it and put it to context... So I think that the content does sort of ...drive the context in the sense that ok this is what they got to know now...ok...how can I present it to them. (P3:22)*

*...it was the mathematics that came out in using the real life situation. Uhm... definitely a more focus on that mathematics than the situation itself Uhm...I would say ..the cont...let me see...the content drove the context. (P1:46)*

*The Mathematics drove...what the curriculum stated, is what drove what we did. (P5:38)*

#### 5.4.4 Reflection on the programme

The responses regarding what participants thought of the programme were elicited by asking the question whether the material learned in the programme was used by the participants. Figure 5.11 shows the relationships and ideas that could be linked to form an emerging theme.



**FIGURE 5.11 REFLECTION ON THE PROGRAMME**

From Figure 5.11 it seems as if participants are of the opinion that they learned more about theory in the course and not practical material that would benefit them when teaching Applied Mathematics and Mathematics for Work and Everyday Life.

*I feel like a lot about we're learning all sorts about theory base some really amazing at kind of. In a sub conscious way but uh...its not like uh...concrete.*  
(P1:24)

It also appears as if the participants are satisfied with the way they have been prepared in terms of mathematical knowledge and skills in the programme. They are fairly confident that they will be able to handle the mathematics that is embedded in Applied Mathematics and Mathematics for Work and Everyday Life:

*Well like my mathematical background myself definitely prepared me as far as for math.* (P1:68)

One participant indicated an uncertainty whether the material that had been learnt in the programme was used by her, when she was asked the following question:

**Researcher:** *Did you in any way use the study material from the mathematics teacher education program to prepare for this lesson. If yes, how did it help you, if no, please explain why you did not use it?*

**Response:** *Don't know if I did. Uhm...I didn't get to use methods...I can't think of any others that I wanted to use, okay I can't think of any other methods right now from the class.* (P2:22)

Based on the responses the programme did not give specific training for teaching the Applied Mathematics and Mathematics for Work and Everyday Life course in Canadian schools:

*So the word mathematical they were mathematical based things but they were still more personal finance material and really I'm not having the training that I found that was applicable to teaching that type of material. (P5:24)*

One of the practising teachers interviewed in the study to shed more light on the actual teaching as it happens in practise, suggested that the existing teacher training course should focus specifically on the teaching of Applied Mathematics:

*I mean at the faculty it is an interesting thing to do that if it is a course that the kids can take or if it's a part of the entire programme where they focus on Applied I think it'd be perfect. (P3:34)*

The other teacher interviewed to shed more light on the actual practical teaching process, acknowledged that student-teachers in the existing mathematics education programme might have the necessary content knowledge, but she had serious doubts whether these teacher-students know and can apply the methods to convey this knowledge to learners taking Applied Mathematics and Mathematics for Work and Everyday Life:

*It could be assumed that they...they certainly would have the content knowledge...do they...but do they understand how kids learn...I think its really important for them to understand that because you can't you don't know your multiplication facts, doesn't mean you can't do math. (P4:44)*

It appears that an explicit focus on understanding what Applied learners can do and what they cannot do, would be helpful in the teacher training programme.

This need was also very clear in observations (field notes) I made as participant observer during the class which I attended along with the pre-service teachers in Canada: Coming back from teaching practicum, the pre-service teachers were given the opportunity to reflect on their experiences in the schools. It appears that they have learned a lot from their associate teacher and express the need to be taught strategies to help the specific kind of learner in the Applied Mathematics and Mathematics for Work and Everyday Life course.

The next section provides a summative overview on the analysis of the empirical data and includes a comparison of the main differences and similarities between the Advanced Certificate in Education (Mathematical Literacy), (ACE in ML), at the North-West University in South Africa and the Intermediate/Senior Mathematics Teacher Education Programme, (I/SMTEP), at Brock University in Canada.

## **5.5 SUMMATIVE OVERVIEW**

The aim of this section is to summarise the data that was generated and reported in this chapter and will add to the preliminary comparison of the two training programmes provided in Chapter 2 (Table 2.5).

### **5.5.1 Amalgamated Summary**

This section provides an amalgamated summary of the different data collection instruments presented in terms of the first two research questions in Table 5.12.

**TABLE 5.12 SUMMATION OF GENERATED DATA IN TERMS OF THE RESEARCH QUESTIONS**

PRIMARY RESEARCH QUESTION	SECONDARY RESEARCH QUESTIONS	QUESTIONNAIRE	FOCUS GROUP DISCUSSIONS	INDIVIDUAL INTERVIEWS
<p>Can we, as developers of teacher training programmes for Mathematical Literacy teachers in South Africa, learn from the teacher training programmes for similar subjects in Canada in order to improve our own programmes?</p>	<p>1. How do teachers in an in-service Mathematical Literacy training programme view the Mathematical Literacy training and how did they experience the programme?</p>	<p>Not all participants could define mathematical literacy.                      The ability to teach the subject was an important motivator.                      Expected to be taught personal mathematics content knowledge.                      Use curriculum documents to inform and guide.                      Majority of participants use text book as primary resource.                      Mathematics modules benefited South African participants.                      Didactics modules benefited South African participants and boosted confidence.                      Influence of programme: positive.                      Participants indicated that the times when they were using real-life situations they could draw on their experiences in the programme.                      Sufficient emphasis on Mathematical processes.</p>	<p>Mathematical Literacy not yet fully conceptualised.                      The importance of addressing specific needs in programme.                      History not important for teaching Mathematical Literacy.                      Developing a new status identity.</p>	

PRIMARY RESEARCH QUESTION	SECONDARY RESEARCH QUESTIONS	QUESTIONNAIRE	FOCUS GROUP DISCUSSIONS	INDIVIDUAL INTERVIEWS
	<p>2. How do teachers in a pre-service mathematical literacy training programme view the training for Applied Mathematics (gr.10) and Mathematics for Work and Everyday Life (gr. 11-12) and how did they experience the programme?</p>	<p>Majority of participants could define mathematical literacy.</p> <p>Ability to teach mathematics well was main motivator.</p> <p>Expected to be taught mathematics-for-teaching knowledge.</p> <p>Use curriculum documents to inform and guide.</p> <p>Use people as primary resource.</p> <p>Mathematics courses enhanced meta-cognitive skills and critical thinking, but did not prepare participants to teach the mathematical literacy courses.</p> <p>Influence of programme: Participants indicated need to be taught mathematics-for-teaching knowledge.</p> <p>Participants indicated that they could draw on the programme when they were using cooperative learning in their lessons.</p> <p>Sufficient emphasis on Mathematical processes.</p>	<p>Applied Mathematics not implemented as was intended.</p> <p>Course repeats content learned in previous courses.</p> <p>Valuable elements in programme.</p>	<p>The attitude towards Applied Mathematics and Mathematics for Work and Everyday Life courses.</p> <p>The focus on the mathematical processes.</p> <p>Context versus content.</p> <p>Reflection on the programme.</p>

## 5.5.2 The similarities and differences in the South African and Canadian context

The last secondary research question is:

<b>3. What are the similarities and differences in the mentioned training programmes offered at the two universities?</b>
---

This question will be answered by firstly stating the common areas that were found in the empirical data and, secondly, the differences in the programmes will be presented in tabular format.

### 5.5.2.1 The similarities in the two programmes

Although the two programmes differ considerably, as can be seen from Table 2.5 in Chapter 2, the following similarities could be abstracted from the analysis of the empirical data:

#### (1) Perceptions of mathematical literacy.

The majority of the participants in the two countries shared the same basic perception of mathematical literacy *viz.* the ability/competency to use/apply mathematics in everyday life (See Table 5.3).

#### (2) Attitudes of learners towards the subject/course

Both Mathematical Literacy in South Africa and the Mathematics for Work and Everyday Life courses, also referred to as the Applied courses in Canada, were viewed by learners as a lower level of Mathematics.

#### (3) The challenging nature and love for the subject/course as motivators for enrolling in the programmes

The challenging nature of the subject/course as well as the love/passion for Mathematics was indicated as motivators for taking part in the programme by both the South African and the Canadian participants.

#### (4) Common uses of the curriculum document

It seems as if both the South African and the Canadian participants in this study have been using the curriculum document to inform and guide them regarding the teaching of the subject or course.

## **(5) The role of the mathematical processes in the programmes**

It appears that the South African and the Canadian participants agreed that sufficient emphasis is placed on the mathematical processes in the programme (Table 5.11).

### **5.5.3 The differences in the two training programmes**

Table 5.13 indicates the differences between the South African context and the Canadian context of the study. These differences were extracted from the analysis of the empirical data

**TABLE 5.13 THE MAIN DIFFERENCES IN THE ACE IN ML AT NWU AND THE I/SMTEP AT BROCK UNIVERSITY**

<b>Data collection instruments</b>	<b>Category</b>	<b>The Advanced Certificate in Education (Mathematical Literacy) South Africa</b>	<b>The Intermediate/Senior Mathematics Teacher Education Programme Canada</b>
The questionnaires	Profile of participants in the programme	The typical South African participant in this study is a middle aged woman (between 30 and 39 years) who is trilingual with Setswana as mother tongue and was trained as pedagogical generalist in some other-than-Mathematics subject specialisation.	The typical Canadian participant in this study is a bilingual (English and French) young girl in her early twenties who most often speaks English.
	Mathematics background of the participants	Has a general orientation of teaching without grade 12 Mathematics and did not undergo any former post-matric Mathematics teacher training and therefore does not have didactical knowledge of Mathematics.	Has a good mathematical background, is well trained in Mathematics as subject.
	Preference for teaching the subject	Participants in the programme want to teach Mathematical Literacy.	Prefer not to teach the Applied course or the Mathematics for Work and Everyday Life course.
<b>Data collection instruments</b>	<b>Category</b>	<b>The Advanced Certificate in Education (Mathematical Literacy) South Africa</b>	<b>The Intermediate/Senior Mathematics Teacher Education Programme Canada</b>
Focus group discussions	Context versus content	Participants feel confident moving from context to content.	Participants place more emphasis on content than on context.
	Knowledge of curriculum	Teachers lacking knowledge of the Mathematical Literacy curriculum.	Teachers well conversant with curriculum documents.
	Type of learner	The learners in the Mathematical Literacy class are learners that do not need mathematics for their future careers.	The majority of the learners in Applied Mathematics and Mathematics for Work and Everyday Life has learning disabilities.
	Mathematical background	Poor mathematical background.	Canadian participants have a strong mathematics background.
	Reflection on the programme	Experienced the programme as positive.	Programme did not supply specific training on how to teach the Applied Mathematics and Mathematics for Work and Everyday Life courses.

## 5.6 CONCLUSION

This chapter provided the analysis and interpretations of the data that were generated and collected for the inquiry. The next chapter will conclude the study with findings and recommendations, as well as possible research questions for future inquiry.

**CHAPTER 6:**

**SUMMARY, FINDINGS AND  
RECOMMENDATIONS**

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## 6.1 INTRODUCTION

The ability to use mathematics effectively or to be 'numerical independent' in a twenty-first century technologically driven world cannot be over emphasised. Effective training programmes to prepare teachers to help learners develop this ability in order to make them, the future adults, self-managing persons, contributing workers and participating citizens (DoE, 2003:9) in a developing democracy, is even more crucial.

The primary aim of this study was to explore the practices and experiences of in-service and pre-service teachers enrolled in mathematical literacy teacher training programmes at two universities, *viz.* the North-West University in South Africa and Brock University in Canada. The question which directed the study was:

Can we as developers of teacher training programmes for Mathematical Literacy teachers in South Africa learn from the teacher training programmes for similar subjects in Canada in order to improve our programmes?

Before I discuss any results, I include a short summary of each chapter in order to illustrate the line of thinking within this inquiry.

### 6.1.1 Synoptic overview of the inquiry

Chapter 1 provided the context for this inquiry, outlined the process and indicated my aim to explore the practices of teachers enrolled in existing mathematical literacy training programmes in order to highlight 'what works and what does not', which is pivotal for the continuous improvement of sustainable teacher training programmes of the highest possible standard.

The second chapter portrayed the two mentioned teacher training programmes that were investigated, but also introduced the reader to the particular nature of the subject Mathematical Literacy in South Africa and the two courses which were focused on in Canada *viz.* Mathematics for Work and Everyday Life and Applied Mathematics. This chapter also gave a view on distance education in South Africa as well as the particular nature of the pre-service mathematics education teacher training programme in Canada at Brock University.

In Chapter 3, I moved on to focus on the following main areas pertaining to my study:

The various definitions from extant literature and the importance of mathematical literacy for the twenty-first century;

The landscape of Mathematics and Mathematical Literacy teacher education; and

The teaching of mathematical literacy subjects or courses.

Chapter 4 provided an outline of the instrumentation and methods that were employed in the study to collect and analyse the data. The chapter also shed some light on the qualitative case study approach and the motivation for using this approach rather than quantitative methods. Procedures like completing the questionnaires, conducting focus group discussions and interviews in order to collect valid and reliable data were described. Chapter 4 also indicated the number of participants and how these participants were selected and outlined the data collection and analysis processes that were employed in this inquiry.

In Chapter 5 the data that was generated and collected was systematically reported by firstly analysing the questionnaires: The perceptions of mathematical literacy by the participants were analysed as well as their expectations of and motivations for enrolment in the programme. The data from these questionnaires were used to inform the themes mirrored in various networks generated by ATLAS. ti, which underpins the discussion of the data.

Against the background of the above summative overview, I will start this chapter with an explanation of why it was necessary to explore the practices and experiences of teachers in the Mathematical Literacy teacher training programme in South Africa and the Mathematics teacher education programme in Canada. I will then portray the findings against each of the three secondary research questions and lastly reflect on recommendations and possible questions for further research.

## **6.2 THE NEED FOR REFLECTION ON CURRENT MATHEMATICAL LITERACY PROGRAMMES**

Mathematical Literacy is the new subject in South African schools. It is also the subject that was included in the school curriculum to empower our learners to make sense of, to contribute to and to participate in the twenty-first century world. Most importantly, it is the subject which, together with Mathematics, provides an opportunity to all learners to engage in mathematics. The teachers who were to teach this subject had to be re-trained to teach Mathematical Literacy in a way that would ensure that Mathematical Literacy becomes the vital subject it was intended to be. Herein lies the difficulty: How should these teachers be prepared in a Mathematical Literacy teacher training programme to enable them to teach Mathematical Literacy?

Canada, as developed country, was included in this study because Mathematics for Work and Everyday Life is one of the courses that can be taken by learners who do not need Mathematics to pursue study or work in mathematically-based fields, just like Mathematical Literacy in South African schools. In contrast with Mathematical Literacy, this course has been part of the Canadian school curriculum for almost 10 years already. Canada ranked among the first three of 43 countries in an international assessment programme, PISA 2003

(see 1.1.5) in which the mathematical literacy of 15-year old learners were assessed. It therefore makes perfect sense to explore views and experiences from prospective teachers enrolled in similar programmes in a developed country like Canada, but also to investigate the views of prospective teachers enrolled in teacher training programmes in our own country in order to improve Mathematical Literacy training programmes in South Africa.

In the next section I will provide a very short summary of extant literature which served as the framework against which the findings were positioned.

### **6.2.1 Definitions of mathematical literacy**

Mathematical literacy as ability to use and appreciate mathematics in everyday life has different names in various countries: In South Africa it is called mathematical literacy, whilst elsewhere it is called numeracy, quantitative literacy, mathemacy or matheracy and as such there are different definitions for this ability. However, the subject Mathematical Literacy that was implemented in 2006 in the South African school curriculum and which must develop mathematical literacy in learners has its counterparts in other countries: In England this subject is called Functional Mathematics and in Canada the course is called Mathematics for Work and Everyday Life. Currently, four years down the line in South Africa, there is still debate on what exactly Mathematical Literacy as subject entails.

### **6.2.2 The landscape of Mathematics and Mathematical Literacy teacher education**

Mathematical Literacy teacher education is embedded in the broader spectrum of Mathematics teacher education and therefore the literature review also focussed on Mathematics teacher education. According to researchers in the mathematics education arena (Adler, 2005:63; Brown & Schäfer, 2006:2; Bishop, 1991:173; Lerman, 2001:87; Da Ponte & Chapman, 2002:223; Malara & Zan, 2002:535; Ball & Bass, 2003:1; Graven & Venkat, 2007:337), Mathematics teacher education is a complex issue. Various ways of dealing with this complexity and consequently ways of dealing with mathematical literacy teacher training has been focussed on in research, but still no mathematical literacy teacher training model, tailor-made for the South African context, could be found in extant literature. Becoming a mathematical literacy teacher has implications for developing a new identity as Mathematical Literacy teacher. The role of literacy, but also Mathematics, in the training of mathematical literacy teacher was discussed in Chapter 3 (see 3.3.2 and 3.3.3).

### 6.2.3 The teaching of mathematical literacy subjects and courses

The nature of a subject should to a large extent inform how it is taught and should subsequently influence the training of the teacher. Different approaches (see Table 3.7) of researchers (Brown & Schäfer, 2006:50; Frith & Prince, 2006:53; Graven & Venkat, 2007: 3) formed part of the literature review in order to find effective approaches to how this new subject could be taught most effectively. The fact that the subject or courses should develop in learners the ability to apply their mathematics knowledge to real-life situations makes it imperative that learners are taught the mathematics that would be needed to engage meaningfully in real-life situations, in other words, how to move from context to content (see Table 3.12). This requires that certain mathematical processes (see Table 3.11) should form part of teaching mathematical literacy subjects or courses effectively. The dilemma of mathematics content knowledge and mathematics-for-teaching knowledge, which Ball and Bass (2003:1) and Davis and Simmt (2006:293) focus on, was also discussed.

## 6.3 SYNOPSIS OF KEY FINDINGS

In order to answer the primary question, three secondary questions were asked.

### 6.3.1 Views and experiences of the South African in-service teachers in the programme who were involved in the study

The following views and experiences were extracted from the results of the generated data and address the **first secondary question**:

How do teachers in an in-service Mathematical Literacy training programme view the Mathematical Literacy training and how did they experience the programme?

**South African in-service teachers** who participated in this study:

- could not all define mathematical literacy (Table 5.3);
- experienced the ability to teach the subject as an important motivator (Table 5.4);
- expected to be taught personal mathematics content knowledge (Table 5.5);
- used curriculum documents to inform and guide them (5.2.2.1);
- used text books as primary resource (Table 5.7);
- benefited from the mathematics modules in the programme (5.2.2.3);
- experienced the didactics modules as beneficial to them and it boosted their confidence (5.2.2.4);

- experienced the programme positively (5.2.2.6);
- indicated that the times when they were using real-life situations they could draw on their experiences in the programme (5.2.2.7); and
- experienced that sufficient emphasis was placed on the mathematical processes (5.2.2.8).

In addition to the above mentioned views and experiences, the following findings can be made about the South African participants in this study:

**(i) Mathematical Literacy is not yet fully comprehended by the South African participants and their learners**

Participants in the study had different views on what mathematical literacy entails (Table 5.3). These different connotations of mathematical literacy as ability, as well as the subject, were identified during the focus group discussions with the South African participants (Figure 5.1). I then triangulated these findings with data from the literature (see 3.2.1 and 3.3.1.4).

A thorough understanding of the concepts of mathematical literacy by the prospective Mathematical Literacy, Applied Mathematics or Mathematics for Work and Everyday Life teacher will enhance teaching and learning methods in the class room. It will further also enhance understanding of the type of learner who is taking these subjects which will result in more effective teaching. This could be combined with professional input from diagnostic tests that can effectively identify possible learning obstacles that prevent the optimal learning of mathematics by learners.

Lastly, a clear conceptualisation of mathematical literacy in the subject or course by the teachers, learners, as well as the parents, will most likely reveal the need for an additional literacy course which could take care of the understanding of text and language in the context for which knowledge of mathematics is required.

**(ii) South African participants developed a new ‘status’ identity as Mathematical Literacy teachers.**

Based on the empirical data in this study I found that the development of a new identity was mainly influenced by the ‘attitude towards mathematics’. The South African participants in the study came from diverse backgrounds in terms of their mathematical competence (Table 4.7) and were not all teaching Mathematical Literacy at their schools. They were teaching a variety of subjects which ranged from Languages to Social Sciences (Table 4.8). Data drawn from the focus groups, the questionnaires and field notes of discourses during the classes show the self-positioning of the South African participants within the learning of mathematics in the teacher training programme. It appears that for these teachers, being trained as some

kind of mathematics teacher, i.e. to be trained as Mathematical Literacy teacher, was a very new and challenging experience in which they were developing some sort of status-embraced identity (field notes). I could triangulate this finding with the fact that Brown and Macrae (2005:53) list the following aspects as possible factors which consequently influence the development of an identity viz.: Attitude towards mathematics (attitudes were positive, see 5.2.2.3); student adaptation to university life (was positive, field notes); social and economic background and lastly educational background (Table 4.13).

### **6.3.2 The views and experiences of the Canadian pre-service teachers in the teacher education programme who were involved in the study**

The following views and experiences were extracted from the results of the generated data which address the **second secondary research question**:

How do teachers in a pre-service mathematical literacy training programme view the training for Applied Mathematics (gr.10) and Mathematics for Work and Everyday Life (gr. 11-12) and how did they experience the programme?

**Canadian pre-service teachers** who participated in this study:

- were able to define mathematical literacy (5.2.1.1);
- experienced the ability to teach mathematics well as main motivator (5.2.1.2);
- needed and expected to be taught mathematics-for-teaching knowledge (5.2.2.3 and 5.2.1.3);
- used curriculum documents to inform and guide them (Table 5.6);
- used people as primary resource (5.2.2.2);
- experienced that Mathematics courses enhanced meta-cognitive skills and critical thinking, but did not prepare participants to teach the mathematical literacy courses (Table 5.8);
- could draw on the programme when they were using cooperative learning in their lessons (5.2.2.7); and
- experienced sufficient emphasis on mathematical processes in the programme (Table 5.11).

In addition to the above mentioned views and experiences from the Canadian participants, the following findings pertaining to the practises of the Canadian participants are provided:

### **(i) Emphasis should be placed on mathematical processes**

While it appears that Canadian participants have no problem implementing mathematical processes in other courses (5.4.2), they are of the opinion that some of these processes require higher order thinking which is above the ability of the kind of learner in their Applied Mathematics or Mathematics for Work and Everyday Life classes (Figure 5.9). However, the mathematical literacy processes are well emphasised and discussed in the revised curriculum documents (MoE, 2007:17) and when visiting schools in Canada I found that in two classes these processes were hanging on the walls of the classes in the form of posters. It was also evident from the classes which I attended that mathematical processes were viewed as important in the teaching of mathematics to learners (field notes). Canadian participants also indicated in their questionnaires that the mathematical processes were sufficiently focussed on in their teacher education programme (Table 5.11).

An intersection of the PISA competencies (OECD, 2003:47) and the mathematical processes listed by the Canadian Mathematics Curriculum Framework (MoE, 2004:10) (Figure 3.3) indicates Problem-Solving, Reasoning and Proof as well as Representations as the most important processes that should take place through modelling, communicating, reflecting and connecting, using aids, tools (technology), symbols and also computational strategies.

### **(ii) Content drives context**

There are some mixed feelings regarding whether context should drive content or whether content should drive context if one looks at extant literature (3.4.1). From the analysis of the empirical data it appears as if the Canadian participants were of the opinion that content should drive context. This might also be because there was no explicit focus on the mathematical literacy courses (Mathematics for Work and Everyday Life and the Applied Mathematics courses) in their teacher education programme. Based on the responses in the individual interviews (Figure 5.10) it appears as if Canadian participants valued the mathematics more than they valued real-life situations. I also found this phenomenon in the responses to the questionnaires (Table 5.8). In my field notes of observations during the course at Brock University when students were asked to present lessons I noted that students place a strong focus on the mathematics when presenting their lessons.

## **6.4 THE SIMILARITIES AND DIFFERENCES IN THE MENTIONED TRAINING PROGRAMMES OFFERED AT THE TWO UNIVERSITIES**

The following similarities and differences were found in the analysis of the generated data and address **the third secondary question:**

What are the similarities and differences in the mentioned training programmes offered at the two universities?

#### 6.4.1 . Similarities:

- It appears as if both programmes aim to train teachers for a subject or course that is regarded as a lower level of Mathematics by the wider society;
- From the analysis of the generated data it seems as if both the South African and the Canadian participants agreed that sufficient emphasis is placed on mathematical processes in the programme (Table 5.11).
- It appears as if both the South African and the Canadian participants use the curriculum documents to inform and guide them regarding the teaching of the subject or course.

#### 6.4.2 Differences:

- The first difference between the two programmes was the mode of delivery and the type of student enrolled in the programme: In Canada at Brock University the programme is delivered on-campus with a lot of contact classes for pre-service teachers, while in South Africa at the North-West University the classes are off-campus with only 12 contact sessions for in-service teachers.
- Another difference is that South African participants did not undergo any former post-matric Mathematics teacher training (and often did not even take Mathematics in grade 12), while the Canadian participants had a strong mathematics background and some of the participants took university bound mathematics courses in school (4.7.2.4).
- It also appears as if the programme in Canada prepares prospective teachers for the majority of learners who struggle with learning disabilities in the Mathematics for Work and Everyday Life and the Applied classes, while the programme in South Africa prepares prospective Mathematical Literacy teachers for learners who want to be taught the basic ability to engage meaningfully in mathematically based real-life situations.
- The last significant difference between the two programmes has to do with the expectations and the preferences of participants: It was found that the South African participants expected to be taught mathematics content knowledge and preferred to teach Mathematical Literacy, while the Canadian participants

expected to be taught mathematics-for-teaching knowledge and did not indicate any eagerness to teach Mathematics for Work and Everyday Life upon completion of the programme.

## 6.5 THE PRIMARY RESEARCH QUESTION

Can we as developers of teacher training programmes for Mathematical Literacy teachers in South Africa learn from the teacher training programmes for similar subjects in Canada in order to improve our programmes?

### (i) Lessons from Canada and from our own programme

I am of the opinion that developers of Mathematical Literacy teacher training programmes in South Africa can indeed learn from the Canadian participants, as well as from participants in our own programme in the following manner:

- **The mathematical processes have a large role to play in any mathematical literacy curriculum** and should be explicitly mentioned in the National Curriculum Statements and not only be implied as is currently the case. From the empirical data it appears that sufficient emphasis is placed on the mathematical processes in the different mathematics courses (Table 5.11) in Canada and these processes are explicitly stated in the curriculum documents for all mathematics courses in Canada. In South Africa though, it appears that these processes are not coming to its full right in Mathematical Literacy classrooms as teachers are not very aware of these processes (field notes). From extant literature, as discussed in Chapter 2 (see Table 2.6), it appears that no explicit focus is placed on mathematical processes in the National Curriculum Statement (2003) for the South African subject Mathematical Literacy. Problem-solving, Reasoning, Communication, Connection and Representation is only implied in this document (see 2.8).
- **More emphasis should be placed on a strong mathematics background.** Based on the empirical data (Table 4.12) it was evident that the Canadian pre-service teachers have strong mathematical background knowledge and appeared confident in their mathematical abilities during the classes which I attended as participant observer (field notes). When presenting lessons, the mathematical competence of these pre-service teachers was obvious (field notes).

- **People are valuable resources in the teaching and learning of Mathematical Literacy.** The analysis of the generated data (5.2.2.2) clearly indicates that the Canadian participants are making good use of their colleagues, associate teachers and previous teachers' experiences from the internet to inform their own teaching. This phenomenon was not found among the South African participants. The South African in-service teachers who were involved in this study indicated the textbook and other written material as main resource used by them for the teaching and learning of Mathematical Literacy.
- **More emphasis should be placed on mathematics-for-teaching knowledge in the programmes.** It was clear throughout the analysis of the data that the Canadian participants expect to and expressed the need to be taught the mathematics-for-teaching knowledge that Ball and Bass (2003:1) and Davis and Simmt (2006:293) discuss. As was previously mentioned, they were quite comfortable with their mathematical knowledge, but indicated a definite need for knowledge on how to transfer their mathematics content knowledge, especially to the type of learner in the Applied Mathematics and the Mathematics for Work and Everyday Life classes. This need was not articulated at all by the South African participants. One explanation for this phenomenon might be that the pre-service teachers were beginner teachers and as such still need a lot of guidance with actual teaching practise.

(ii) **What can Canada learn from South Africa?** In South Africa teachers are specialising in the subject Mathematical Literacy. In this regard Canada can learn from South Africa in that specific focus should be placed on the training of teachers for Mathematics for Work and Everyday Life and the Applied Mathematics courses by adjusting existing courses to place more emphasis on the exclusive preparation of teachers to teach the mentioned courses. These courses require a specific approach and are different from the approach used by Mathematics teachers.

Before the recommendations and possible questions for further research are given, Table 6.1 is inserted to provide an overview of all the data from extant literature as well as empirical data, results and findings with reference to the research questions of this study.

TABLE 6.1

SUMMARY AND FINDINGS OF ALL THE DATA WITH REFERENCE TO THE RESEARCH QUESTIONS

		Primary Research Question		
		Can we as developers of teacher training programmes for Mathematical Literacy teachers in South Africa learn from the teacher training programmes for similar subjects in Canada in order to improve our own teacher training programmes?		
		Secondary Research Questions		
Data collection instruments		1. How do teachers in an in-service Mathematical Literacy training programme view the Mathematical Literacy training and how did they experience the programme?	2. How do teachers in a pre-service mathematical literacy training programme view the training for Applied Mathematics (gr.10) and Mathematics for Work and Everyday Life (gr. 11-12) and how did they experience the programme?	3. What are the similarities and differences in the mentioned training programmes offered at the two universities?
Results	Questionnaire	<p>Not all participants could define mathematical literacy. The ability to teach the subject was important motivator. Expected to be taught personal mathematics content knowledge. Use curriculum documents to inform and guide. Majority of participants use text book as primary resource. South African participants benefited from the Mathematics modules. South African participants benefited from Didactics modules and it boosted their confidence Influence of programme: positive. Participants indicated that the times when they were using real-life situations they could draw on their experiences in the programme. Sufficient emphasis on Mathematical processes.</p>	<p>Majority of participants could define mathematical literacy well. Ability to teach mathematics well was main motivator. Expected to be taught mathematics-for-teaching knowledge. Use curriculum documents to inform and guide. Use people as primary resource. Mathematics courses enhanced meta-cognitive skills and critical thinking, but did not prepare participants to teach the mathematical literacy courses. Influence of programme: Participants indicated need to be taught mathematics-for-teaching knowledge. Participants indicated that they could draw on the programme when they were using cooperative learning in their lessons. Sufficient emphasis on Mathematical processes.</p>	<p><b>Similarities:</b> The majority of the participants in the two countries shared the same basic perception of mathematical literacy viz. the ability/competency to use/apply mathematics in everyday life. Both Mathematical Literacy in South Africa and Mathematics for Work and Everyday Life courses or the Applied courses in Canada were viewed by learners as a lower level of Mathematics. It seems as if participants from both countries used the curriculum document to inform and guide them regarding the teaching of the subject or the course.It appears that the South African and the Canadian participants agreed that sufficient emphasis is placed on the mathematical processes in the programme <b>Differences:</b> Canadian participants have a good mathematical background, are well trained in Mathematics teaching; South African participants have a poor mathematical background with no training in Mathematics teaching. Canadian participants do not prefer to teach the Applied course or the Mathematics for Work and Everyday Life course, South African participants were eager to teach Mathematical Literacy.</p>
	Focus Groups	<p>Mathematical Literacy is not yet fully conceptualised Needs in programme. History not important for teaching Mathematical Literacy. Developing a new status identity.</p>	<p>Applied Mathematics not implemented as was intended. Course repeat content learned in previous courses. Valuable elements in programme.</p>	<p><b>Differences:</b> Canadian participants needed mathematics-for-teaching knowledge, while South African participants needed mathematics content knowledge. South African participants experienced programme as positive, while Canadian participants indicated that the programme did not prepare them for teaching Applied and Mathematics for Work and Everyday Life courses.</p>

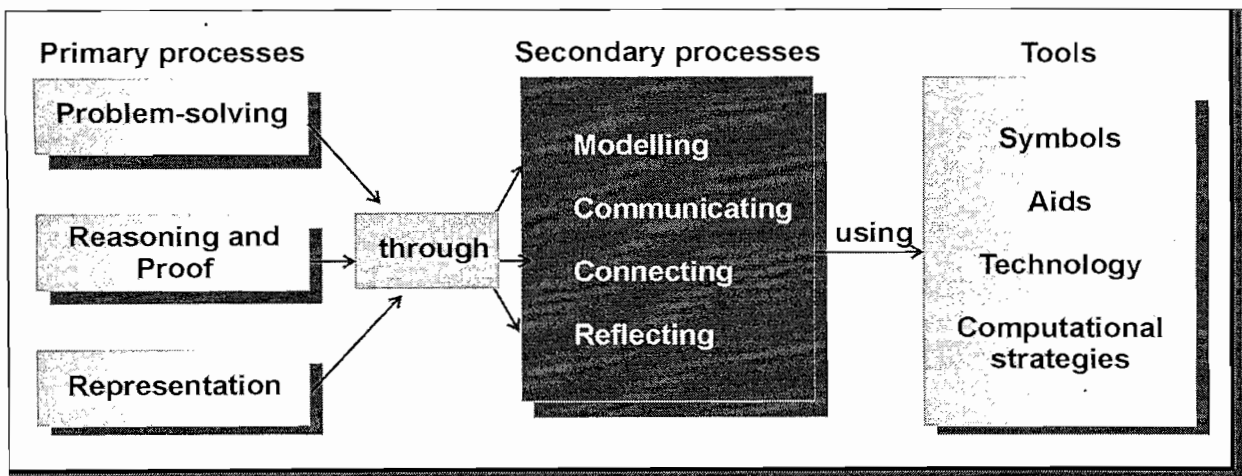
	Individual Interviews		<p>The attitude towards Applied Mathematics and Mathematics for Work and Everyday Life courses. The focus on the mathematical processes. Context drove content.</p> <p>Reflection on the programme.</p>	
Relevant Literature	<p>Different definitions for mathematical literacy. Possible factors influencing the development of an identity are: Attitude towards mathematics; student adaptation to university life; social and economic background and educational background.</p>	<p>Problem Solving, Reasoning/Argumentation and Representations are focussed on in both the PISA framework and the Canadian Mathematics Curriculum Framework.</p>	<p><b>Differences</b>  Programme in Canada is on-campus with ample classes for pre-service teachers, while in South Africa programme is of-campus with only 12 classes per year for in-service teachers.</p>	
Findings	<p>Mathematical Literacy is not yet fully conceptualised  South African participants developed a new 'status' identity as Mathematical Literacy teachers.</p>	<p>Emphasis should be placed on mathematical processes.  Content drives context.</p>	<p><b>Similarities:</b> Subject and course are both seen by the wider society as a lower level of Mathematics;  Participants agreed that sufficient emphasis is placed on the mathematical processes in the programme.  All participants used the curriculum documents to inform and guide them.  <b>Differences:</b> Delivered on-campus, lot of contact classes for pre-service teachers in Canada, while in South Africa classes are off-campus, 12 contact classes per year for in-service teachers.  South African participants - poor mathematical background; Canadian participants - strong mathematical background.</p>	

## 6.6 RECOMMENDATIONS AND POSSIBLE QUESTIONS FOR FURTHER RESEARCH

### 6.6.1 Recommendations

#### 6.6.1.1 An explicit focus on mathematical processes in the Mathematical Literacy Curriculum

Mathematical processes should be included in the curriculum document of any mathematical literacy curriculum so that teachers could focus explicitly on firstly using these processes themselves, and secondly, use them in teaching learners how to use the mathematical processes in order to develop mathematical literacy in learners. To engage meaningfully in a real-life situation that is mathematically based, requires the application of mathematics content knowledge which could only be gained through these processes. A model of Mathematical Literacy processes, based on Pugalee's model of mathematical literacy (Pugalee, 1999:20), is proposed for the Mathematical Literacy class (Figure 6.1).



Source: Pugalee, 1999:20 (adjusted)

**FIGURE 6.1 A PROPOSED MODEL OF MATHEMATICAL LITERACY**

As indicated in figure 6.1 the three mathematics processes, viz. Problem-solving, Reasoning and Proof, and Representation, are proposed as primary processes which should take place by means of one or a combination of the secondary processes, viz. modelling, communicating, connecting and reflecting, by using one or a combination of the tools, viz. symbols, aids, technology and computational strategies, when engaging in a real-life situation that is mathematically based in the Mathematical Literacy class. Although I

attempted to address the literacy question in this study not enough information could be collected to gauge the role of language in Mathematical Literacy classes.

#### 6.6.1.2 The need for a course to upgrade the mathematics content knowledge prior to the programme

A course to revise or/and upgrade the mathematics content knowledge of prospective Mathematical Literacy teachers without post-matric mathematics training or without grade 12 Mathematics on their Senior Certificate is also recommended. Although the mathematics envisaged for the Mathematical Literacy curriculum is quite basic, the National Curriculum Statement (DoE, 2005:21) requires “a robust understanding of Mathematics”. The prospective Mathematical Literacy teacher should know mathematics well enough so that they can do mathematics themselves, diagnose the misconceptions regarding mathematics and realise the effects of applying mathematics with ease. However, how much mathematics content knowledge is needed in order to teach Mathematical Literacy effectively could not be established with this study.

#### 6.6.1.3 An explicit focus on mathematics-for-teaching knowledge should be part of any effective mathematical literacy teacher training programme

Not only should prospective Mathematical Literacy teachers know mathematics themselves, they should also know how to transfer mathematical content knowledge to their learners. Herein lies the need for mathematics-for-teaching knowledge in an effective Mathematical Literacy teacher training programme.

#### 6.6.1.4 The need for developing a course or adjusting an existing course to specifically train teachers to teach Mathematics for Work and Everyday Life or the Applied Mathematics classes

At Brock University in Canada a course should be developed, or an existing course should be adjusted, to train teachers specifically for the Applied Mathematics classes or the Mathematics for Work and Everyday Life courses. It was found that difficult and complex content in university bound mathematics courses can be a stumbling block for teachers who want to teach these courses at school level.

#### 6.6.1.5 ‘New status identity’

Developers should capitalise on this new status identity as Mathematical Literacy teachers by offering effective programmes that empower these teachers to become effective and

enthusiastic Mathematical Literacy teachers when prospective Mathematical Literacy teachers complete the training programme.

### **6.6.2 Possible questions for further research**

- (i) The role of language in the Mathematics class is well documented, but what role of language plays in the Mathematical Literacy classroom was found not to be sufficiently covered by extant literature and more research is needed.
- (ii) What is the extent of mathematics content knowledge that prospective Mathematical Literacy teachers should have in order to teach Mathematical Literacy effectively?
- (iii) The forming of new status identities by Mathematical Literacy teachers in this study was only established through focus group discussions and questionnaires. More research with other data collection instruments, for example a case study, is required.

## **6.7 CONCLUSION AND REFLECTION**

Mathematical Literacy as subject in the Further Education and Training band in South African schools has the potential to be the most powerful subject at school level in empowering our learners to realise the dream to change South Africa from a developing country into a developed country, if it is taught by inspired teachers who understand why Mathematical Literacy was implemented in the first place. I must acknowledge though, that there is no magical framework for the training of these teachers, but engaging critically in mathematics using the mathematical processes might be the first step towards this dream.

Through this study I did not only have the opportunity to do some valuable reflection on the Mathematical Literacy teacher training programme here at the North-West University, but I also had the opportunity to reflect on my own capabilities. I have grown tremendously, firstly as a person and also as a researcher. I also value the experience of my four months in Canada and the opportunity I had to learn how the training of teachers for similar courses is done elsewhere.

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# **LIST OF ADENDA**

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**ADDENDUM A:** LETTER TO THE REGIONAL OFFICE OF THE DEPARTMENT OF EDUCATION

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B1: ETHICS APPROVAL CERTIFICATE FROM THE NORTH-WEST UNIVERSITY RESEARCH ETHICS COMMITTEE

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- E17: HERMENEUTIC UNIT – Final analysis of exploring the practices of teachers in South Africa and Canada - ATLAS.ti 5.0
- E18: HERMENEUTIC UNIT AS MHT FILE -ATLAS.ti 5.0 (HU Final analysis of exploring the practises of teachers in)

**ADDENDUM F: DECLARATIONS**

ADDENDUM A  
**LETTER TO THE REGIONAL OFFICE OF  
THE DEPARTMENT OF EDUCATION**

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P.O. Box 19885

Noordbrug

2522

31 May 2010

Mr. H. M. Mwelil

Regional Executive Manager

Kenneth Kaunda Region

Potchefstroom

Dear Sir

**Permission requested to involve teachers from the Kenneth Kaunda region in study**

I am Joany Fransman, lecturer and developer of the mathematical literacy training programme, The Advanced Certificate in Education (Mathematical Literacy) for in-service teachers at the North-West University. I am currently enrolled with the University for my M.Ed degree with specialisation in Mathematical Literacy.

The purpose of my study is to explore components of a Mathematical Literacy teacher education programme that might positively influence the Mathematical Literacy teaching practices in South Africa. With Mathematical Literacy the new subject in the South African FET school curriculum, it becomes critical that effective Mathematical Literacy training programmes are developed. Studies like mine can shed more light on how the teachers view the programme and more insight might be gained into what works and what does not work in mathematical literacy teacher education programmes in a developing country like South Africa as well as in a developed country like Canada. It is therefore envisaged that findings from this study can contribute to bringing about sustainable and effective enhancement of existing programmes.

Teachers will only be requested to complete questionnaires and take part in focus group discussions. Data from this study will be combined with those collected in Canada. Please note that data will not be anonymous due to the audio recording of the focus group discussions, but teachers will be able to drop out of the study at any given time.

I trust that my request will receive your favourable consideration.

Yours sincerely

(Mrs) J.S. Fransman

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ADDENDUM B  
**ETHICS APPROVAL DOCUMENTS**

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**B1: ETHICS APPROVAL CERTIFICATE FROM THE NORTH-WEST UNIVERSITY RESEARCH ETHICS COMMITTEE**



NORTH-WEST UNIVERSITY  
YUNIBESITI YA BOKONE-BOPHIRIMA  
NOORDWES-UNIVERSITEIT

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**Ethics Committee**

Tel +27 18 299 4850  
Fax +27 18 293 5329  
Email [Ethics@nwu.ac.za](mailto:Ethics@nwu.ac.za)

2009-03-31

Dr. M van der Walt

**Ethics Approval of Project**

The North-West University Ethics Committee (NWU-EC) hereby approves your project as indicated below. This implies that the NWU-EC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

<b>Ethics number:</b>		<b>Project title:</b>														
		N	W	U	-	0	0	9	0	-	0	8	-	A	2	
		<small>Institution</small>			<small>Project Number</small>				<small>Year</small>		<small>Status</small>					
		<small>Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation</small>														
<b>Approval date:</b>		27 February 2009							<b>Expiry date:</b> 26 February 2014							

Special conditions of the approval (if any): None

General conditions:

*While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:*

- *The project leader (principle investigator) must report in the prescribed format to the NWU-EC:*
  - *annually (or as otherwise requested) on the progress of the project,*
  - *without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.*
- *The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-EC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.*
- *The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-EC and new approval received before or on the expiry date.*
- *In the interest of ethical responsibility the NWU-EC retains the right to:*
  - *request access to any information or data at any time during the course or after completion of the project;*
  - *withdraw or postpone approval if:*
    - *any unethical principles or practices of the project are revealed or suspected,*
    - *it becomes apparent that any relevant information was withheld from the NWU-EC or that information has been false or misrepresented,*
    - *the required annual report and reporting of adverse events was not done timely and accurately,*
    - *new institutional rules, national legislation or international conventions deem it necessary.*

The Ethics Committee would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the Ethics Committee for any further enquiries or requests for assistance.

Yours sincerely

Prof MMJ Lowes  
(chair NWU Ethics Committee)  
Committee: Teaching and  
Learning )

Prof M. Monteith  
(Chairman: NWU Ethics

**B2: ETHICS APPROVAL NOTIFICATION FROM BROCK  
UNIVERSITY RESEARCH ETHICS BOARD**

DATE: November 14, 2008

FROM: Michelle McGinn, Chair  
Research Ethics Board (REB)

TO: Joyce Mgombelo, Education  
Joany Fransman, Marthie van der Walt

FILE: 08-129 MGOMBELO/VAN DER WALT  
Masters Thesis/Project

TITLE: Exploring the practices of teachers in mathematical literacy training programs  
in South Africa and Canada

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The Brock University Research Ethics Board has reviewed the above research proposal.

**DECISION: ACCEPTED AS IS WITH NOTES**

- Despite the fact that you are focusing on student teachers, school board approval may be needed for you to enter the classroom. Please seek advice from the school principals.
- Please indicate in the verbal script that this project has received REB clearance at Brock University.

This project has received ethics clearance for the period of **November 14, 2008 to March 31, 2009** subject to full REB ratification at the Research Ethics Board's next scheduled meeting. The clearance period may be extended upon request. *The study may now proceed.*

Please note that the Research Ethics Board (REB) requires that you adhere to the protocol as last reviewed and cleared by the REB. During the course of research no deviations from, or changes to, the protocol, recruitment, or consent form may be initiated without prior written clearance from the REB. The Board must provide clearance for any modifications before they can be implemented. If you wish to modify your research project, please refer to <http://www.brocku.ca/researchservices/forms> to complete the appropriate form Revision or Modification to an Ongoing Application.

Adverse or unexpected events must be reported to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants and the continuation of the protocol.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the

ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of any research protocols.

The Tri-Council Policy Statement requires that ongoing research be monitored. A Final Report is required for all projects upon completion of the project. Researchers with projects lasting more than one year are required to submit a Continuing Review Report annually. The Office of Research Services will contact you when this form *Continuing Review/Final Report* is required.

Please quote your REB file number on all future correspondence.

MM/an

Research Ethics Office  
Brock University  
Office of Research Services, MC D250A  
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[http://www.brocku.ca/researchservices/Ethics\\_Safety/Humans/Index.php](http://www.brocku.ca/researchservices/Ethics_Safety/Humans/Index.php)

# ADDENDUM C

## **CONSENT FORM**

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**Invitation and Informed Consent for teachers/ teacher candidates/practising teachers who will be involved in interviews, lesson observation, focus groups and questionnaires**

Date:

October 2008

**Project Title: Exploring the practices of teachers in mathematical literacy training programs in South Africa and Canada.**

**Principal Student Investigator (Researcher):**

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### INVITATION

You are invited to participate in a study that involves research. The purpose of this study is to explore components of a Mathematics teacher education program that might positively influence the mathematical literacy teaching practices in Canada. This research is sponsored by Foreign Affairs and International Trade Canada (DFAIT) 2008 Graduate Students' Exchange Program (GSEP).

### WHAT IS INVOLVED

As a participant, you will be asked to complete an open-ended questionnaire regarding the Mathematics Teacher Education program you are currently enrolled for. This questionnaire will request some biographical details, your perceptions on mathematical literacy as well as your views of the mathematics teacher education program you are currently enrolled in. This questionnaire should take you approximately one hour to complete. Examples of questions that will be used in the questionnaire include the following:

- How would you describe a mathematical literate person?
- In your view how would you define mathematical literacy?

During your teaching block in October/November 2008 I will be observing at least two of the lessons you will be presenting from the Applied Mathematics or the Mathematics for Work and Everyday Life course. During these visits I will write field notes documenting what takes place and the teaching materials used. I will NOT collect any data from the school students.

Examples of criteria that will guide my observation are:

- How you are setting the scene for the lesson (context for mathematics learning)?
- Teaching strategies employed by you

Please note that this lesson observation should in no way be seen as evaluative as I am only interested in how your teacher education programme informed your teaching practice. You will in no way be criticised or judged in your lesson by me. I will not ask any questions or make any comments. If you feel at any time that my presence is affecting your performance, you may let me know and I will leave immediately.

As a participant you will be requested to have one interview with me. The interview will be tape recorded. This interview will be an individual one hour interview regarding the lessons you have been presenting with open ended questions like the following:

- Did you in any way use the study material from the mathematics teacher education program to prepare for this lesson? If yes how did it help you? If no, please explain why you did not use it.
- What evidence did you use to assess the success of the lesson?

Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish.

Lastly I will have a focus group discussion with you together with three other participants. The discussion should take approximately one hour and will be tape recorded. This discussion will focus on the curriculum and will include questions like the following:

- What is your view on the similarities and differences in Applied Mathematics as opposed to Academic Mathematics?
- What is your view on the need for a mathematics teacher education program with a specific focus on courses like Applied Mathematics and Mathematics for Work and Everyday life?

Shortly after the discussion has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our discussion and to add or clarify any points that you wish.

The interviews and focus group discussions will be audio recorded and transcribed by me.

**Please note that participation in all the research tasks will take approximately 3 hours of your time.**

#### POTENTIAL BENEFITS AND RISKS

Participation in this research study should benefit you as prospective teacher in the following ways:

You will be getting the opportunity to reflect meaningful about the mathematics teacher education program you have enrolled for;

You will get exposure to how mathematical literacy teaching training is done in South Africa. This will be made possible through the interactions e.g. recruitment, focus group discussions (participants may also pose questions to researcher to enhance their understanding), and feedback. You will gain valuable insight into teaching approaches done by teachers in your own country as well as in South Africa;

The results are expected to highlight best practices in both the countries that could be used to enhance future mathematics teacher education programs.

There are no known or anticipated risks associated with participation in this study. Your participation will in no way influence your status in the class as the supervisor will not have any access to the data.

## CONFIDENTIALITY

Please take note:

1. The information you provide will be kept confidential. Your name will not appear in any thesis or report resulting from this study; however, with your permission, anonymous quotations may be used.
2. Pseudonyms will be used for the names of participants in the reporting of the findings from this study. The master list of participants' real names and their pseudonyms will be kept in a locked cabinet in my office.
3. Due to your relationship with the supervisor from Canada (instructor for your course) only the researcher and the supervisor from South Africa will have access to the data. The supervisor from Canada will have access to all of the data from the teacher candidates after the grades are assigned for the course.
4. All participants for the interviews and focus group discussions will have access to their own data and be given the opportunity to review/member-check the interpretations made about their participation.
5. For the focus group discussion session please note that all information you provide will be considered confidential and grouped with responses from other participants. Given the format of this session, I ask you to respect your fellow participants by keeping all information that identifies or could potentially identify a participant and/or his/her comments confidential.
6. On March 31, 2016 (seven years after the completion of the study) all data including paper documents will be destroyed by shredding and electronic files (emails and computer files) deleted or erased. Until this date all data will be kept by the researcher in a locked file cabinet in a locked office.
7. Data from this study will be combined with those collected in South Africa.
8. Please note that data will not be anonymous due to the audio recording of the interviews and focus group discussions.

## VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time. If an individual participant withdraws from the study, any data pertaining exclusively to the participant will be destroyed. However, you should take note that it will be difficult to remove individual data from the focus group discussion.

## PUBLICATION OF RESULTS

Results of this study may be published in professional journals and presented at conferences. Feedback about this study will be available from the end of September 2009. The relevant person to be contacted is Dr. Joyce Mgombelo, Assistant Professor Mathematics Education at [joyce.mgombelo@brocku.ca](mailto:joyce.mgombelo@brocku.ca). You can also e-mail me at [joany.fransman@nwu.ac.za](mailto:joany.fransman@nwu.ac.za) after the mentioned date.

## CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact the researcher or the Faculty Supervisor (where applicable) using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (**file 08-129**). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, [reb@brocku.ca](mailto:reb@brocku.ca).

Thank you for your assistance in this project. Please keep a copy of this form for your records.

## CONSENT FORM

I agree to participate in this study described above. I have made this decision based on the information I have read in the Invitation-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name: \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

ADDENDUM D  
**DATA COLLETION INSTRUMENTS**

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**D1: QUESTIONNAIRE**

**EXPLORING THE PRACTISES OF TEACHERS IN MATHEMATICAL LITERACY PROGRAMS IN SOUTH AFRICA AND CANADA.**

**J. S. Fransman**

**OPEN-ENDED QUESTIONNAIRE FOR EDUC 8P81 TEACHER CANDIDATES/IN-SERVICE TEACHERS**

**THE SUPERVISOR (WHO IS THE INSTRUCTOR OF THE COURSE) WILL NOT HAVE ACCESS TO THE DATA UNTILL GRADES ARE ASSIGNED.**

This questionnaire consists of 3 parts: (1) Background Information, (2) Mathematics content knowledge and (3) Didactics. Please provide as much detailed information as possible.

**Part 1: Background Information**

**1a Your age:**

**1b Your gender:**

**2. Language proficiency:**

Canada:

<b>Language</b>	<b>Read</b>	<b>Speak</b>	<b>Write</b>
English			
French			
Other			

South Africa:

Language	Read	Speak	Write
English			
Setswana			
Afrikaans			
Other			

3. How would you describe a mathematical literate person?

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4. What is your understanding of the term “mathematical literacy”?

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5. Canada: What motivated you to become a Mathematics teacher?  
South Africa: What motivated you to enrol for the training programme in Mathematical literacy (ACE in ML)?

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6. What were your expectations of the teacher education program?

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7. How were these expectations met or not met till thus far?

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Part 2: Mathematics content

8. Canada: Your teachable subjects:

Major:.....

Minor:.....

South Africa: Please indicate the most appropriate option concerning your school education in Mathematics with X:

Options	
I've done Maths up to grade 12 and passed it	
I've done Maths up to grade 12 and passed it	
I did Maths up to grade 9 only	
Other (Please specify)	

9. Canada: How did the university mathematics courses/program prepare you for teaching the Applied Mathematics/Mathematics for Work and Everyday Life/College Mathematics course in terms of mathematical subject matter knowledge?

South Africa: How did the mathematics modules (MLED 571 and MLED 573) in the training programme prepare you for teaching Mathematical Literacy in terms of mathematical subject matter knowledge?

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10. Canada: In your view, does your other teachable subject help you in any way to teach the Applied Mathematics/Mathematics for Work and Everyday Life/College Mathematics course? Explain.  
South Africa: In your view, did the didactics modules (MLED 572 and MLED 574) help you in any way to teach the Mathematical Literacy? Explain.

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11. Canada: Comment on you having to learn mathematics in one faculty and learning to teach the course Applied Mathematics/Mathematics for Work and Everyday Life/College Mathematics course in a different faculty.

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Part 3: Didactics

12. Canada: Please indicate your preference of teaching the following courses by using numbers 1 to 6:

Applied Mathematics Grade	<input type="text"/>
Academic Mathematics Grade	<input type="text"/>
Mathematics for Work and Everyday Life Grade	<input type="text"/>
University bound Mathematics	<input type="text"/>
University functions and applications	<input type="text"/>
	<input type="text"/>

South Africa (11): Please indicate the correct grade/s and subjects/s that you are teaching this year:

Mathematical Literacy	Pure Mathematics
Grade 10	Grade 8
Grade 11	Grade 9
Grade 12	Grade 10
	Grade 11
	Grade 12

13. Canada: How did the training program influence your way of teaching Applied Mathematics/Mathematics for Work and Everyday Life/College Mathematics?  
 South Africa (12): How did the mathematics teacher education training programme(ACE in ML) influence your way of teaching Mathematical Literacy?

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14. Canada: Describe specific times in teaching Applied Mathematics/Mathematics for Work and Everyday life/College Mathematics that you could draw on your experiences during the training program.  
 South Africa(13): Describe specific times in teaching Mathematical Literacy that you were able to draw on your experiences during the mathematics teacher education programme(ACE in ML).

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15. Canada: In what ways did the curriculum documents inform your teaching of Applied Mathematics/Mathematics for Work and Everyday Life/College Mathematics?  
South Africa(14): In what ways did the curriculum documents inform your teaching of Mathematical Literacy?

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16. Elaborate on other resources that you are using in teaching of Applied Mathematics/Mathematics for Work and Everyday Life/College Mathematics/Mathematical Literacy?  
South Africa(15):

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17. Canada: Do/Would you use the study material from the training program in when you teach Applied Mathematics/Mathematics for Work and Everyday life/College Mathematics?  
South Africa(16): In what ways did you use the study material/references from the mathematical literacy training programme when you teach Mathematical Literacy?

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18. Canada: If yes to the previous answer...how do/would you use it? If no, why do/would you not use it?

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19. Canada: The Ontario curriculum mentions 7 mathematical processes that support effective learning in mathematics and they are: problem solving, reasoning and proving, reflecting, selecting tools and computational strategies, connecting, representing and communicating. How did you experience these processes in the teacher education program you are currently enrolled in?

South Africa(17): In the curriculum documents for Mathematical Literacy there are 7 mathematical processes (implicated but not stated explicitly) that support effective learning in mathematical literacy and they are: problem solving, reasoning and proving, reflecting, selecting tools and computational strategies, connecting, representing and communicating (DoE, 2003: 10). How did you experience these processes in the teacher education program that you have completed?

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20. Canada: comment on the use of English as the language of learning and teaching in Applied Mathematics/Mathematics for Work and Everyday life/College Mathematics/Mathematical Literacy.  
South Africa (18):

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21. Canada: What questions need to be asked about the training program regarding its influence on the practices of teachers who will be teaching Applied Mathematics/Mathematics for Work and Everyday life/College Mathematics?

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End of questionnaire. Thank you for your valuable input

## **D2: QUESTIONS FOR FOCUS GROUP DISCUSSIONS**

### **Questions for focus group discussions**

**Title of the study: Exploring the practises of teachers in mathematical literacy training programmes in South Africa and Canada**

#### **South Africa:**

1. Share your view on mathematical literacy as opposed to pure mathematics.
2. Give me examples of times when you've realised that what you're doing in class was not part of your training and that it should have been part of it.
3. Comment on the opportunities that you might have experienced in your training program until thus far.
4. Comment on the challenges that you might have experienced in your training program until thus far.

#### **Canada:**

1. Share your view on Applied Mathematics as opposed to Academic Mathematics.
2. Give your view on the need for teacher training programs with a specific focus on courses like Applied Mathematics and Mathematics for Work and Everyday life.
3. Comment on the opportunities that you might have experienced in your training program until thus far.
4. Comment on the challenges that you might have experienced in your training program until thus far.

## **D3: QUESTIONS FOR INDIVIDUAL INTERVIEWS**

### **Questions for interview with participants after the lesson**

1. Tell me about the lesson. How did you experience it?
2. What context did you use for your lesson?
3. How did you decide on that context?
4. Did you in any way use the study material from the training program to prepare for this lesson? If yes how did it help you? If no, please explain why you did not use it.
5. Comment on the mathematics that might have been learned in this context.
6. What evidence will you (the teacher) use to assess the success of this lesson?
7. What teaching approach/es did you employ in this lesson?
8. What was the reason for using the teaching approach/es?
9. What was your outcome for the lesson?
10. Do you think that you have reached your outcome? Explain why you think you did or did not.
11. Comment on the use of the curriculum documents in preparing for your lesson.

## D4: CRITERIA FOR LESSON OBSERVATION

### LESSON OBSERVATION:

#### Classroom description

Criteria	Observation
How is teacher candidate setting the scene	
How is the Mathematics extracted from the context	
What teaching approach/s are used by teacher	
What learning and teaching resource material are used by teacher	
Achievements as teacher	
Challenges for teacher	
Assessing the lesson	