

**PRIMARY MATHS TEACHER LEARNING AND IDENTITY
WITHIN A NUMERACY IN-SERVICE COMMUNITY OF
PRACTICE**

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

DOCTOR OF PHILOSOPHY (PhD)

RHODES UNIVERSITY

by

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April 2014

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ABSTRACT


This study focuses on the processes of primary maths teacher learning and how their identities and practices evolve in relation to participation in a primary maths focused in-service teacher education programme, called the Numeracy Inquiry Community of Leader Educators (NICLE). Additionally it investigates activities, relations and forms of participation within the Community of Practice (CoP) which enable or constrain evolving primary maths identities and practices and how these relate to the broader context. The study draws from the situative-participationists (Lave, 1996; Wenger, 1998; Sfard & Prusak, 2005; Wenger et al, 2002) theoretical framework supplemented by Bernstein's (2000) pedagogic identity model. Using a qualitative educational interpretive approach I sampled 8 primary teachers drawn from NICLE and gathered data through participant observations, interactive interviews, document analysis and reflective journals. Analysing the key data themes that emerged from teacher learning stories, which I have called *stelos*, the study explains the nature of the primary maths teachers' learning, transformation and participation experiences in NICLE using the synonyms *reinvigoration* and *remediation* and *activation* and relating these semantics to the teachers' mathematical identities and histories. The study also explains the processes through which primary maths teacher identities evolve in relation to participation in an in-service CoP as '*insiding*' and '*outcropping*'.

Interpreting qualitative data from the empirical field indicates that teachers participating in NICLE mostly took-up into their maths classrooms key numeracy-domain concepts, resources and issues presented by primary maths experts which are informed by research and theory that link to practices. Teachers collaboratively and actively engaged in a range of activities that relate to classroom practices. Teacher learning was also enabled when teachers engaged in maths overlapping communities of practice, shared classroom experiences in friendly ways with fellow NICLE teachers and engaged with NICLE presenters who mutually respected and regarded them as professionals. Such affordances were said to enable teachers to engage learners in maths classes and improve their understanding of specific primary maths concepts. On the other hand teachers felt challenged by the travelling distance, limited time and also raised the tension of how to scale-up maths professional development initiatives to include schools from their community. The study makes a theoretical contribution by illustrating how Bernstein's pedagogic identity model and its elaboration by Tyler (1999) provides analytical tools to interrogate macro educational changes and connect these to the micro processes and teacher identities.

KEY WORDS: Primary maths teacher identity (PMTI), primary maths teacher learning, Communities of Practice, Learning stories – *stelos*, Reinvigoration, Activation and Remediation, Outcropping, Insiding, NICLE

DECLARATION

I, Peter Pausigere, hereby declare that this thesis is a result of my research investigations and findings. All the work that was written by other authors and used in the thesis is fully acknowledged and a reference list is included. This work has not been previously submitted in part or entirety for degree purposes to any other university. Submitted in fulfilment of the PhD degree in Mathematics Education at Rhodes University.

Signature..... 

Peter Pausigere

Date.....29 August 2014.....

DEDICATION

This work is dedicated both to my aunt, Gladys Hazvinei Pausigere-Chindewere who passed away when I was writing up this study and to my son Percival ‘Kamukosi’ Pausigere who has shown outstanding social and emotional capabilities. May God grant you good health and long life.

PEER REVIEWED PUBLICATIONS AND PRESENTATIONS EMANATING FROM THIS RESEARCH

- Pausigere, P. (2014). On South African primary mathematics learner identity: a Bernsteinian illumination. In P. Webb, M. G. Villanueva & L. Webb (Ed.), *New avenues to transform Mathematics, Science and Technology Education in Africa: Proceedings of the 22 Annual meeting of the Southern African Association for Research in Mathematics, Science and Technology Education* (pp. 113-128). Nelson Mandela Metropolitan University, Port Elizabeth: SAARMSTE.
- Pausigere, P., & Graven, M. (2014). Learning metaphors and learning stories (stelos) of teachers participating in an in-service numeracy community of Practice. *Education As Change*, 18(1), 33-46.
- Pausigere, P., & Graven, M. (2013d). Unveiling the South African official primary maths teacher pedagogic identity. *Perspectives in Education, Special Edition 13 (3)*, 19-33.
- Pausigere, P., & Graven, M. (2013c). Using Bernstein to analyse primary maths teachers' practices and identities in the context of education change: the case of ANA. *Journal of Education*, 58, 1-22.
- Pausigere, P., & Graven, M. (2013b). Affordances and constraints in a Primary Maths Community of Practice in-service programme. In N. Mpalami, & Letlatsa R (Ed.), *Proceedings of the Fourth Regional Congress of the International Commission on Mathematics* (pp. 104-111). Lesotho: AFRICME 4.
- Pausigere, P., & Graven, M. (2013a). On the Constituents of Primary Maths Teacher Identity: towards a model. In S. K. Kwofie, M. B. Ogunniyi, O. Amosun, K. R. Langenhoven, & S. Dinie (Ed.), *Making Mathematics, Science And Technology Education, Socially And Culturally Relevant in Africa: Proceedings of the 21st annual meeting of the Southern African Association for Research in Mathematics, Science and Technology Education* (pp. 184-196). University of the Western Cape, Cape Town: SAARMSTE.
- Pausigere, P., & Graven, M. (2012). Primary Teachers' imagination and the emergence of numeracy teacher identities through participation in a Numeracy Community of Practice. In S. Nieuwoudt, D. Laubscher, & H. Dreyer (Ed.), *Proceedings of the 18th National Congress of the Association of Mathematical Education of South Africa* (pp. 276-286). North-West University, Potchefstroom: AMESA.

ACKNOWLEDGEMENTS

There are many people who led to the realisation of this thesis and through their advice and assistance shaped this study at its various stages and at different times. Firstly I extend my sincere gratitude to my Supervisor, Professor Mellony Graven from whom I have learned a lot from and who has throughout this study given me guidance, encouragement and expressed confidence in me and in my work. This work benefited immensely from your positive feedback, detailed and thoughtful comments. It is also through your effort that I was awarded the NRF scholarship which financially supported me in carrying out this research and enabled me to study as a full time PhD fellow in the South African Numeracy Chair Project. I am greatly indebted to you for your kind support and insights throughout my PhD study journey.

Through the financial support of the South African Numeracy Chair I presented and shared my research findings, at numerous local, regional and international maths teacher education and teacher education conferences between 2012 and 2014. These conferences allowed me to engage further and deeper with several colleagues across universities on key research issues that immensely and directly benefited this PhD study. I acknowledge the contribution and insights of participants at these conferences to this PhD.

Secondly I would like to acknowledge all the colleagues in the FRF Maths and the SANC Chairs at Rhodes University who engaged with my work in the initial stages of the study. It is in this community's stimulating discussions that most of the ideas expressed in this study were conceptualised and critically engaged with. It is also from this community that I made research colleagues some who become personal friends especially Dr Mike Mhlolo, Gervasus Stephanus, Nyameka Kangela, Ajaya Narayanan and Diliza Hewana who provided me with the warm support and encouragement throughout the study.

I am also thankful to Professor Heyd-Metzuyanim and Professor Steve Lerman (internationally distinguished scholars) who read some of my work and provided encouraging comments, stimulating ideas and wonderful perspectives regarding the study.

I am equally grateful to all the NICLE teachers and specifically the 8 NICLE teachers who in different ways participated in this research and willingly answered my questions and gave of their time. Without your co-operation, this research would not have been possible.

Thanks also to Sirion Robertson who read and provided editorial and thought-provoking comments to my work.

Last but not least I would like to express my sincere appreciation to my parents, my wife and children, my brother, my uncle and all close family members for your inspiration and emotional support and most importantly for bearing all the difficulties created by my long absence at home.

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LIST OF ABBREVIATIONS/ACRONYMS

AMESA	Association of Mathematics Educators of South Africa
ANA(s)	Annual National Assessment(s)
C2005	Curriculum 2005
CAPS	Curriculum and Assessment Policy Statement
CoP	Community of Practice
CoPs	Communities of Practice
DBE	Department of Basic Education
DHET	Department of Higher Education and Training
DOE	Department of Education
FP	Foundation Phase
INSET	In-service Education and Training
IP	Intermediate Phase
Maths	Mathematics
NCS	National Curriculum Statement
NICLE	Numeracy Inquiry Community of Leader Educators
OBE	Outcomes Based Education
PMTI	Primary Maths Teacher Identity
PMT(s)	Primary Maths Teacher(s)
RUMEP	Rhodes University Mathematics Education Project
SANC	South African Numeracy Chair
SANCP	South African Numeracy Chair Project
TDC	Teacher Development Co-ordinator

CHAPTER 1: INTRODUCTION

1.1 Background to the study

South African primary mathematics education has been described as being in a crisis state (Fleisch, 2008). Whilst historically there had been a strong focus on improvement of the matric (Grade 12 exit) maths results, recent educational policies and studies have begun to focus on how to improve the performance of primary maths¹ learners. This shift in focus parallels regional and national standardised assessment tests that point to extremely poor primary performances. Evidence from national, regional and international tests reveals that local primary learners cannot execute maths tasks at the appropriate grade levels and have a poor grasp of elementary foundational mathematical concepts (OECD, 2008; Schollar, 2008; Fleisch, 2008; Reddy, 2006; DOE, 2008; DBE, 2012). Evidence of poor basic maths content knowledge levels and pedagogical content knowledge have also been noticed in primary maths teachers (Fleisch, 2008; Taylor, 2011; Hoadley 2007; Taylor & Vinjevold, 1999; Taylor et al, 2013; Carnoy et al, 2011; Askew, Venkat & Matthews, 2012). It is within the context of these primary maths education challenges that the South African Numeracy Chair² (SANC) at Rhodes University was established in 2011 with national research funding organisations to increase dialogue around solutions for the primary mathematics education crisis (Graven, 2011b; Graven & Schafer, 2011).

The South African Numeracy Chair at Rhodes University, Grahamstown, is part of the six FirstRand Foundation Numeracy and Mathematics Chairs initiatives that are searching for sustainable and practical solutions to the mathematics education crisis (Graven, 2011b). Whilst four of the Mathematics Education Chairs focus on secondary school mathematics, the Numeracy Education chairs at Wits (in Johannesburg) and Rhodes University focus on improving the quality of teaching and learning of primary maths (Graven, 2011a & 2011b). The strategic and broad vision for the South African Numeracy Chair Project (SANCP)³ involves the creation of a hub of mathematical activity, passion and innovation that blends teacher and learner numeracy development with research focused on searching for sustainable ways forward in navigating the many challenges of mathematics education in South Africa –

¹ In South Africa the shortened form of the word mathematics is maths (in the USA they use the term math) and this is the word used throughout this study. It is also important to note that in this thesis I mainly use the word primary maths, which is the term used in recent curriculum documents (DBE, 2011b; DBE, 2011c). The term numeracy was used in the previous curriculum to refer to one of the three learning programmes (areas) in the Foundation phase (DOE, 2002a: 2002b; 2002c). In the study I use the term numeracy in relation to the empirical field (NICLE), local primary maths curriculum documents and teacher utterances.

²By the South African Numeracy Chair I refer to Professor Mellony Graven, as the person who holds the chair.

³ The term SANCP refers to the broader project and the staff or project team members in the Chair.

thus the establishment of two interconnected communities of practice (the NICLE teacher development program and the Numeracy education researchers) (SANC, 2011; 2012; 2013). These two interconnected communities are developed by the Chair simultaneously.

The Numeracy Inquiry Community of Leader Educators (NICLE) was launched on 30 March 2011. The NICLE initiative focuses on numeracy teacher development within the critical transition from the foundation to the intermediate phases (i.e. Grade 3 to grade 4) in 12 core participating primary schools in the Grahamstown greater area (SANC, 2011; 2012; 2013). The primary maths teacher development programme currently in 2014 has 43 regularly attending teachers including principals and deputy principals who attend NICLE fortnightly seminars and inquiry sessions. Two departmental district and provincial mathematics specialists also participate regularly. During the two-year research period of this study between 2011 and 2012 about half of the NICLE sessions were presented by the SANCP team members and half by invited guests (local and international). The numeracy teacher development programme by its intentions is explicitly designed as both a Community of Practice (CoP) and a Community of Inquiry teacher development approach and is framed by Wenger's Communities of Practice perspective (Wenger, 1998, Lave & Wenger, 1991) and by Jaworski's (2005, 2006) concept of mathematics Communities of Inquiry. NICLE is also articulated and conceptualised as a long term partnership through *on-going commitment* and *active participation* between in-service teachers and the Chair and partners of the Chair (Graven, 2010).

In order to contextualise the study I briefly provide some provincial and district background. The Grahamstown education district is one of the 23 districts in the Eastern Cape Province. The Eastern Cape together with the Limpopo province are regarded as the poorest regions amongst the nine provinces in South Africa. The 2011 and 2012 Eastern Cape Province ANA primary maths test score ranges are within the national average percentage marks (DBE, 2012). The 2012 average maths tests scores for Grade 3 and 6 learners in the Grahamstown education district was 37, 8% and 25, 6% respectively and these are similar to the provincial scores (DBE, 2012). Both the Eastern Cape provincial and the Grahamstown district maths scores reflect that this region is no exception to the South African primary maths 'crisis'. The Eastern Cape department of education was also put 'under administration' in 2011 and 2012 following financial mismanagement that led to the non-payment of temporary teacher salaries, termination of the school feeding programme and the learner transport initiative. At the beginning of 2012 many Eastern Cape teachers engaged in a 'go slow' action for three weeks to protest against the dismissal of temporary teachers, who were later reinstated by the

provincial department. Thus this study unfolds against a backdrop of a poorly run provincial department of education whose learners' primary maths performance together with that of the Grahamstown district reflects the acute challenges to the national primary maths education crisis.

Besides the NICLE development program, the Chair also focuses on the growing of a primary maths education research community, developed in parallel with the teacher community (Graven, 2010; SANC, 2011; SANC, 2012; SANC, 2013). To this effect I was the first student to join this community as a full time PhD fellow, in January 2011. I was interested in the research initiatives of the SANC because her work and the SANCP conceptualisation draw from the Communities of Practice theory and interpretive methodology. In my Masters Research within a refugee community I used the ethnographic methodology (which is one of the major types of qualitative interpretive research approaches) with the sociocultural participationists' theory. I also strengthened my understanding of social practice theory when I taught curriculum studies, professional studies and the 'school in context' courses to undergraduate and in-service teacher education students at the Wits School of Education. As a PhD fellow in the project, my doctoral research focuses on primary maths teacher learning and identity within NICLE - which is a key research program⁴ of the Chair. Besides conducting my PhD study, my mandate within the project included presenting and sharing my research findings at local, regional and international maths education conferences and also co-publishing peer reviewed articles (see page V for a list of these) with the Chair through her support.

The numeracy (primary maths) in-service teacher education professional development programme, NICLE, forms the empirical field of research to this study. In carrying out my empirical fieldwork research I used a qualitative educational interpretive approach and gathered data through participant observations, document collections, interactive interviews and journal entries. I purposively selected 8 NICLE teachers. The educational interpretive approach provided the study with thick descriptions on how primary maths teachers learn and fashion their identity through participation in NICLE. I was also motivated to use the interpretive approach as the Chair's work draws from this research methodology. I also chose to employ the educational interpretive approach as it relates well with the theoretical framing informing this study (Lave, 1996), the Chair's situated view of learning and the key research question underpinning this study as will be explained fully in Chapter 5.

⁴ Other research programmes include researching after school maths clubs and the impact of the project on learner performance.

In relation to this, this study uses Wenger's theory of learning particularly Communities of Practice (CoPs) and the key notion of identity to interrogate and illuminate the four research questions underpinning this study. My motivation to use the sociocultural-participationists⁵ theoretical framework also stems from the fact that the CoP conceptual orientations relates with the design of the empirical field of study, NICLE, as said earlier. Thus for this study using the social learning theory and the Communities of practice concepts as analytical tools not only resonates with my view and experience of learning, but also with how the empirical field of study has been conceptualised and the Chair's situated perspective on how primary maths teachers learn within practice-based professional development initiatives.

1.2 Primary education in South Africa

I now explain the South African primary education school system illustrating, where possible with examples from the sampled teachers and their respective schools, thus giving the reader a background of both the South Africa primary education context and the sampled study participants. South African primary education comprises of private and public schools which are governed by the Department of Basic Education (DBE). The DBE decentralises its functions through the nine provincial education departments which are responsible for implementing national policies and dealing with local issues. The South African school grades are organised into two broad bands of education namely the General Education and Training Band (GET) and the Further Education and Training (FET) band. The FET band consists of grade 10-12, whilst the GET band consists of three phases: *Foundation*, grades R-3, *Intermediate*, grades 4-6 and *Senior*, grades 7-9. Grade 1 up to Grade 9 is compulsory. The Foundation phase includes a pre-school grade known as Grade R (for reception) or Grade 0. Grade R is not compulsory and not all primary schools offer grade R. However all the sampled schools in this study offered grade R classes, with two of the participants being Grade R teachers who attained formal Diploma qualifications in Grade R teaching.

The Foundation Phase (FP) offers an integrated focus on Literacy, Numeracy and Life Skills (DHET, 2011b). Thus FP teachers teach all three areas and official discourse identifies teachers as 'phase specialist' (DOE, 2000, p. 14; DHET, 2011b). This contrasts with the promoted subject specialist identity in the intermediate phase. The Intermediate Phase (IP) offers the following subjects; Life Skills, Social Sciences, Science and technology, mathematics and languages - home language and first additional language. IP teachers are required to specialise in teaching language together with at least two other subjects from

⁵ Chapter 3 provides a detailed discussion of the situative-participationists theoretical framework and analytical tools informing this study.

those mentioned above (DHET, 2011b). Thus teacher training of IP teachers promotes a subject(s) specialists teacher identity. In this study five of the eight sampled teachers are FP teachers (Grade 0 – 3) while three are IP teachers. All FP teachers teach across the learning areas as well as one farm school multigrade (Gr4-5) IP teacher. The other two IP teachers teach either only mathematics or mostly mathematics.

International and local research is increasingly arguing that learners' home languages should be used as a support for learning mathematics (Setati, 2005; Setati & Planas, 2012; Taylor et al, 2013) and policy positions are taking this up (DHET, 2011b; DBE, 2010). The South African, Language in Education Policy argues for “maintaining the use of home language⁶ as the language of teaching and learning especially in the early years of learning, while providing access to additional language(s)” (DBE, 2010, p. 6). However, as Setati & Planas (2012) have argued, take-up on the ground is lagging. The international, commercial and political role of language and the complex ways in which it functions in schools influences the use of multilingualism in classrooms (Setati, 2005; Setati & Planas, 2010). Thus many learners learn in English in the early years of learning despite the limitations of this choice on epistemological access (DBE, 2010; Setati, 2005). In this study three of the FP teachers teach in English, one in Afrikaans and one in isiXhosa as the language of instruction.

Primary school starts from Grade R or 1 up to Grade 6 or 7 - as some primary school end at Grade 6 or 7. Thus the structuring of most South African primary schools is a little bit complex and does not relate to the phases. For example in the study one of the schools in a historically *coloured* area (Delta Primary School) ended at Grade 7, with one of the sampled male teachers teaching both the intermediate and the senior phases and this is commonly called the intersen phase. Some of the primary schools are stand-alone primary-level-only schools and some are combined-schools that have both primary and secondary schools. In the study sample two⁷ of the teachers were from combined schools whilst the other teachers taught in primary-level only schools. One of the combined schools was in a historically *coloured* area (Delta Combined School).

The South African primary education system also has multigrade and preparatory schools. These add to the complexity of the local primary education system. Multigrade teaching is a common practice in local primary schools located in remote or sparsely populated areas that

⁶ Whilst the South African Language in education policy allows the children to learn in their language of choice, mainly their home language (or mother tongue), it is the School Governing Body's responsibility to determine the school's language of instruction (Taylor et al, 2013; DHET, 2011b; DOE, 2003; DBE, 2010).

⁷ One of the research participants transferred from a primary only Farm school to a combined school during the period of the study.

have low numbers of learners. In some cases multigrade classes also address teaching staff shortages. One of the teachers in the study (Everton) taught at a multigrade *Farm school* (Martindale) in which Grades 2 and 3; Grades 4 and 5 classes were combined. Whilst this sampled teacher taught at the Intermediate phase (Grade 4 and 5) where there is often subject specialisation, she had to teach across all the IP subjects, because of the low numbers of teachers. One of the preparatory schools (Heritage) from which there were two sampled participants is an *ex model C*⁸ public school which focused on grades R to 3, although in 2013 they introduced a grade 4 class.

Before the end of apartheid in 1994 public schools were categorised according to race thus there were African, Coloured, Indian and White-only schools. Post-apartheid school categories still bear some of these influences. Former white-only schools are now called *ex-Model C* and these receive supplementary funding from their school governing bodies. In the study sample two of the teachers taught at such a school (Heritage Preparatory school). In relation to local school categories, two of the sampled teachers were from an *African township school* (Bongani Primary), two are from historically *coloured schools* (Delta Primary and Delta Combined School) and two are from a *Farm school* (Martindale Primary). The sampled participants' schools thus include four different types of public schools in the South African education system.

1.3 Primary maths teacher identity

The notion of identity is central to this study as it is one of the four key components of Wenger's (1998) social learning theory and the NICLE teacher development programme focuses explicitly on "creating opportunities for the development of more positive numeracy professional identities" (SANC, 2012, p. 5). For the purpose of this study the notion of primary maths teacher identity is defined "*as a way of talking about who primary maths teachers are and how they name themselves and how they are recognised by others with respect to the subject of mathematics and its corresponding activities*". This working definition of identity is informed by the theoretical framework (Wenger, 1998; Bernstein & Solomon, 1999) and key maths teacher education literature (Grootenboer, Smith & Lowrie, 2006; Bishop, 2012).

I thus use the term primary maths teacher identity (PMTI) because of my theoretical framework and because the sampled teachers were participating in a primary-maths focused

⁸ Ex model C schools were reserved for whites during apartheid.

in-service CoP. Graven (2002a; 2004) also talks of the transformation in identities from ‘teachers of maths’ to ‘mathematics teachers’. However FP specialist teachers are teachers of maths but do not necessarily identify themselves as maths teachers. My data derives from practising primary teachers most of whom are responsible for teaching all aspects of the primary curriculum. In South Africa maths or numeracy is one of the subjects that primary teachers do teach. Therefore my use of the term primary maths teacher and PMTI must be understood within theoretical, empirical, research and local primary education contexts.

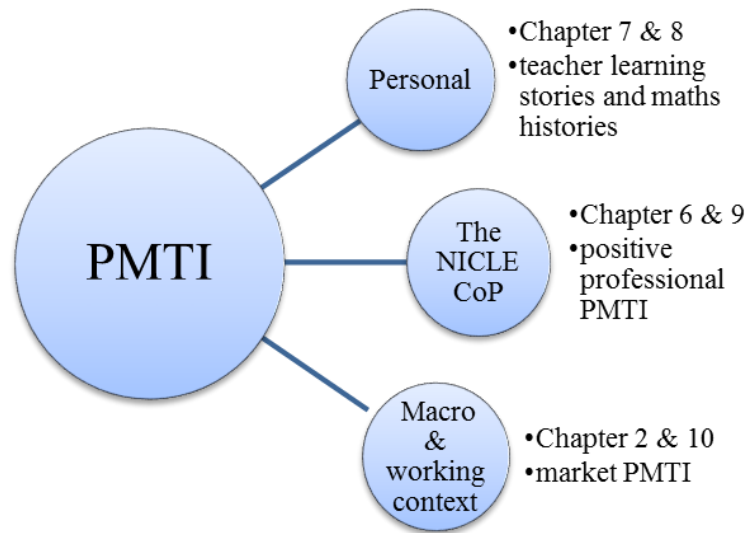
It is important to note that within the situative-participationists theoretical framework learning and identity are inseparable, simultaneous and intertwined processes (Lave, 1996; Lave & Wenger, 1991; Wenger, 1998; Lave 1993b; Sfard & Prusak, 2005; Wenger et al, 2002). Sfard and Prusak (2005, p.19) similarly state that “identities are crucial to learning”. This sociocultural-participationists’ notion of connecting identity formation and learning is central and key to this study. Several local (Graven 2004; Graven, 2012; Nel, 2012; Adler, 2000) and international (Hodgen & Askew, 2007; Lerman, 2012b; Lerman, 2001; Matos, 2009; Kazemi & Hubbard, 2008) maths education studies have drawn from the situative-participationists theory to explain maths teacher learning as identity transformation. Grootenboer & Zevenbergen (2008) also explain that identity is a useful concept to explore and understand mathematical teacher learning whilst connecting with the broader context of the learning environment and bringing together individual elements such as life histories, affective qualities and cognitive dimensions. The coupling of learning and identity formation enables the study to investigate the nature of primary maths teacher learning and the processes of identity formation within the primary maths teacher professional development CoP.

Whilst the situative-participationists theoretical elements are key in analysing primary maths teacher learning and identity formation within the NICLE CoP it however does not provide the study with theoretical tools to analyse primary maths teacher identity at the macro (institutional/policy) and micro (classroom interaction) levels (Sadovnik, 1995; Bernstein, 2000; Adler, 2000). To complement the study of identity and to analyse the officially promoted South African primary maths teacher identity at the macro level the study theoretically draws from Bernstein’s (2000)⁹ notion of pedagogic identity and Tyler’s (1999) extension of the model in terms of classification and framing. Thus in Chapter 2 the study discusses how the South African primary maths teacher identities promoted by both the

⁹ The model had its origins in a response (Bernstein, 1995) to a paper by Tyler (1995). The source I mainly refer to appears in Bernstein’s (2000) revised edition and is similar to the Bernstein’s (1999) version. Bernstein’s (2000) analysis builds on and develops previous work.

previous and current maths education policies relate to Bernstein's model of pedagogic identity and its realisation through classification and framing principles. Bernstein's notion of pedagogic identity is used to analyse the contents of key national curriculum statements and primary maths curriculum policy documents and to illuminate the broader contextual aspects within which learning and identity unfolds. In Chapter 10 the study also uses Bernstein's pedagogic identity model's four generated positions to understand how the sampled PMTs relate to their learning, identities and practices to the broader official pedagogic identities promoted nationally.

Besides analysing primary maths teacher identity at the NICLE CoP level and at the macro policy level, the study's unit of analysis is the 'numeracy teacher in-NICLE'. This allows the study to interrogate identity at the personal level. Such a focus of the study is informed by Lave (1993a), Wenger (1998) and Lerman (2000) suggestions on the unit of analysis within CoPs. Shulman and Shulman (2004), and Borko (2004) who have studied maths teacher learning within in-service CoP informed programmes have simultaneously identified 'the individual teacher' and his/her learning and the 'community of teachers' as fundamental units of analysis. This study therefore analyses primary maths teacher identity at the interrelated and connected levels of the individual, community and the policy level. Figure 1.1 illustrates these three levels used in this study to analyse the sampled PMTIs. It also investigates how other contextual factors enable or constrain teacher evolving identities and practices. Thus the sampled primary maths teachers' identities were influenced by participating in the primary maths in-service CoP professional development programme, the broader educational reforms, working contexts and the teachers' own maths experiences.



Figure

re 1.1: Levels of analysing Primary maths teacher identity in this study

Document analysis (in Chapter 2) at the policy level reveals that the current CAPS curriculum changes and a focus on learner performance in the nationally administered Annual National Assessments (ANAs) tests officially projects a market primary maths teacher identity. However PMTs position themselves differently in relation to educational changes and their identities are also influenced by their working contexts. Empirical data indicates that the NICLE primary maths teacher development initiative focuses on strengthening and developing a more positive numeracy professional teacher identity. At the individual level the use of interactive interviews allowed the sampled teachers to narrate their maths “experiences” from which arise their maths learning “stories” (Clandinin & Connelly, 1994, p. 415; Sfard & Prusak, 2005, p. 17), which I have called ‘*stelos*’ (explained in Chapter 7). Stories also have implications on understanding how learning takes place and identity changes within CoPs (Lave, 1993b; Cain, 1991; Lave & Wenger, 1991; Sfard & Prusak, 2005). I define ‘*stelos*’ as learning stories or stories about learning changes in one’s identity through participation in a CoP. The teacher learning stories reveal that teachers with a history of maths competence have their maths identities *reinvigorated*, whilst teachers with identities that previously shied away from maths have their maths identities *remediated* and new mathematical identities are *activated* through participation in communities of practice, resulting in both instances in teachers with stronger maths identities. Thus considering the three levels of PMTI analysis the study shows that primary maths teachers’ identities and practices are transformed through participation in the in-service CoP, and also by the broader education contexts and the teachers’ personal maths learning experiences and histories.

I should also clarify that within the informing sociocultural theory learning, identity and practices changes occur simultaneously (Lave, 1996; Wenger, 1998). Thus at times I interchangeably use the terms identities and practices, and even the research questions reflect this relationship. To define primary maths teaching practices I borrow from Lampert (2010) and Ball and Cohen's (1999) definitions of teaching practices. Thus for this study primary maths teaching practices relates to what primary teachers do when teaching learners maths. It is also important to note that what I call primary maths teaching practices these are in fact the sampled teachers' articulation or journaling of their primary maths teaching practices. This study therefore reports on the teachers' utterances or written accounts of their primary maths teaching practices rather than observed practices.

1.4 In-service teacher education training in South Africa

This study is situated in a primary maths in-service teacher education programme. In South Africa in-service teacher education (INSET) is also called professional development (Adler & Reed, 2002), and the two terms are used interchangeably throughout this study. Locally teacher professional development has taken many different forms (OECD, 2008; Kretchmar et al, 2012). There are short standardised workshops run by the department of education and aimed at disseminating information on new policies (Kretchmar et al, 2012). There are also formal qualification-based continuing professional development programmes or teacher re-skilling programmes run by universities – these lead to the attainment of formal academic qualifications (DHET, 2011a; OECD, 2008; Nel, 2012). The new framework for teacher education and development envisages the establishment of district-level professional learning communities in which teachers, school managers and subject advisors participate collectively to set up activities that drive their development (DHET, 2011a). Locally there have been several small-scale CoP informed mathematics-focused professional development initiatives run by university staff members (Graven, 2004; Brodie, 2013; Nel, 2012). The NICLE development programme is a long-term CoP and thus provided for longitudinal targeted research and development work with primary maths teachers. Below I unpack the different forms of teacher professional development in South Africa.

In South Africa large scale national in-service training of teachers occurred during the orientation, training and support of teachers for implementation of Curriculum 2005 (C2005) in the second half of 1997. The Cascade training model was used for preparing national educators in relation to C2005 and this strategy was widely criticised as inadequate, weak and insufficient for delivering effective in-service training of educators for the new curriculum (Chisholm et al, 2000; Taylor & Vinjevold; 1999; OECD, 2008; Kretchmar et al, 2012). It has

been the norm in South Africa that when a new curriculum is introduced or restructured teacher training workshops are conducted by the department of education to familiarise teachers with policies. Recently primary teachers were trained before the introduction of the CAPS curriculum in 2012. This national in-service teacher training programmes was conducted and facilitated by district department of education officials, over a period of one week and specifically targeted and trained groups of a particular phase¹⁰.

After the attainment of democracy, in 1996 the Presidential Education Initiative (PEI) was set up, leading to the establishment of the Teacher Development Centre in the Department of Education with one of its primary intentions being the “upgrading and reskilling of serving teachers in science, mathematics and technology” (Taylor & Vinjevold, 1999, p. 3). In South Africa the need for professional training in maths and science was prioritised given the fact that there was a high shortage of qualified maths and science teachers and one third of teachers who taught those subjects were either underqualified or unqualified (Reddy, 2006, OECD, 2008). During the same period a variety of uncoordinated in-service teacher development programmes were implemented for science, language and maths, however these were criticised for not making direct impact on improving learner knowledge and skills and were of poor quality (OECD, 2008, Reddy, 2006).

As part of this initiative both secondary and senior primary school unqualified and underqualified mathematics, science and English language practising teachers were given the opportunity to ‘top up’ their qualifications with a Further Diploma in Education (FDE) (e.g. the Wits University’s FDE programme in 1996 (Adler & Reed, 2002). This mixed mode delivery programme aimed at improving teachers’ subject and subject teaching knowledge and skills over two years, part-time (Adler & Reed, 2002). The Advanced Certificate in Education was also introduced during the same time and later replaced the Further Diploma in Education. This Advanced Certificate in Education in-service teacher qualification was meant to reskill and upgrade both primary and secondary school practising teachers with a sound knowledge base for teaching a particular subject/learning area and or phase (DHET, 2011b; Nel, 2012). Initially the Advanced Certificate in Education provided educators access to study for a Bachelor of Education Honours degree, without first having to complete a

¹⁰ In December 2011, I attended the CAPS orientation Foundation phase training programme conducted by the Grahamstown department of education district. From my observations, these training workshops sessions actively and collaboratively engaged teachers in classroom practice relevant activities, tasks and discussions and greatly differed from what was reported during the implementation of C2005 (Fieldwork notes, 5-7 December 2011).

degree, however recent teacher education policy has changed this as teachers with an ACE are now required to complete an Advanced Diploma in Education before accessing an Honours degree (DOE, 2000; DHET, 2011b). Teachers can also study further and acquire a Master or a Doctor of education degrees to supplement their existing qualifications and develop new specialisations and career trajectories (DHET, 2011b).

Recently the Department of Education (DOE) and the Department of Higher Education and Training (DHET) have introduced the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa, 2011-2025 (DHET, 2011a). Under this new policy South African Council of Educators (SACE) has been mandated to promote, support, identify, and endorse teacher professional development needs and courses. Under the current framework teachers will engage in approved and endorsed professional development activities (totalling 80 hours per annum) for which they will earn professional development points over a stipulated period (DHET, 2011a OECD, 2008). At the primary level in-service teacher training has targeted and prioritised the Foundation phase and the following subjects: numeracy, literacy and English as first additional language (DHET, 2011a). Of interest to this study is that under the new policy professional learning communities are to be established at the district level and these will provide the setting and necessary support for groups of classroom teachers, school managers and subject advisors to participate collectively in activities that drives their development. The envisaged teacher learning community activities and materials aim to stimulate teacher content knowledge and practices (DHET, 2011a).

Evidence from local maths teacher learning communities indicates that such initiatives transform teacher identities and hold potential to improve teachers' conceptual understanding and teaching practices (Graven, 2004; Brodie, 2013; Nel, 2012). Some of these maths teacher learning communities provide for longitudinal targeted research and development work with maths teachers (Graven, 2004; Brodie, 2013; Askew, Venkat & Matthews, 2012; Graven, 2012).

However both local small and large scale teacher development initiatives are faced with many dilemmas and challenges. Whilst teacher education literature and policy notes that longer intensive, school-based, subject-focused, and flexible professional development initiatives are effective, there are resources, cost implications and time-tensions (Graven, 2005b, Adler & Reed, 2002; Reddy, 2006; Taylor & Vinjevoold, 1999; Chisholm, et al, 2000; DHET, 2011b). In the light of the challenges and enablers of maths teacher learning this study also investigates, in Chapter 9, primary maths teaching learning affordances and constraints within the primary maths focused in-service CoP-informed teacher development programme.

1.5 Problem statement, rationale and research questions

1.5.1 Problem Statement

South African primary maths education faces acute problems and attempts are being harnessed to provide for professional development models that result in quality and effective teaching and learning of primary maths. The South African Numeracy Chair initiative provides for longitudinal research and development work with primary maths teachers in order to search ways forward to the crisis. The NICLE primary maths focused teacher development programme of the South African Numeracy Chair, Rhodes University, forms the empirical field for this study. Although there has been increasing research on maths teacher learning within community of practice-based professional development initiatives (Graven, 2004; Adler, 2000; Matos, 2009; Brodie, 2013; Shulman & Shulman, 2004; Little, 2003; Jaworski, 2005), there is little known about how *primary* maths teachers learn and how their identity and practices evolve within CoP informed in-service programmes. While there are studies that focus on primary maths teacher learning within teacher learning communities (for example Farmer et al, 2003; Graven, 2003; Heaton & Mickelson, 2002; Kazemi & Hubbard, 2008; Hodgen & Askew, 2007; Little et al, 2003), these do not foreground the interrelationship between identity changes and the broader working context as I intend to do in this study. This study therefore explores, particularly *primary* maths teacher learning across foundation and intermediate phases, in a mathematics CoP in-service programme using the sociocultural-participationists (Lave, 1996; Wenger, 1998; Sfard & Prusak, 2005; Wenger et al, 2002) theoretical components supplemented by Bernstein's (2000) pedagogic identity model.

1.5.2 Purpose statement

The purpose of this study is to explore and explain the nature of teacher learning with a particular focus on how primary maths teacher professional identities and practices evolve within a Community of Practice professional development initiative and the broader setting and the implications of such educators' development models towards primary maths teacher learning and effective maths teaching.

1.5.3 Rationale

1. The research seeks to investigate primary maths teacher learning mechanisms within communities of practice context.

2. The study can be viewed as a case of primary maths practice and inquiry informed professional teacher development with a focus on primary maths teacher identity and can contribute to the growing body of literature that highlights learning as changing identity.

3. The study can contribute to policy and practice in the field of in-service primary maths teacher professional development.

1.5.4 Research Questions

The key research questions addressed in this study are:

Overarching Question

What is the nature of primary maths teacher learning within an in-service community of practice-inquiry context?

Research Questions

1. How do primary maths teachers' professional identities evolve in relation to participation in an in-service community of practice-inquiry (as well as in other overlapping communities of practice)? What are the processes through which primary maths teacher identities evolve?
2. What activities, relations and forms of participation within the Community of Practice enable or constrain evolving primary maths teacher identities and practices? How do these enable or constrain?
3. How do these teacher evolving identities and practices relate or align to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP?

From my initial set of questions at the start of the research I have added the contextual question that emerged during the study as this helps investigate and analyse the South African official primary mathematics pedagogic identities promoted by the post-apartheid curriculum reforms and the recent changes.

Contextual Question

What types of primary mathematics pedagogic identities are promoted within the official national curriculum context and how do these identities relate to classification and framing principles?

Question three, was thus rephrased in relation to the above contextual question and is theoretically illuminated by Bernstein (1999) pedagogic identity model's generated four pedagogic identity positions. All four research questions are illuminated by the situative-participationists framework that is the social learning theory and the CoPs concept (Wenger, 1998; Lave, 1996; Lave, 1993a & 1993b; Sfard & Prusak, 2005; Wenger et al, 2002) paying particular attention to the notion of identity.

In this study I propose new terms or phrases and thus a language to describe the processes of the primary maths teachers' identity formation and learning through participation in a numeracy in-service community of practice. The working definitions of these neologies are provided below. The Collins online dictionary defines neologies as newly coined word or phrase or a familiar word used in a new sense.

1.6: Definition of terms introduced in the study

The following working definitions of terms emerged from and are used in the study.

Activation: This is a process used to describe how primary teachers with a history of weak (negatively valued) mathematical identities describe their participation experiences in the in-service community of practice resulting in increasingly positive maths identities.

Insiding: A process describing teacher trajectories that limit their mathematical participation in the in-service community of practice and in maths classes. The term borrows from and extends Wenger (1998) *insider trajectories*, under which full participating members continuously change their practices and renegotiate their identities in relation to new demands, new inventions and new generations

Outcropping: A process describing teacher trajectories that do not confine or limit their participation to the in-service CoP and maths classes but also extend their maths identities into a wide range of mathematical and mathematics education practices. The term '*outcropping*' relates to what Wenger (1998) identifies as '*Boundary trajectories*' which are amongst the various types of trajectories found in communities of practice. *Boundary trajectories* find value in "spanning boundaries and linking communities of practice" (Wenger, 1998, p. 154).

Primary Maths Teacher Identity: *A way of talking about* how primary teachers know and name themselves and how they are recognised by others with respect to the subject of mathematics and its corresponding activities. This definition is informed by the theoretical

framework (Wenger, 1998; Bernstein & Solomon, 1999) supplemented with insights from maths identity literature (Bishop, 2012; Grootenboer et al, 2006).

Reinvigoration: Is the umbrella term used to represent several synonyms used by the teachers with positively valued maths histories to explain their participation and learning experiences within NICLE.

Remediation: Is the umbrella term used to represent several synonyms used when participants past negatively valued (mathematical) identities evolve through participation in a (in-service) community of practice towards more positive identities. The concept of remediation is akin to the terms ‘reconstruction’ (Lave, 1993b, p. 73) and ‘reconstitution’ (Cain, 1991, p. 218) used by both Lave and Cain. Reconstitution or reconstruction occurs as participants ‘exorcise’ negative identities and gradually interpret and construct a community identity (Cain, 1991, Lave, 1993b).

Stelos: These are learning stories or stories about learning changes in one’s identity through participation in a community of practice. The term *stelos* borrows from Sfard and Prusak’s (2005) proposal that identities be equated with stories and Lave’s (1996) notion of *telos*. The term *stelos* is born out of our cloning of the words ‘story’ and ‘*telos*’, or simply put: story + *telos* = *stelos*.

Stunted: Is the term used to express ways in which life, school or teaching experiences results in identity trajectories that shy away from maths. The word *stunt* also draws from the sociocultural framework with the antonym of this term within the situative framework being ‘*sustained*’, with Lave (1993b) indicating that identities and knowledge are formed and sustained in communities of practice.

1.7 Outline of the thesis

Chapter One In this chapter I have provided the background to the study – briefly outlining the key foregrounded concepts and embedding the study in the local primary (maths) teacher education context. I also provided the research questions that I set to investigate. Below I present a brief overview of the thesis and outline what follows in each chapter in the thesis.

Chapter Two contextualises the study and explores the nature of the South African primary maths education crisis. Theoretically informed by Bernstein’s (2000) notion of pedagogic identity and Tyler’s (1999) extension of the model in relation to classification and framing principles, the chapter discusses the primary maths teacher identities projected by the post-

apartheid curriculum reforms and changes undertaken in South Africa. Coupling the theoretical perspective with curriculum policy document analysis indicates that the officially projected South African PMTI shifted from a significantly weakened and symbolic therapeutic primary maths teacher identity to the current market primary maths teacher identity. Such a promoted identity is strongly classified and exhibits a strengthened frame. It focuses on the progressive development of fundamental maths concepts and the improvement of learner performance in the nationally administered ANAs.

Chapter Three discusses and explains the situative-participationist theoretical framework used in this study. That is, Lave and Wenger's social learning and the Communities of Practice theory (Wenger, 1998; Lave & Wenger, 1991; Lave, 1996; Lave, 1993b; Wenger et al, 2002). The chapter also outlines the situative-identity (Wenger, 1998; Sfard & Prusak, 2005; Lave 1993b; Lave, 1996) analytical tools informing this study. The sociocultural-participationists theory illuminates the investigation of the four research questions underpinning this study and informs the key arguments that I will make in Chapters 8, 9 and 10.

Chapter Four reviews relevant local and international literature that has researched the notion of (primary) maths teacher identity and maths teacher professional development programmes. Drawing on this literature the study discusses aspects relating to primary maths teacher identity formation and learning and how maths teacher identities relate to curriculum reforms before providing for a working definition of Primary Maths Teacher Identity. Finally it engages with relevant teacher education literature to discuss the re-orientation, challenges and the characteristic features of 'successful' teacher development approaches.

Chapter Five discusses the research design and methods. It outlines the empirical field of study (NICLE), my positioning in the research and the qualitative interpretive research methodology used in the study. The chapter also discusses the research study sample and the four data collection strategies (interactive interviews, participant observations, reflective journals and document collection) used to gather data that informs the analysis in Chapter 6 and 7 and the discussions in Chapter 8, 9 and 10. This chapter concludes with a discussion on a range of methodological issues that concern ethics, validity and reliability, data analysis and the generalisability, relatability and generativity of the study's findings.

Chapter Six elaborates on the empirical field of study discussing four purposively selected NICLE sessions presented by primary maths education specialist guest speakers and two

combined sessions reconstructed from eight presentations by the Chair and staff in the Chair. These NICLE sessions describe and illuminate the nature of activities that teachers engaged in across the two year period of this study. My analysis of the NICLE CoP sessions and SANCP documents reveals that NICLE provided opportunities that prioritize the projection and the promotion of positive professional numeracy teacher identities and practices. The chapter finally unpacks the components that comprise the type of primary maths teacher identity envisaged within NICLE.

Chapter Seven presents the teacher learning stories-*stelos* which provides detailed descriptions of each of the sampled teachers' utterances and journal writings on how their mathematical learning and identity formation unfolded prior to and during participation in NICLE. The narrative explorations presented in this chapter lays the foundation for the reader to engage with the discussion in Chapter 8 and also provides the backdrop for interrogating the main research question and the semantics used to explain how primary maths teachers dialectically learn within NICLE. The teacher learning stories together with other sources of data further illuminate the discussions in Chapter 8, 9 and 10 and assist the interrogation of the other research questions underpinning this study.

Chapter Eight discusses the key research findings and the main contribution of the study. It provides rich and in-depth descriptions and analysis on the nature of teacher learning and how primary maths teachers' professional identities evolved in relation to participation in NICLE. The study illuminates how teachers with positively valued maths histories *reinvigorated* their mathematical identities, whilst teachers with weak mathematical histories had their maths identities *remediated* and new mathematical identities *activated* through participation in NICLE, leading to stronger maths identities. The study also explains the processes through which primary maths teacher identities evolve as *outcropping* under which teacher identities trajectories extend into a wider range of mathematical and maths education practices and as *insiding* which involve teachers limiting their mathematical participation in NICLE and in maths classes.

Chapter Nine discusses and analyses the primary maths teacher learning affordances and constraints described by teachers within NICLE. The study indicates that teachers participating in NICLE mostly take-up into their maths classrooms key numeracy-domain concepts, resources, issues and approaches presented by primary maths experts which are informed by research and theory that link practices. Teachers collaboratively and actively engaged in a range of activities that relate to primary maths classroom practices. Teacher

learning was also said to be enabled when teachers engage in maths overlapping communities of practices, share classroom experiences in friendly ways that mutually respect teachers and regard them as professionals. Such activities, relations and forms of participation improved the primary maths teachers' understanding of specific numeracy concepts and also enabled teachers to engage learners in maths classes. Whilst the teachers felt challenged by the travelling distance and limited time to engage in professional work, they also provided attunements to these constraints. The chapter also raises the tension of how to scale-up maths professional development initiatives.

Chapter Ten interrogates the third research question of the study, using Wenger's (1998) notion of alignment and Bernstein's (2000) pedagogic identity model generated four teacher categories, discussed in Chapter 2. Given the current local primary maths education curriculum and policy changes the study identified four market-related teacher positions in the sample of teachers which shows that most of the teachers' practices and identities were aligned to and positively influenced by the new CAPS curriculum though the teachers take different positions in relation to the ANAs. Besides the broader educational changes, the research findings also indicate that primary maths teacher identities and practices are also influenced by their classroom and school working contexts.

Chapter 11 concludes with a discussion of the main findings, contributions and limitations of the study. This chapter also makes recommendations and suggests further avenues of research emanating from the study.

CHAPTER 2: Analysis of the South African primary maths education context and the projected primary maths teacher identities

2.1 Introduction

To contextualise the study, this chapter initially engages with local primary maths education literature to explore the nature of the South African primary maths crisis, and discusses problems and challenges facing the teaching and learning of primary maths. I review the challenges that have had a bearing on, the numerous curriculum developments and changes witnessed in primary maths education in post-apartheid South Africa. All the teachers in my sample (except Edna and Mary) have more than 12 years teaching experiences and thus have been affected by the last two major curriculum changes experienced locally. All the sampled teachers had been affected by the recent restructuring of the CAPS curriculum.

This chapter is theoretically informed by Bernstein's (2000)¹¹ notion of pedagogic identity and Tyler's (1999) extension of the model in relation to classification and framing principles. This model helps to interrogate the contextual question and discuss the primary maths teacher identities projected by the post-apartheid curriculum reforms and changes undertaken in South African from the time Curriculum 2005 (C2005) was launched in 1997, through the revision of the National Curriculum Statement (NCS) which began in 2002 up to the recently implemented Curriculum and Assessment Policy Statement (CAPS). I analyse the contents of key national curriculum statements and primary maths curriculum policy documents using Bernstein (2000) and Tyler's (1999) pedagogic identity model. I argue that during the 15 year period under review the officially projected South African primary maths teacher identity shifted from a significantly weakened and symbolic therapeutic primary maths teacher identity to the current market primary maths teacher identity. This identity orientation is more strongly classified, exhibits a strengthened frame and focuses on the progressive development of fundamental maths concepts and the improvement of learner performance in the nationally administered Annual National Assessments (ANAs) tests.

¹¹ As noted earlier, the model had its origins in a response (Bernstein, 1995) to a paper by Tyler (1995). The source I mainly refer to appears in Bernstein's (2000) revised edition which builds on and develops previous work.

The pedagogic identity model allows the study to investigate the contextual question relating to the type of primary mathematics pedagogic identities promoted within the official national curriculum context, and shows how these can be expressed as a function of classification and framing principles. The model also informs the key arguments that I make in Chapter 10. These arguments respond to the third research question, which relates to how teacher evolving identities and practices align to the broader official pedagogic identities promoted nationally (especially the current primary maths education policy changes concerning the new restructured CAPS curriculum and the ANA tests) and to other contextual factors external to the CoP.

2.2 The South African Primary Maths Crisis

South African primary maths education has been described to be in a crisis (Fleisch, 2008). Local primary maths literature published in South Africa's post-apartheid education context explains the nature of the South African primary maths crisis (Fleisch, 2008; OECD, 2008; Schollar, 2008; Van der Berg & Louw, 2006; Reddy, 2006; DOE, 2008). The crisis is evident in the local learners abysmal performance in numeracy and maths in international, regional, sub-regional and national tests (DOE, 2008; OECD, 2008; Fleisch, 2008; Schollar, 2008; Carnoy et al, 2011; Mullis et al, 2012; Taylor et al, 2013; DBE, 2012). Below I explore the implications of this crisis for primary maths teacher education.

Firstly, evidence from national, regional and international tests reveals that local primary learners cannot execute maths tasks at the appropriate grade levels or at the expected competence levels (OECD, 2008; Schollar, 2008; Fleisch, 2008; DOE, 2008). The 2001 Southern Africa Consortium for Monitoring Educational Quality (SACMEQ) II dataset indicates that half of Grade 6 mathematics learners perform at the Grade 3 level or lower (Schollar, 2008; Van der Berg & Louw, 2006). The 2005's Department of Education's systemic evaluation mathematics scores reveals that only one in ten learners were at the standard required by the NCS (Fleisch, 2008). This has led some commentators to conclude that 80% of South African learners are below the minimum expected standards for their grade (Schollar, 2008).

Secondly, the learner performance tests show that most South African primary scholars have a poor grasp of elementary foundational mathematical concepts, as reflected by the 30% average scores for both the 2001 Grade 3 numeracy national tests and the 1999 Monitoring Learning Achievement (MLA) Grade 4 numeracy assessment, in which South Africa had the lowest score amongst the 12 African participating countries (OECD, 2008; Reddy, 2006). Schollar (2008) clearly illustrates this and notes that the majority of South African learners do

not have an understanding and knowledge of basic number bonds (algorithms), place value and cannot readily understand the meaning of multiplication and division. In the international and highly cited Trends in International Mathematical and Science Study (TIMSS) (1999, 2002, 2011) the local Grade 8 maths scores are at the bottom of the maths league tables (OECD, 2008; Reddy, 2006; Howie, 2001; Mullis et al, 2012).

As a result of the South African learners' poor performance in international tests the Minister of Education announced the withdrawal of South Africa from participation in these external tests and the launch, in 2008, of the Foundations for Learning Campaign (FFL) which aims at improving the average learner performance in literacy and numeracy to 60% by 2014 (DOE, 2008). Under the new national monitoring measures, put in place by the Department of Education, all South African primary learners in government schools (Grades 1-6 and 9) must undergo Annual National Assessments in Numeracy and Literacy, using standardised tests to monitor their literacy and numeracy levels. The 2012 ANA Maths national mean scores show a slight improvement from the 2011 average marks, with the 2012 mean scores revealing that performance tends to decline as one moves up the grades. Thus 77.4% of Grade 1 learners achieved over 50% for mathematics, reducing to 67.8%, 36.3%, 26.3% 16.1% and 10.6% for grades 2 to 6 respectively (DBE, 2012). Whilst the recent DBE (2012) ANA maths test scores show some improvement in the Foundation phase, the Intermediate phase maths score show little improvement. Thus the major curriculum reforms and the FFL campaign have yet to make an impact on the crisis.

2.2.1 South African primary maths teaching and learning challenges

In this section I discuss the primary maths teaching and learning challenges that have frequently appeared in local primary maths education literature, and also has a bearing on the curriculum developments and changes witnessed in post-apartheid education. Thus literature-informed discussion will provide supplementary evidence of how the recent curriculum developments and policy changes have projected a particular primary maths teacher in light of the challenges faced.

Several studies foreground the concept of the opportunity to learn (OTL), which implies the time, coverage, sequencing and pacing of curriculum content made available to learners, point out that local primary maths teachers teach content, skills and concepts that were supposed to have been covered in the lower grade levels (Reeves & Muller, 2005; Fleisch, 2008; Taylor & Vinjevoold, 1999; Taylor, 2011; Carnoy et al, 2011). One important aspect of the OTL is time. Local research shows that time management is a significant problem in most South African schools (Van der Berg & Louw, 2007; Taylor & Vinjevoold, 1999; Taylor,

2011; Taylor et al, 2013). The three TIMSS (1995, 1997, 2003) reports state that school and class attendance is a major problem that shortens South African students' classroom learning time (Howie, 2001; Reddy 2006). Recently the 'Carnoy (2011) report' and Taylor (2011) study have shown that the amount of time during the year that teachers actually teach learners mathematics is disturbingly low, with some primary maths teachers preferring not to cover the more advanced topics.

Local literature and researchers also depict primary maths teachers as having weak maths conceptual and pedagogical content knowledge (Fleisch, 2008; Hoadley, 2007; Taylor & Vinjevold, 1999; Taylor et al, 2013; Taylor, 2011). Teachers with a poor grasp of fundamental concepts deprive learners of higher-order tasks and contribute to low levels of learner achievement (Taylor & Vinjevold, 1999; OECD, 2008; Carnoy et al, 2011; Taylor, 2011). The Khanyisa Programme's Grade 3 teacher numeracy tests and the 2007 Grade 6 SACMEQ III maths test scores, indicate that the majority of local primary teachers know little about the subjects they teach, especially maths (Schollar, 2008; Taylor et al, 2013; Taylor, 2011). Recent work by Askew, Venkat & Matthews (2012), focused on primary maths teachers' pedagogical content knowledge, reveals poor, incoherent and inconsistent primary maths lessons that inhibit learners from understanding and making meaning of mathematics. In the early years of post-apartheid, the abolition of a national progressive syllabus of study (that prescribes progressively the content to be taught) combined with the non-provision of textbooks or workbooks to give effect to the syllabus exacerbated the problem (Schollar, 2008; Fleisch, 2008; Taylor & Vinjevold, 1999; OECD, 2008; Taylor, 2011).

South Africa schooling system is generally characterised by vast inequalities (Reddy 2006; Fleisch, 2008). Across the different social and economic groups educational material and human resources are unequally distributed (Adler & Reed, 2002). Hoadley's (2007) study illuminates how social class inequalities have infiltrated into South African grade 3 primary maths classrooms, resulting in middle-class learners acquiring the specialised knowledge of mathematical principles whilst working-class students have been exposed to local everyday knowledge, meanings and practices. Related to this, the first post-apartheid South African curriculum (C2005) has been criticised for its emphasis on applying mathematics to real-life situations at the expense of understanding and mastering basic fundamental mathematics concepts and skills (Reddy, 2006; Taylor & Vinjevold, 1999; DOE, 2000, Fleisch, 2008; Hoadley, 2007). Another educational challenge existing in South African primary maths classes concerns the language of instruction. Advocates of bi/multilingualism as a resource

and code switching practices argue that multilingualism can be used to enable learners to understand and explore mathematical concepts and ideas, support classroom communication, peer discussion and can help teachers provide learner support needed to develop proficiency in the language of learning and teaching (Setati, 2005, Setati & Planas, 2012; Taylor & Vinjevold, 1999; Taylor et al, 2013). While multilingualism is being increasingly promoted within curriculum and policy documents as shown in Chapter 1, take-up is slow as the politics of language use in the classroom is complex (Setati & Planas, 2012). In the last 15 years the numerous curriculum developments and changes have been intended to overcome some of the local primary maths classes' problems and challenges discussed herein, and in the process portray, project and promote a particular primary maths teacher identity

2.3 Why use Bernstein to analyse the South African Curriculum changes and the projected primary maths teacher identities?

Whilst the work of Lave and Wenger (1991) and Wenger (1998) offer a more localised form of analysis of identity within CoPs such as NICLE, Bernstein (2000) and Tyler's (1999) pedagogic identity model connects and links the concept of identity both to macroforms (structures of power and control) and microprocesses (transmission, pedagogy and evaluation) (Sadovnik, 1995; Bernstein, 2000), and offers conceptual tools to analyse and relate South African PMTIs to the education macro policy context and the micro classroom interactions. Bernstein's connection of the pedagogic identity at both the macro and micro levels provides the study with "useful grammar" (Lerman, 2012b p.176) and a "specialised ...language of description" (Bernstein & Solomon, 1999, p. 272; Bernstein, 2000, p. xvi) to interrogate the South African PMTI within the local post-apartheid education reform context. Bernstein's (2000) concept of the pedagogic identity model and Tyler's (1999) extension of the model also allows the study to interrogate the contextual question and the 3rd research question that investigates how teacher evolving identities and practices relate to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP. In other words the pedagogic identity model enables the study to focus on how "contemporary resources... construct" (Bernstein & Solomon, 1999, p. 272) *who* South African primary teachers are "with respect to the subject of mathematics and its corresponding activities" (Bishop, 2012, p. 39). Besides illustrating the contextual questions the pedagogic identity model also illuminates and informs some of the key arguments that I make in Chapter 10 concerning how primary maths teachers align to curriculum and education policy changes.

Both Bernstein and Wenger's theories have the same origins and inspirations as they are informed by Karl Marx, Emile Durkheim and Max Weber's classical theoretical traditions (Wenger, 1998; Sadovnik, 1995; Lerman, 2012b). Thus both Wenger and Bernstein borrow from the modern version of the social theory found in the work of Karl Marx, Emile Durkheim and Max Weber (Wenger, 1998; Sadovnik, 1995) and connect their work to theories of power (Durkheim, Marx, Weber and Bourdieu) and theories of identity¹² (Wenger, 1998; Bernstein, 1971, 2000). Graven (2002a) who used the two theories in her PhD research study to analyse maths teacher identity during curriculum change in South Africa explains how these theories cohere and complement each other.

Bernstein's (1971, 2000) classification and framing theory, his pedagogic model and pedagogic identity concept have been used to study maths teachers' official pedagogic identities within reform contexts in South Africa (Graven, 2002a; Graven, 2002b; Parker, 2006; Pausigere & Graven, 2013d), in Britain (Morgan et al, 2002; Day et al, 2005; Woods & Jeffrey, 2002) and Sweden (Johansson, 2010)¹³. Closely related and relevant to this study is Johansson's (2010) paper that has been informed by Bernstein's concept of pedagogic identities to study school mathematics reforms in Sweden. Tyler (1999, p. 277) specifically notes that "Bernstein's pedagogic identities are the 'langue of reform'". Bernstein's concept of pedagogic identity provides the study with tools for analysing positions of South African primary maths teachers in the contexts of education reform. It thus allows the study to interrogate the contextual question relating to the type of primary mathematics pedagogic identities promoted within the official national curriculum context and how these identities relate to classification and framing principles.

In summary Bernstein's theory and his concept of pedagogic identity provides analytic, descriptive and explanatory tools that enable the investigation of South African primary maths teachers' identities within South Africa's curriculum reform and education change context.

2.3.1 Bernstein (2000) and Tyler's (1999) Pedagogic Identity model

Bernstein (2000) and Tyler (1999) used the concept of pedagogic identity to analyse British and Australian educational reforms in the last quarter of the 20th century. These were

¹² Both Bernstein (Bernstein & Solomon, 1999) and Wenger (1998) concur that the theory or concept of identity is a resource concerned with the understanding of the person in a context of mutual constitution between individuals (self) and groups (others).

¹³ Harley and Parker (1999, p. 193) have also essentially noted that while "Bernstein's theory can be applied to changes in many settings, the sheer scale and speed of change in South Africa make the theory resonate evocatively".

characterised by moves towards a homogenous national curriculum and the compulsory testing of primary learners in core subjects. As noted above South Africa has experienced major curriculum reforms and changes, over the past two decades, which have involved the repeated revision of common curriculum frameworks. These include Curriculum 2005, National Curriculum Statement, and recently the Curriculum and Assessment Policy Statement. Recently (2012) and in primary maths education, South Africa introduced universal standardised primary learner Annual National Assessments in numeracy and literacy at primary level. These developments are similar to the education reforms experienced in the United Kingdom and Australia in the 1990s. The contextual question therefore arises as to whether (and in what ways) the South African primary maths teacher identities promoted by both the previous and the current South African maths education policies relate to Bernstein's model of pedagogic identity and its realisation through classification and framing principles.

According to Bernstein identity refers to “contemporary resources for constructing belonging, recognition of self and others, and context management (what I am, where, with whom and when)” (Bernstein & Solomon, 1999, p. 272). Central to Bernstein's pedagogic identity model (Bernstein, 2000; Bernstein & Solomon, 1999) is the argument that the official knowledge and pedagogic modalities of curriculum reforms distributed in educational institutions construct, embed and project different official pedagogic identities. Bernstein's concept of pedagogic identities generated four distinct pedagogic identity positions, namely Conservative, Neo-Conservative, Therapeutic and Market¹⁴, which are constructed and projected through changes in the official knowledge brought about by curricular reform. Though Bernstein explained that pedagogic identities are outcomes of classification and framing concepts he did not make a clear formulation, interpretation or repositioning of the pedagogic identities in terms of the classification and framing principles. Tyler (1999) extended Bernstein's concept of pedagogic identity and developed a comprehensive model for describing the four identity positions in terms of classification and framing. The study thus theoretically supplements Bernstein's (2000) pedagogic identity model with Tyler's (1999) work, which explains the pedagogic identity positions as a function of classification and framing.

¹⁴ Of the many terms interchangeably used by Bernstein to describe the pedagogic identity categories I have chosen to use these four terms consistently throughout this study.

2.3.2 Classification and Framing

It is important for this study to explain the concepts of classification and framing, as these are key to Tyler's (1999) extension of the pedagogic identity model and are also core to Bernstein's (1971) educational knowledge code theory. Classification and framing, according to Bernstein (1971), determines the structure of curriculum (knowledge), pedagogy and evaluation in any education system. Classification, according to Bernstein (2000, p.6), refers to "relations *between* categories" or "*relationships* between contents" (Bernstein, 1971, p. 205) [italics in original]. With strong classification, areas of knowledge and subject contents are well insulated into traditional subjects (Sadovnik, 2001; Bernstein, 1971). Weak classification refers to an integrated curriculum with blurred boundaries or reduced insulation between contents (Sadovnik, 2001; Bernstein, 1971). According to Bernstein (1995), integrated codes had a stronger ideological life in the late 60s and early 70s in Great Britain with collection codes prevalent in Britain before the 1960s.

On the other hand, the concept of frame "determines the structure of the message system, pedagogy" and refers to the "options available to teacher and taught in the *control* of what is transmitted and received in the context of the pedagogical relationship" (Bernstein, 1971, p. 205) [italics in original]. Simply put, it "refers to relations between transmitters and acquirers" (Bernstein, 2000, p.12). According to Bernstein (1971; 2000), where framing is strong, there is a sharp boundary between what may be and may not be transmitted, and the transmitter has explicit control over selection, sequencing, pacing, criteria and social base. Where framing is weak, there is a blurred boundary between what may be and may not be transmitted and the acquirer has more *apparent* control over the communication and its social base. Another aspect of framing pertains to the strength of the boundary between educational and non-school everyday knowledge (Bernstein, 1971).

Whilst in his earlier writing Bernstein (1971) explained selection, sequencing, pacing, progression and timing as critical variables of the frame strength, in his later work he also considers hierarchical (regulative/social order) and evaluative (criteria) rules as core components of framing (Bernstein, 2003; Bernstein, 2000), which he calls pedagogic practice (Bernstein, 2003). The *regulative* or hierarchical rules¹⁵ establish the conditions for social order, character and manner in the pedagogical relation (Bernstein, 2000; 2003). The rules of

¹⁵ According to Bernstein (2003) hierarchical rules can be explicit or implicit. Under explicit hierarchical rules the relationship is one of clear subordination and super ordination – its positional, in an implicit hierarchy relationship power is masked or hidden by the devices of communication – its inter-personal.

selection, sequence¹⁶, pacing¹⁷ and criteria are called instructional or discursive rules (Bernstein, 2000; 2003). Bernstein (2000) thus called the rules of social order *regulative discourse*, and the rules of discursive order *instructional discourse*. He consequently defined framing as follows:

$$\text{Framing} = \frac{\text{instructional discourse } ID}{\text{regulative discourse } RD}$$

It is important to note that the framing values (selection, sequencing, pacing, criteria and the social base) and also the strengths of framing (instructional and regulative discourse) may vary with respect to the elements of the pedagogic practice (Bernstein, 2000: 2003). Whilst the strength of the classification and framing can vary independently of each other, this is not the case with evaluation, which Bernstein (1971, p. 206) describes as a “function of the strength of classification and framing”.

For Bernstein (1971, p. 203), assessment or evaluation implies “what counts as a valid realization of knowledge on the part of the taught”. He distinguishes it from criteria or criteria rules which “...enable the acquirer to understand what counts as a legitimate or illegitimate communication, social relation, or position” (Bernstein, 2003, p. 65). Criteria under which the “acquirer will be made aware of how to recognise and realise the legitimate text” (Bernstein, 2000, p. 47) can be explicit and specific; or they can be implicit, multiple and diffuse, in which case the “child is not aware except in a very general way of the criteria s/he has to meet” (Bernstein, 2003, p. 68). The integrated code gives rise to multiple criteria of assessment and its weak framing may lead to a situation where assessment takes ‘inner’ attributes of the student into account such as, for example, through profiling, and criteria-referenced assessment (Bernstein, 1971, p. 224; Bernstein 2003). On the other hand, the collection code creates ordered principles of evaluation which result in a relatively objective procedure (Bernstein, 1971).

2.3.3 Bernstein and Tyler’s pedagogic identities

Bernstein’s concept of pedagogic identities generated four distinct pedagogic identity positions, namely Conservative, Neo-Conservative, Therapeutic and Market. These are

¹⁶ Bernstein (2000, p. 12) defines sequencing as “what comes first, what comes second”. Later in his work uses the words sequence and pace interchangeably and also relates sequence to progression (Bernstein, 2003).

¹⁷ Pacing is the rate of expected acquisition (Bernstein, 2000; 2003) or learning (Bernstein, 1971). With strong pacing not only is “time is at a premium”, but it tends also to “reduce pupils’ speech and privilege teachers’ talk” (Bernstein, 2003, p. 73).

constructed and projected through changes in the official knowledge brought about by curricular reform. In education reform contexts the pedagogic identities can be available in “pure or mixed forms” (Bernstein, 2000, p. xii).

2.3.3.1 Conservative Pedagogic Identities

Bernstein (2000, p. 66) classified Conservative Pedagogic identities as those teacher positions generated and shaped by national resources or discourses and “grand narratives of the past” that provide exemplars, criteria, belonging and coherence. In this category of identity there is tight control over the content of education but “*not over its outputs*”, thus it’s “discourse does not enter into an exchange relation with the economy” (Bernstein, 2000, p. 67). Because of their content bias and focus Conservative teacher identities are “formed by hierarchically ordered, strongly bounded, explicitly stratified and sequenced discourse and practices” (Bernstein, 2000, p. 67). The resulting identities, according to Tyler (1999, p. 276), are “inflexible and generalised.” Tyler (1999) explains that in terms of educational codes this identity position can be described as having both strong classification and framing properties typical of a collection code, as was the case with Britain before the 1960s.

2.3.3.2 Neo-Conservative Pedagogic Identities

Neo-Conservative Pedagogic identities are “formed by recontextualising selected (and appropriate) features from the past to stabilise” and facilitate “engaging with contemporary change” (Bernstein, 2000, p. 68). Thus “this identity is constructed to *deal with cultural, economic and technological change*” (Bernstein, 2000, p. 67) [emphasis in original]. This ‘new fusion’ of identity, according to Bernstein (2000, p. 76) foregrounds the career base (individualised construction), with an emphasis on performance and takes heed of social relations. Because of its emphasis on performances which have an exchange value, the management of this ‘externally-oriented’ identity category requires the state to control education inputs and outputs (Tyler, 1999, p. 276; Bernstein, 2000). Implicit in this emerging identity is “the beginning of a change in the moral imagination” (Bernstein, 2000, p. 77). Because of its dual desire to stabilise the past and engage with change by creating appropriate attitudes towards it, this teacher identity category exhibits strong framing typical of the Conservative position, yet its disregard for traditional disciplinary boundaries and academic identities leads to weak knowledge classification (Bernstein, 2000; Tyler, 1999). In other words Neo-Conservative pedagogic identities are sustained in official education arenas whose curriculum is strongly framed and weakly classified.

2.3.3.3 Therapeutic Pedagogic Identities

Therapeutic pedagogic identities are “produced by complex theories of personal, cognitive and social development, often labelled progressive” (Bernstein, 2000, p. 68) or “child centred” (Bernstein, 2003, p. 63). The therapeutic position projects autonomous, non-specialised, sense-making, integrated modes of knowing and adaptable co-operative social practices that create internal coherence. Bernstein (2000, p. 69) however cautions that such a pedagogic identity “is very costly to produce and the output is not easily measurable”. The transmission which produces this identity is against specialised categories of discourse and prefers weak knowledge boundaries (Bernstein, 2000). Tyler (1999, p. 276) describes the Therapeutic position as “weakly classified and framed, since it exhibits low specialisation and localised, adaptable practices”. Bernstein (2000, p. 69) explains that in the educational reforms introduced by the National Curriculum in the United Kingdom in the late 1980s, the Therapeutic identity was “projected weakly if at all”. Later I discuss how this identity position was promoted through C2005, launched in South Africa in the late 1990s.

2.3.3.4 Market Pedagogic Identities

Lastly Bernstein (2000, p. 71) identified the Market position, which integrates “a decentralised device of management (for example in evaluation) embedded in a curriculum emphasising national enterprise (cultural, economic and political)”. The Market teacher identity category is characterised by autonomy, with a focus on producing competitive output-products (students) with an exchange value in a market and constructing an outwardly responsive identity driven by external contingencies. This identity is also orientated towards the intrinsic value of the discourse responsible for the serial ordering of subjects in the curriculum, and has to contend with the possible tension between enhancing learners’ test performance and teaching disciplinary knowledge. The tension between satisfying external competitive demands and an orientation towards the intrinsic value of the discourse led Bernstein (2000, p. 71) to call this category a “new pathological position at work in education; a pedagogic schizoid position” or “a new pedagogic Janus” (Bernstein, 2003, p. 80). Bernstein (2003, p. 80) notes that the market pedagogic identity category is “ideologically a much more complex construction”.

Tyler (1999, p. 276) notes that there are similarities between this identity category and “visible market pedagogy”, notably, according to Bernstein (2003, p. 80), in terms of “explicit rules of selection, sequence, pace and criteria”. The explicit rules of selection, sequence, pace and criteria have two different implications. Firstly according to Bernstein (2003, p. 80) they “readily translate into performance indicators of schools’ staff and pupils”.

curriculum policy documents reveal that this new curriculum had a clear political agenda, for it was regarded as the pedagogical route out of the stultifying legacy of apartheid education, with the new curriculum promoting knowledge, globally transferable skills and social justice values for all citizens (Taylor & Vinjevold, 1999; Chisholm et al, 2000; Jansen, 2001; DOE, 1997c; Graven, 2002b). Bernstein (2000, p. 73) states that the Therapeutic identity “is a truly symbolic construction” meant in the case of South Africa to serve a political mandate and inculcate democratic and social values. The primary teacher’s role is inscribed within key macro-political responsibilities that characterised the new South African pedagogical order which were also to be translated and realised in the microprocesses of maths classroom interactions.

2.4.1 C2005: Promoting learner-centredness, integration and everyday knowledge

The core curriculum design features which underpinned C2005 were constructivism manifested in learner-centredness, integration and outcomes-based education (Chisholm et al, 2000; Muller 1998; Taylor & Vinjevold, 1999). Other key principles on which C2005 was based were “...holistic development, relevance, participation and ownership, accountability and transparency, flexibility, critical and creative thinking, progression, anti-biased approach, inclusion of learners with special education needs, quality standards and international comparability” (DOE, 1997a, p. 2-3; DOE, 1997b, p. 2-3). These core design features, principles and values of C2005 affected the mathematical knowledge that was to be taught, and how it was to be taught and evaluated at the primary level.

The post-apartheid curriculum’s main shift was from the traditional objectives and content-based prescriptive syllabus to an outcomes-based approach, which emphasised the importance of integration and relevance (DOE, 1997a; DOE, 1997c; Ensor & Galant, 2005). Thus the then Learning Area of Mathematical Literacy, Mathematics and Mathematical Sciences (MLMMS) for Grades 1 to 9 had specific outcomes which outlined the knowledge, skills, attitudes and values learners were expected to demonstrate that they understood and could apply or display in a particular context (DOE, 1997c). As noted above, constructivism underpinned C2005, manifesting itself in learner-centredness (Chisholm et al, 2000). Because C2005 was learner-centred, policy documents envisaged “active, participating learners”, who thrived in a “co-operative learning environment” working “effectively in groups” and taking “responsibility for their own learning” (DOE, 1997b, p. 24 DOE, 1997c, p. 29). Teachers no longer bore the responsibility of being “source[s] and transmitters of knowledge” but were instead designated as “facilitator[s] of learning” with the freedom to develop their own

learning programmes (DOE, 1997c, p. 29; DOE, 1997a, p. 27). The outcomes-based approach meant that primary maths teachers had to shift from focusing exclusively on mathematical knowledge and include attention to aspects of learning that promoted theme based learning across learning areas and promoted acceptable societal attitudes, attributes and competences amongst learners. The primary maths teachers' pedagogical roles and consequently their identity were covert as he or she was seen as the "guide on the side rather than the sage on the stage" (Jansen, 2001, p. 243).

Bernstein (2000, p. 68) notes that the Therapeutic identity "is produced by complex theories of personal, cognitive and social development often labelled progressive". The learner as characterised by C2005 moreover accords with Bernstein's Therapeutic pedagogic category's production of a "participating, co-operative modality of social relations" which is orientated to "autonomous ... flexible thinking and socially to team work as an active participant" (Bernstein, 2000, p. 68). The Therapeutic teacher identity thus foregrounds facilitation of a particular kind of learner and learning through cooperative social approaches, thus resonating strongly with C2005's promoted teacher roles (Graven, 2002a).

2.4.2 C2005's framing and knowledge classification

My reading of the curriculum policy documents through Bernstein's theoretical lens indicate that the pedagogical relationship between the 'facilitator' and 'learner', implied weak framing, with the teacher having a limited degree of control of both the pupil and the knowledge transmitted (Bernstein, 1971). This concurs with Harley and Parker (1999) and Taylor and Vinjevold's (1999) findings that C2005's framing was weak. The transmitter and acquirer under this curriculum were in an implicit hierarchical relationship, with the latter having "more *apparent* control over the communication and the social base" (Bernstein 2003; Bernstein, 2000, p. 13). Tyler (1999) also maintains that Therapeutic positions are weakly framed. From a framing perspective C2005 projected a Therapeutic primary maths teacher as one who would facilitate learning to an active and creative learner (DOE, 1997c). The labelling of the learners as being 'creative' and 'interactive' according to Bernstein (2000, p. 13) is typical of weak framing. The C2005's official position skewed the teacher-pupil-knowledge triad relationship and constructed a weak identity for primary maths teachers.

The key C2005 guiding principle of integration relates to the Therapeutic teacher identity. Because South Africa embarked on transformational OBE, it involved the most radical form of integration, across all eight Learning Areas, through the pursuit of cross-curricular themes (DOE, 1997a; DOE, 1997b). Because C2005 foregrounded learners' personal experiences

and everyday knowledge, learners were evaluated mainly through the popular continuous formative assessment method of portfolios. Teachers awarded marks not only for subject knowledge but also for their creativity and critical thinking (DOE, 1997c). Through C2005's emphasis on integrating mathematics with other learning areas and applying it to real-life situations, many argued that the progressive development of conceptual mathematical knowledge was downplayed (Taylor & Vinjevd, 1999; Chisholm et al, 2000; Graven, 2002a; Reeves & Muller, 2005; Fleisch, 2008). To this effect Graven (2002b) points out that the MLMMS's specific outcomes and its *Rationale* had political reconstruction aims, and revealed a radical shift in the philosophy of maths and the development of maths teacher identities. With progression and summative assessment backgrounded, and integration between learning areas and everyday knowledge emphasised, the subject specific (maths) pedagogic identity of the primary teacher was significantly weakened.

In terms of Bernstein's (1971) concept of classification, C2005 was weakly classified as the boundaries of discipline knowledge were blurred through the integration of the eight Learning Areas and the blending of educational and everyday non-school knowledge. Local studies by Reeves and Muller (2005), Hoadley (2007), Ensor and Galant (2005), Taylor and Vinjevd (1999) and Harley and Parker (1999) also report that under C2005 knowledge was weakly classified. Bernstein (2000) and Tyler (1999) agree that the Therapeutic teacher identity's transmission prefers weak boundaries. Simply put, this position is weakly classified. Bernstein (2000) and Tyler (1999) outline some Therapeutic pedagogic identity features that can be related to C2005, especially the fact that this identity is opposed to specialised categories of discourse and prefers an integrated modality of knowing – hence its recourse to regions of knowledge or arenas of experiences referred to as Learning Areas. Even the naming of the Mathematical learning area, as Mathematical Literacy, Mathematics and Mathematical Sciences (MLMMS) according to Graven (2002a) foregrounded integration.

Evidence from the primary maths curriculum documents concerning the teaching and learning contact times also points towards weak framing. In the foundation phase, 25% of the notional time was set for maths, with 15% being set for this Learning area at the Intermediate phase (DOE, 1997a, 1997b). Furthermore 25% and 5% of the contact time in the Foundation and Intermediate phases was 'flexible time' reserved for learners to work and develop at their own pace (DOE, 1997a; DOE, 1997b; DOE, 1997c). In this curriculum therefore the sequencing and pacing of knowledge was weak or low, as the acquirer had the privilege and opportunity to "construct personal time" (Bernstein, 2000, p. 13 & 73). This applied to all the

Learning areas, thus the teaching and learning of primary maths was not an exception to this curriculum guiding principle.

2.4.3 C2005's forms of assessment

Under C2005 teachers had to continuously and formatively assess learners through a wide range of strategies, including learner portfolios, self and peer assessment, group work and project work, with external formal assessments being undertaken at the end of Grade 3 and 6 (DOE, 1997a; DOE, 1997b; DOE, 1997c). C2005's emphasis on continuous formative assessment strategies over terminal summative assessment is consonant with Bernstein's (2000, p. 213) portrayal of the Therapeutic pedagogic identity as an "internally regulated construction ... relatively independent of external consumer signifiers". Bernstein (1971) notes that evaluation is a function of the strength of classification and framing - thus in an integrated, weakly classified and framed curriculum, such as C2005, evaluative criteria tend to be weak, with multiple criteria for assessment emphasising ways of knowing rather than the acquisition of knowledge. From a Bernsteinian perspective, C2005's forms of assessments were meant to recognise and liberate individual learner qualities and inner attributes (Bernstein, 2003). Such evaluative practices impacted on the assessment of learners' mathematical work, with the result that the primary maths teacher had to contend with awarding marks not just for "remembering subject content" but also for "different aspects of the learners' abilities, such as their creativity and critical thinking" (DOE, 1997c, p. 12). In sum, C2005's radical form of integration, weak classification, orientation to integrated mathematical knowledge and emphasis on continuous formative assessment projected a South African Therapeutic primary maths teacher identity as one which foregrounded social and political healing, perhaps at the expense of progressive mathematical conceptual understanding (Taylor & Vinjevold, 1999; Chisholm et al, 2000; Graven, 2002a).

2.5 The (Revised) National Curriculum Statement and the projecting of a Market primary maths teacher identity

The National Curriculum Statement officially replaced the C2005 in May 2002 after the Ministerial Review committee's recommendations for streamlining and strengthening of disciplinary knowledge in C2005 (DOE, 2002a; DOE, 2002b). Of relevance to maths education was the Review Committee's recommendation that the maths subject foreground and promote systematic conceptual progression, minimise the radical integration of school and everyday knowledge, improve the availability of learning and teaching materials, specify the crucial areas of content (knowledge and skills) to be taught and align learning outcomes and assessment standards (Chisholm et al, 2000; DOE, 2002a). The criticisms and

recommendations outlined by the Review Committee were also raised in local teacher education literature (Taylor & Vinjevold, 1999; Howie, 2001; Graven, 2002a; Muller, 1998 & 2006). In light of the Review Committee’s recommendations the National Curriculum Statement maths subject guidelines, through learning outcomes, stipulated the knowledge and skills levels to be achieved by learners in each grade (in C2005 these were phase based) and set out the conceptual progression from grade to grade (DOE, 2002a; DOE, 2002c; Muller, 2006). However the NCS retained the principle of integration¹⁸, which is integral to outcomes-based education and encourages a “participatory, learner centred and activity-based approach to education” (DOE, 2002a, p. 12; DOE, 2003; DOE, 2002c, p. 1).

2.5.1 Ensuring maths conceptual development through educationally sound integration and learner-centred opportunities

Central to the NCS and key for the maths subject and the resulting primary maths teacher identity was the *intended* achievement of an optimal relationship between integration and conceptual progression which would ensure the acquisition of conceptual knowledge, the gaining/development of skills and the engendering of the necessary values and attitudes (DOE, 2002a; DOE, 2002b; DOE, 2002c; DOE, 2003). The NCS thus required a primary maths teacher who would dually ensure maths conceptual development in learners and look for necessary and educationally sound integration and learner-centred opportunities (DOE, 2002c; DOE, 2003). Such a primary maths teacher identity resonates with Bernstein (2000) and Tyler’s (1999) market pedagogic identity, which is orientated both towards the intrinsic value of the subject - typical of strong classification and a radically transformed regulative discourse (rules of the social order) of the weak frame.

2.5.1.1 Developing maths conceptual understanding and progression

The Learning Outcomes and their Assessment Standards¹⁹, which are described as “cognitively dependent and supportive of each other”, were the two critical curriculum design features that ensured maths conceptual progression and specified the depth and breadth of essential high level maths knowledge, skills and values to be covered and achieved by learners in each grade (DOE, 2002a; DOE, 2002c). In primary maths education the five key learning outcomes in the renamed ‘Mathematics’ (previously MLMMS) learning area statement were Numbers, operations and relationships; Patterns, functions and algebra; Space and shape; Measurement and Data Handling (DOE, 2002a; DOE, 2002b; DOE, 2002c;

¹⁸ The NCS adopted an ordered form of integration which according to Bernstein (1971, p. 222) has a “sense of time, place and purpose”.

¹⁹ Learning outcomes describe what learners should know and be able to do. Assessment standards describe the minimum level, depth and breadth of what is to be learnt (DOE, 2002a).

DOE, 2003). The first learning outcome was allocated 55% and 40% of the Foundation and Intermediate phase maths time respectively so as to ensure that learners develop a strong number sense, numerical knowledge, memorise multiplication fluently, sharpen mental calculation skills and perform efficient and accurate algorithms and solutions (DOE, 2002b; DOE, 2002c; DOE, 2003). The complementary third and fourth learning outcomes were allocated 30% of the primary maths learning time and content weighting because “measurement is a rich context for the development of Numbers, Operations and Relationships and Space and Shape a context for developing the early algebra skills of pattern recognition” (DOE, 2003, p. 21). The new curricular also had an increased focus on data and data handling so as to develop sensitivity to the power of data and to enable learners to learn the skills of collecting, summarising, displaying and critically analysing information (DOE, 2003; DOE, 2002c). In addition to the knowledge and skills listed in the Learning Outcomes the maths learning area also promoted problem solving, mathematical reasoning and offered opportunities for learners to communicate about mathematics, across the learning outcomes (DOE, 2003). The key learning outcomes and the promoted skills across the learning outcomes were meant to ensure that learners engage in worthwhile and challenging mathematical tasks that give opportunities for learners to develop a deep and coherent conceptual understanding of maths (DOE, 2003). Analysing these local primary maths knowledge’s orientations through Bernstein’s work points to a market pedagogic identity which is oriented towards the institutional discourse of the school and its intrinsic value (Bernstein, 2000). Thus the NCS focused on the key yet critical and basic concepts of school mathematics knowledge. Such a knowledge orientation under the NCS resulted, according to Muller (2006), in mathematics to be strongly classified.

2.5.1.2 Balancing integration and conceptual progression

The “achievement of an optimal relationship/balance between integration and conceptual progression” were central to this curriculum (DOE, 2002a, p. 13; DOE, 2003, p. 6; DOE, 2002c). However “conceptual development was not to be compromised by integration” (DOE, 2003, p. 26). I now turn to discuss how conceptual progression was embedded within teacher developed Learning Programmes. Teachers were ‘supported’ to develop their own Learning programmes through tightly sequenced and ordered guidelines (DOE, 2003). The principles and values of the NCS learning area statements underpinned these phase-long plans, which are defined as structured and systematic arrangements of activities that specify the scope of learning and promote the attainment of learning outcomes and assessment standards for the phase (DOE, 2002a; DOE, 2002c; DOE, 2003). The Foundation phase Numeracy and the Intermediate phase Mathematics learning programmes ensured that the

prescribed outcomes, the core knowledge, context and concept choices for this learning area are covered effectively and comprehensively in a sequential way across the phase, resulting in coherent, meaningful and relevant teaching, learning and assessment activities (DOE, 2002c; DOE, 2002a; DOE, 2003). The Learning programmes also contained work schedules of a *yearlong programme* on how teaching, learning and assessment was to be sequenced and paced in a *particular* grade (DOE, 2002a; DOE, 2003). The next level of planning involved a Lesson Plan which drew directly from the work schedule and provided detailed structure for teaching, learning and assessment activities (DOE, 2003). Overall the Learning Programmes, work schedules and lessons plans under the NCS took heed of the fact that “the learning of mathematics is developmental, hierarchical and dependent” – thus learners were supposed to be familiar with certain basic concepts before they dealt with more advanced mathematical concepts (DOE, 2003, p. 20). Under the NCS the primary maths learning area’s learning programmes, work schedules and lessons plans embedded (implicit) rules of selection, sequencing and pacing. According to Bernstein (2003) this is typical of a market-oriented visible pedagogy which is similar to a market pedagogic identity (Tyler, 1999). Strong rules of the discursive order can be read as part of measures to strengthen the frame of educational knowledge, especially the instructional discourse frame (Bernstein, 1971; Bernstein, 2000). The resulting primary maths teacher had to provide opportunities for learners to develop a deep and coherent conceptual understanding of maths and also enable structured conceptual progression.

2.5.1.3 Introducing Learning programmes and Learning support materials

Also to support conceptual links, progression and the selection, sequencing and pacing of key primary maths knowledge and skills was the introduction in the NCS of Learning Programmes/Learning areas time allocations and learning support materials which included manipulatives, textbooks, worksheets and technological devices (e.g. calculators, computers) (DOE, 2002a; DOE, 2003). The primary maths subject guidelines explained that textbooks were to be used coherently and in an orderly manner to support conceptual development in learners (DOE, 2003). Textbooks would also be relevant especially for the intermediate phase learners who were expected to work mathematical tasks independently and unsupervised (DOE, 2003). Bernstein (2003) argues that the textbook is highly prioritised in a market-visible pedagogy to enable learners to carry independent solitary work and to access alternative knowledge perspectives. In the Foundation phase the Numeracy learning programme was allocated 40% and the Intermediate phase Mathematics Learning area was given 18% of the total teaching time (a 15% and a 3% time increase respectively from C2005) (DOE, 2002a; DOE, 1997a; 1997b). Unlike C2005, which had time allocated and

reserved for flexibility and enrichment, the NCS had all its formal teaching time allocated for subject learning, and this, alongside strong pacing, indicates that time under this curriculum was at a premium (DOE, 1997a; DOE, 1997b; DOE, 2002a; Bernstein, 2003). The increase in numeracy and mathematics teaching time was also meant to indicate the strong emphasis and prioritising of this learning area, of course alongside literacy/languages. The increased time devoted for primary maths also indicates the status and the significance of this learning area/programme under the NCS (Bernstein, 1971).

2.5.1.4 Encouraging learner-centred and activity-based approaches

Like C2005, the Constitution of South Africa informed the revision of the NCS, which still “held dear the principles and practices of social justice, equity and democracy” and interweaved these goals across the curriculum (DOE, 2002a, p. 1 & 8; DOE, 2002c; DOE, 2003). Because the curriculum aimed at giving the Constitution practical expression in the classrooms, Outcomes-based education philosophy alongside the critical and developmental outcomes (inspired by the constitution) formed the foundation of the NCS (DOE, 2002a; DOE, 2002b; DOE, 2003). As an indication of embodying social democratic values in the school systems’ knowledge and skills, the NCS’ outcomes approach encouraged and emphasised a “participatory, learner-centred and activity-based approach to education” (DOE, 2002c, p. 1; DOE, 2002a, p. 12). Thus the curriculum, through the critical outcomes, expected learners to work effectively as members of a group or team, organise and manage themselves and make decisions using critical and creative thinking (DOE, 2002a; DOE, 2002c; DOE, 2003). The mathematics curriculum subject guidelines also gave room for primary teachers to innovatively and creatively determine appropriate teaching approaches (such as drill and practice, problem solving and investigation) that engage learners in worthwhile and challenging mathematical tasks, and gave them structured learning opportunities to develop a deep, coherent and interrelated understanding of mathematics (DOE, 2002a; DOE, 2002c; DOE, 2003). Teachers were also encouraged to provide learning opportunities that support “the different learning styles of the learners” taking heed of the fact that “learners learn at a different pace to each other” (DOE, 2003, p. 32 & 12). Teachers were also encouraged, where appropriate, to use the learners’ mother tongues and allow code switching in maths classes (DOE, 2003). Such personalised teaching practices are explained by Tyler (1999) as being characteristic of the market-pedagogic identity position. The primary maths curriculum guidelines thus encouraged the use of personalised practices, learner-centred approaches and teacher-oriented strategies that were discipline-focused and enhanced the conceptual understanding of maths.

2.5.1.5 Integration

The NCS also retained the principle of integration which is central and integral to outcomes-based education (DOE, 2002a; DOE, 2003). However the NCS had a different form of integration, compared to C2005's more radical form of integration, which subordinated the learning of mathematics in pursuit of theme-based activity and learners' personal everyday experiences (DOE, 1997a; DOE, 1997b; Ensor & Galant, 2005; Taylor & Vinjevold, 1999; Chisholm et al, 2000; Graven, 2002a; Reeves & Muller, 2005; Fleisch, 2008). Under the NCS, integration was driven by 'learning outcomes' rather than 'themes', and it was also not only limited to linking and relating the eight Learning Areas but meant to support "conceptual development rather than being introduced for its own sake" (DOE, 2003, p. 6 & 26). Integration and interrelations of mathematical concepts both within and across the learning outcomes was encouraged; with relevant social, economic, cultural and political contexts at the local, national and international level being selected to enhance the understanding of mathematical skills and knowledge. Furthermore teacher collaboration team planning approach for work schedules also promoted integration. With regard to integration, the NCS adopted an ordered form of integration which, according to Bernstein (1971, p. 222), produces a learning and teaching culture that has a "sense of time, place and purpose".

2.5.2 NCS's framing and knowledge classification

The retention of an outcomes-based education philosophy, integration and learner-centred approaches under the NCS, are characteristics of the market pedagogic identity which according to Bernstein (2000, p. 71) "radically transforms the regulative discourse of the institution", resulting in a weak regulative discourse frame (Bernstein, 2000), and leading to a weakly framed transmission (Tyler, 1999). Similarly the NCS did not forego the political pedagogical intentions and the progressive learning theories, such as learner centred approaches, that initially informed curriculum reform in South Africa. However in the primary maths subject guidelines teachers were also encouraged to use "explicit hierarchical" (Bernstein, 2003, p. 66) teaching strategies such as repetitive practice to "consolidate the learning of concepts" and to enhance the "mastery of various skills" (DOE, 2003, p. 24). Such teacher-oriented approaches alongside the explicit rules of selection, sequencing and pacing lead to a stronger primary maths instructional discourse. However with the instructional discourse "always embedded in the regulative discourse" and with the regulative discourse being the "dominant discourse", the primary maths frame under the NCS was *weakened* but not as *weakly framed* as the C2005 (Bernstein, 2000, p. 13). This resonates with Tyler's (1999) positioning of the market pedagogic identity position which he explains as not strongly framed.

Bernstein (1971, p. 206) argued that “evaluation is a function of the strength of classification and frames”. Because the NCS strengths of classification and framing varied independently of each other, as it was strongly classified with a weakened frame, it encouraged a wide range of primary maths assessment strategies. The NCS and the primary maths subject guidelines encouraged teachers to use various assessment strategies that accommodate divergent contextual factors, consider learner differences and the diverse needs of learners and also ensure that learners integrate and apply knowledge and skills (DOE, 2003; DOE, 2002a; DOE, 2002c). Tests, examinations, performance-based assessments, practical demonstrations and projects were listed as examples of formal assessments, whilst observations, discussions and informal classroom interaction were given as forms of informal daily assessments that teachers could use to measure learner performance (DOE, 2003; DOE, 2007). The different and varied forms of assessments encouraged in the primary maths classes under the NCS gave rise to both multiple criteria of assessment, which take the inner attributes of the student into account and ordered principles of evaluation which create a relatively objective procedure, which both relate with the weaker framing and the strong classification in the NCS primary maths education (Bernstein, 1971).

2.5.3 NCS’ forms of national assessment and evaluation

The department of education also coordinated and conducted external provincial pen-and-paper Common Tasks Assessments (CTAs) and national systemic evaluation that included a nationally representative sample of grades 3, 6 and 9 learners (DOE, 2007). Systemic evaluation was meant to assess the performance and effectiveness as well as the strength and the weaknesses of the learning sites and learning system on a periodic basis (DOE, 2007). The primary maths curriculum guidelines also noted that the Grade 3, 6 and 9 learners were “increasingly being subjected to systemic assessment by outside agencies” and encouraged teachers to ensure that learners are “sufficiently experienced” to do well in such assessments (DOE, 2003, p. 31). This comment must be read within the context of the participation and the poor performance of South African learners in national, regional and international maths tests. One of the key features of the Market pedagogic identity is its concern with national learner performances in standardised tests (Bernstein, 2000; 2003). Similarly under the NCS the South African national government and the department of education promoted and projected a Market primary maths teacher identity ensuring that learners enhance their performances in standardised maths tests (DOE, 2003). Furthermore under the visible market pedagogy, which is similar to the market pedagogic identity position, mass standardised tests are carried out to ensure greater homogeneity and centralised regulation of practices, and to create performance indicators of accountability, transparency and efficiency (Tyler, 1999;

Bernstein, 2003). Similar objectives were also listed for the national systemic evaluation tests (DOE, 2007), clearly showing that the projected South African primary maths teacher identity under the NCS existed in a market-oriented pedagogy akin to the market pedagogic identity (Tyler, 1999; Bernstein, 2000; 2003).

In sum, the streamlined and strengthened NCS projected and promoted a South African market primary maths pedagogic identity aimed to ensure that learners acquired structured and sequenced maths concepts under an ordered form of integration that retained some learner-centred approaches and aimed at enhancing learner performance in standardised tests. These features resonate with the Market pedagogic identity which is strongly classified and concerned with learner performance, however the NCS framing was *weak* but not as *weakly framed* as C2005. In the next section I discuss how the recently introduced CAPS curriculum is oriented towards a different formation of a primary maths market pedagogic identity compared to that promoted under the NCS.

2.6 The introduction of CAPS and the promotion of a Market primary maths teacher identity

The third major curriculum revision since democratic elections, and paramount for this study, as it was implemented in 2012 at the time of my second year of data collection is the CAPS. I now explain how the recent curriculum changes projects a different kind of market primary maths teacher identity compared to that of the NCS. My discussion centres on the key informing features of the market pedagogic identity (Bernstein, 2000; Tyler, 1999) and how these relate to local educational changes which are interpreted through the classification and framing concepts. Such a focus helps interrogate the contextual question that relates to the types of primary mathematics pedagogic identities promoted within the official national curriculum context and how these identities can be expressed as a function of classification and framing principles. The CAPS projected market pedagogic identity also illustrates the interrogation of the third research question elaborated in Chapter 10.

2.6.1 CAPS' sequencing and content focus

South Africa's new curriculum introduction referred to as, CAPS, was instituted at the primary level across grades in 2012. This repackaged curriculum took heed of the numerous criticisms levelled against the National Curriculum Statement (OECD, 2008; Reddy, 2006; Reeves & Muller, 2005; Fleisch, 2008; Schollar, 2008; Carnoy et al, 2011), and repackaged the NCS into a content-based curriculum organised around knowledge. The restructured common curriculum framework, CAPS, is time-paced, specifies content, knowledge and

skills to be taught, with explicit sequencing and pacing (DBE, 2011b, 2011c) and aims to improve the learner performance levels in ANA numeracy and literacy standardised tests (DBE, 2012). I will show how the current South African curriculum changes convey more of a 'Market' primary maths teacher identity, especially in relation to classification and framing principles (Bernstein, 2000; Tyler, 1999).

The CAPS primary mathematics curriculum documents emphasise the need for deep conceptual understanding and the acquisition of key maths knowledge. The main focus falls on the first of the five content areas, "numbers, operations and relations", which makes up 60% and 50% of the foundation and intermediate phase maths content, respectively. The focus stems from the intention of ensuring that learners acquire "secure number sense and operational fluency" and "develop more efficient techniques for calculations" (DBE, 2011b, p. 8; DBE, 2011c, p. 13). The importance of mental maths initially highlighted in the Foundations for Learning Campaign, launched by the Minister of Education in 2008, also features strongly in the primary maths curriculum, which promotes "number bonds", "times table facts" and "calculation techniques" (DBE, 2011c; p. 35; DBE, 2011b, p. 8; DOE, 2008). The primary maths curriculum documents also highlight the need for learners to engage in problem-solving activities, thereby creating a context for the development of higher order mathematical concepts (DBE, 2011b; DBE, 2011c). The resulting primary maths teacher identity thus corresponds with Bernstein's (2000) Market pedagogic position, which is orientated towards the segmental, serial ordering of subjects within the curriculum.

2.6.2 The CAPS curriculum's framing

Analysis of the CAPS primary maths curriculum documents using Bernstein's (1971; 2000; 2003) and Tyler's (1999) theoretical insights reveals that the new curriculum's framing is strengthened from C2005 and the NCS's frames. Graven (2002a) notes that it is useful to view strengths of classification and framing along a continuum rather than simply as opposites of strong and weak classification and framing. In my analysis of the framing of CAPS, I have found it more useful to locate the shift as a process of movement between the poles of weak and strong framing, where the starting point, direction and distance of movement along the continuum are important (Graven, 2002a). The strengthening of the frame under CAPS could be a result of the type of maths knowledge supposed to be learnt in local primary classes, especially given the fact that the new curriculum puts emphasis on the learners' operational fluency. Bernstein (1971) asserts that the form of knowledge transmitted affects the nature of the framing. It logically follows that the strong CAPS content knowledge classification has resulted in a strengthened primary maths frame. Interpreting the primary

maths curriculum documents using Bernstein's work (1971; 2000) and Tyler's (1999) theoretical insights suggests that the new curriculum's framing ought to be weak, so as to resonate with the Market pedagogic identity position which exhibits weak framing. However from both a theoretical perspective (Bernstein, 1971, 2000, 2003; Tyler, 1999) and a critical analysis of the primary maths curriculum documents there is evidence that the new curriculum's framing is strengthened and thus stronger than C2005 and the NCS' frames. I elaborate below how the CAPS' frame is strengthened.

One of the key aspects of the framing principle is the instructional discourse which refers to the "selection, sequence, pacing and criteria of knowledge" (Bernstein, 2000, p. 13). A strong instructional discourse is evident in the CAPS primary maths curriculum documents through its specification, clarification, timing and sequencing of content from grade to grade across the four terms of the year (DBE, 2011b; DBE, 2011c). In other words, strong pacing and sequencing is indicated through grade by grade "specification of content to show progression" (DBE, 2011b, 19; DBE, 2011c). Such sequencing serves to indicate the "progression of concepts and skills", how content can be adequately spread over time, and also serves to give guidance "on the spread of content in the examination/assessment" (DBE, 2011b, 15; DBE, 2011c, 12). These purposes of strong pacing reported in the new curriculum shows a strengthened CAPS frame as there are "reduced options" available to the primary maths teacher and the learner in terms of the activities that they should engage in (Bernstein, 1971, p. 205). In fact the curriculum subject guidelines states that the primary maths "concepts and skills" supposed to be transmitted and received in the pedagogical relationship should clearly focus "on the mathematics as outlined in the curriculum" (DBE, 2011c, p. 12; DBE, 2011b, p. 8). Bernstein's (2003, p. 73) elaboration that "with strong pacing, time is at a premium" is illustrated in the primary maths curriculum documents' recommended distribution and allocation of mathematics teaching topic-cum-time schedules (DBE, 2011b; DBE, 2011c)²⁰. Furthermore the CAPS primary maths subject guidelines recommend school-based formal assessments such as tests, examinations, projects, assignments and investigations which are "marked and formally recorded by the teacher for promotion purposes" (DBE, 2011c, p. 294; DBE, 2011b). These forms of assessment give rise to ordered principles of evaluation which emphasises relatively objective procedures and leads to a strong instructional discourse, especially on the criteria aspect of the discursive order (Bernstein, 1971; 2000). The recommendation for the use of formal ordered principles of

²⁰ Overall 29% and 20% of the Foundation and Intermediate phases' teaching time is allocated to mathematics (DBE, 2011a; DBE, 2011b).

evaluation and the explicit stating and timing of the mathematical concepts to be transmitted at the primary level strengthens the CAPS framing.

On the other hand there is also evidence that the regulative discourse, which is the other key framing principle, of the primary maths curriculum is strong. This strong regulative discourse has also led to a strengthened CAPS primary maths curriculum. This is likely to be the case for according to Bernstein (2000, p. 13) “the regulative discourse is the dominant discourse”, with the instructional discourse being “always embedded in the regulative discourse”. The strong regulative discourse might be emanating from the CAPS primary maths emphasis on the need for deep conceptual understanding and the acquisition of key maths knowledge. Secondly the CAPS primary maths classroom teaching practices also emphasise teacher-centred and independent activities that foreground mathematical concepts and skills. The whole class activity teaching approach is outlined as the main teaching strategy for: consolidation of key maths concepts, mental mathematics and preparing for independent activities (DBE, 2011a). The fact that the individual learners have to engage in independent mathematical activities closely relates with an explicit regulative discourse. The emphasis in the primary maths curriculum documents of the whole class teaching approach and independent learner activities indicates that the pedagogical relationship between the primary maths teacher and learner shows some hierarchical relations characteristic of strong regulative discourse, which in the case of CAPS points towards a strengthened frame.

Whilst the instructional discourse of CAPS primary maths is strengthened, there are indications that the regulative discourse of the CAPS curriculum also carries messages of a weak social order. A weak regulative discourse is evident in the curriculum’s subject guidelines, which leave room for primary maths teachers to “sequence and pace the maths content differently from the recommendations” in the policy documents (DBE, 2011c, 32)²¹. Secondly, CAPS, like the previous curricula, is founded on and retains allegiance to the principles of “social transformation... human rights, inclusivity and social justice” that were foregrounded initially in C2005 and later in the NCS (DBE, 2011b, 3). Thus the curriculum still emphasises learner-centred approaches such as “small group focused lessons” or interactive group work sessions in which learners should be encouraged to “talk, demonstrate and record their mathematical thinking” (DBE, 2011b, p. 9; DBE, 2011c). The primary maths curriculum policy documents thus encourage “an active and critical approach to learning,

²¹ This however may not be the case in practice as the Provincial Remedial Plans’ recommendations published on 6 September 2011 and the resulting subject guidelines, regional weekly planners and lesson plans enforce the primary maths concepts supposed to be taught.

rather than rote and uncritical learning of given facts” (DBE, 2011b, p. 3; DBE, 2011c, p. 4). According to Bernstein (2000, p. 71) the Market position “radically transforms the *regulative* discourse of *the institution as this affects its conditions of survival*”, resulting in weakly framed transmission (Tyler, 1999). Similarly CAPS did not forego the social transformation and political pedagogical intentions that initially set the groundwork for curriculum reform in South Africa and these are carried through. CAPS also retained some of the informal continuous daily assessments that characterised C2005. Observations, discussions, practical demonstrations and ‘learner-teacher conferences’ (DBE, 2011b & 2011c) are some of the enlisted informal evaluations of primary maths learners. These give rise to multiple criteria which emphasise the inner attributes of students and points towards weak framing (Bernstein, 1971). Thus while shifting towards the market identity there is still some overlap with certain features of the therapeutic identity within CAPS. Because of this, the weak framing of C2005 and the NCS is backgrounded in the strong instructional discourse elements (for e.g. sequencing and pacing) of CAPS, resulting in a strengthened frame. The primary maths teacher identity projected thus actively engages learners within the recommended mathematical concepts and discourse.

The strengthening of the frame under CAPS could be firstly a result of the type of maths knowledge supposed to be learnt in local primary classes, especially given the fact that the new curriculum puts emphasis on the learners to master fundamental maths concepts. Secondly it also results from strong instructional discourse elements, as evident in the CAPS primary maths curriculum documents through its explicitly stated, clarified, timed and sequenced content from grade to grade across the four terms of the year (DBE, 2011b; DBE, 2011c). Thirdly the primary maths teaching and learning approach shows some hierarchical pedagogical relations characteristic of a strong regulative discourse, which also serve to strengthen the CAPS frame. Because the CAPS primary maths curriculum’s framing is strengthened, the resultant primary maths teacher identity is orientated towards a strengthened frame and strong classification. This adds a new dimension and perspective to Bernstein’s (2000) pedagogic identity model and to Tyler’s (1999) theoretical scheme which is that the official pedagogic identity position can be located along different strengths of classification and framing rather than simply as weak and strong classification and framing. This analysis above shows how the theory (Bernstein, 2000, 1975; Tyler, 1999) has illuminated my understanding of the local Market primary maths teacher pedagogic identity position that is promoted within the current curriculum that my sampled NICLE teachers are working with.

2.6.3 Annual National Assessment tests

The Market pedagogic identity position also focuses on “producing an identity whose product has an exchange value in the market” (Bernstein, 2000, p. 69), thus it is interested in learner performances in national standardised tests. This trend emerged locally in the form of national roll out in 2012 of standardised tests that are aimed at ensuring that 60% of learners achieve 50% and above in literacy and numeracy by 2014 (DOE, 2008). Under the new national monitoring measures all South African primary learners undergo Annual National Assessments (standardised tests) to monitor, track and improve the level and quality of their literacy and numeracy (mathematics) levels across Grades 1 to 6 and Grade 9 (DBE, 2008; 2011a; 2012). The ANA tests are administered and scored by teachers (Taylor et al, 2013). The 2012 ANA national maths mean scores reveal that the Grade 1 and 2 learners have achieved above the set targets whilst the Grade 3 to Grade 6 scores are still far below the desired threshold (DBE, 2012). The ANA tests are also meant to serve as a diagnostic tool for identifying areas of strength and weakness in teaching and learning, provide information for school-focused interventions and afford teachers benchmark information and baseline data that can ameliorate classroom assessment practices and inform the teaching and learning of literacy and numeracy (DBE, 2012; DBE, 2011a). From an education policy management perspective, the ANAs provide credible and reliable information to monitor progress, and guide planning and the distribution of resources to help improve learners’ literacy and numeracy knowledge and skills (DBE, 2012; DBE, 2011a). Both Bernstein (2003) and Tyler (1999) argue that under the visible market pedagogy, which is similar to the market pedagogic identity, there is the periodic mass testing of learners which enables centralised monitoring and the homogenisation of educational policies and practices, thereby creating performance indicators for accountability, transparency and efficiency. The intentions and the purposes of the national testing are similar across contexts. The market pedagogic identity category thus focuses on enhancing learner performance in national standardised tests.

The South African market primary maths teacher identity has to meet the dual challenge of teaching learners key mathematical concepts and improving their performance in the ANA tests. Thus according to Bernstein (2000, p. 71), the market teacher identity category must negotiate the tension between “satisfying external competitive demands” and “the intrinsic value of the discourse”. Bernstein typifies this identity category (2003, p. 80; 2000, p. 71) as “the new pedagogic Janus” or “the pedagogic schizoid position” as it is driven by conflicting or contradictory ideas. The market pedagogic identity category is “ideologically a much more complex construction” that has recontextualised and thus repositioned within its own ideology, features of apparently oppositional discourses (Bernstein, 2003, p. 80). The data of

the teachers in this study illuminates these oppositional discourse and tensions. This pedagogic identity has revealed itself in the South African primary maths education context in a slightly changed form; it still remains, as argued by Bernstein and Tyler in their pedagogic identity theoretical schemes, strongly classified with a focus on national tests, however its framing has been *strengthened*.

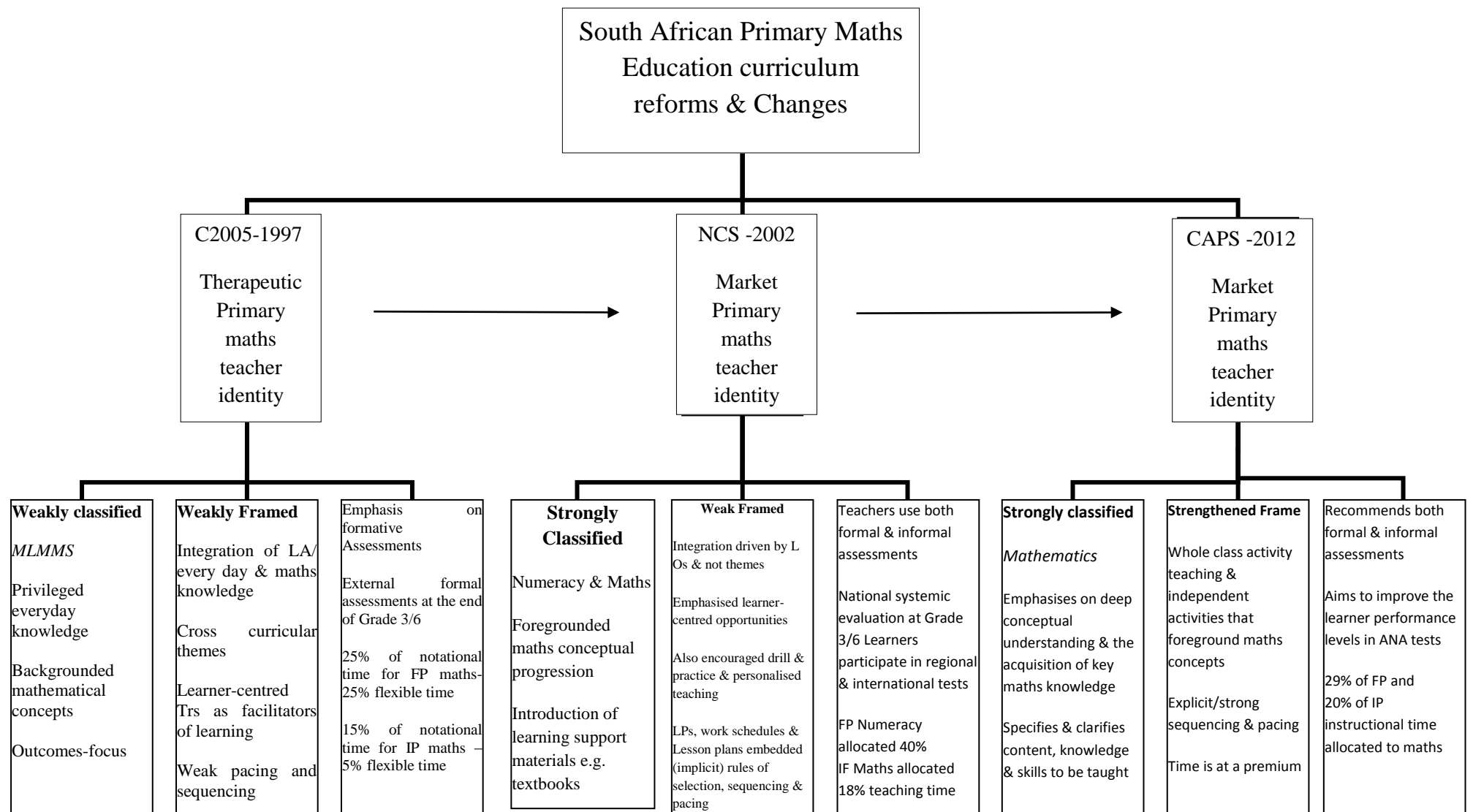
2.7 In Summary

Informed by pertinent local primary maths education studies, this chapter discussed the nature of the South African primary maths crisis and also explained the challenges facing the teaching and learning of mathematics. The challenges and problems discussed in the first part of the chapter influenced in several ways the curriculum developments and changes experienced in primary maths education in post-apartheid South Africa, thus the teacher identity it promoted and projected given the primary maths crisis background.

To interrogate the contextual question that relates to the type of primary mathematics pedagogic identities that are promoted within the official national curriculum context and how these identities relate to classification and framing principles this chapter surveyed and discussed the major curriculum reforms undertaken in South Africa from the time C2005 was launched in 1997, through the period that led to the creation of the Revised National Curriculum Statement in 2002 up to the recently introduced CAPS curriculum. Using Bernstein's pedagogic identity model (Bernstein, 2000; Tyler, 1999) to analyse the education curriculum policy documents reveals that the primary maths pedagogic identity largely shifted from a therapeutic to a market primary maths teacher identity. The study shows that C2005's reforms projected a weakened and symbolic therapeutic primary maths teacher identity that foregrounded integration and everyday knowledge and backgrounded mathematical conceptual knowledge exhibiting a weakly classified and framed orientation, with the NCS and the CAPS curricular changes promoting a more market primary maths teacher identity. Whilst the NCS market identity was strongly classified and *weakly* framed the CAPS market pedagogic identity revealed stronger classification and a *strengthened* frame that engages learners in fundamental maths concepts and improves their performances in standardised tests.

The notion of official pedagogic identity will also illuminate and inform some of the analysis and arguments that I will make in Chapter 10, as I respond to the third research question which relates to how teacher evolving identities and practices relate to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP.

The diagram on the following page summarises the curricula changes discussed in this chapter and the projected primary maths teacher identities that are expressed in relation to classification and framing properties as well as the main primary maths teaching and learning orientations.



Bernstein & Tyler's analysis of South African primary maths curriculum reforms

Figure 2.2: A Diagrammatic Summary of the South African Primary maths curriculum changes and the promoted primary maths teacher pedagogic identities

CHAPTER 3: Theoretical Framework

“...the notion of learning through participation in communities of practice appropriately and powerfully illuminates learning and knowledge about teaching” (Adler, 1998, p. 162).

3.1 Introduction

This chapter serves two purposes: firstly it discusses and explains the situative-participationists theoretical framework informing this study, and secondly it discusses the analytical tools used in this study so as to illuminate the investigation of the four research questions, and to inform the key arguments that I will make in Chapter 8, 9 and 10. These arguments relate to how primary maths teachers learn and how their identities, practices and forms of participation evolve, what enables or constrains such involvement and how these evolving identities relate or align to the broader and working contexts.

In this chapter I initially discuss key sociocultural-participationist theoretical components, namely the Communities of Practice concept and the notion of identity which are central to this study. I explain the reasons for my use of Communities of Practice theory in maths teacher education in general, and in this study in particular and also discuss the limitations. I further elaborate how learning has been conceived in CoPs and the situative-identity theoretical elements which provide analytical tools for this study so as to enable the four key research questions to be addressed.

3.2 The situative-participationists theoretical framework

This study is theoretically informed by the situative-participationists framework; that is Lave and Wenger’s social learning theory and the Communities of Practice concept (Wenger, 1998; Wenger et al, 2002; Lave & Wenger, 1991; Lave, 1996; Lave, 1993b), paying particular attention to the notion of identity within these. This work draws primarily on Wenger’s (1998) seminal study following on from his earlier influential work with Lave (Lave & Wenger, 1991). Besides Lave and Wenger’s work this research is theoretically illuminated by Sfard & Prusak (2005) and Heyd-Metzuyanım & Sfard’s (2012)²²

²² Heyd-Metzuyanım & Sfard’s (2012) recent work has helped in elaborating and operationalising the notion of identity.

educationally operationalized notion of identity and Bernstein's theory of pedagogic identity²³ (Bernstein, 2000; Bernstein & Solomon, 1999; Bernstein, 1971; Tyler, 1999).

I accessed Wenger, McDermott & Snyder's (2002) work at a later stage of my study when I struggled to analyse and present data in Chapter 9. Wenger et al's (2002) three fundamental elements of a CoP, namely *domain*, *community* and *practice*, helped me to investigate the 2nd research question and strongly illuminated NICLE teacher learning affordances and enablers. Wenger et al's (2002) structural elements of CoP are similar to the social learning theory components (Wenger, 1998), which provide most of the theoretical concepts framing this study.

The social practice theory emphasises the relational interdependency of agent (person) and world (setting), activity, meaning, cognition, learning and knowing (Lave, 1993b, p. 67; Lave & Wenger, 1991, p. 50). This theory regards learning as social participation within a community of practice. Under this perspective learning broadly implies socially negotiated meaning, active participation in practices of communities and constructing identities in relation to these communities (Wenger, 1998, Lave & Wenger, 1991). Wenger's (1998) social theory of learning encompasses four key learning components: identity, practice, meaning and community. This research will place identity (learning as becoming) as the central element of Wenger's theory of learning. Wenger (1998) notes that one can place any of the four elements in the centre of the diagram (below) and it would still make sense. Wenger's (1998, p. 5) diagrammatic presentation of components of the social theory of learning is given below. In my study I highlight the element of identity which is the driving cog of this research (see Figure 3.2).

²³ Bernstein's pedagogic identity model has been used in the previous chapter to analyse the South African education change context and the envisaged primary maths teacher identity.

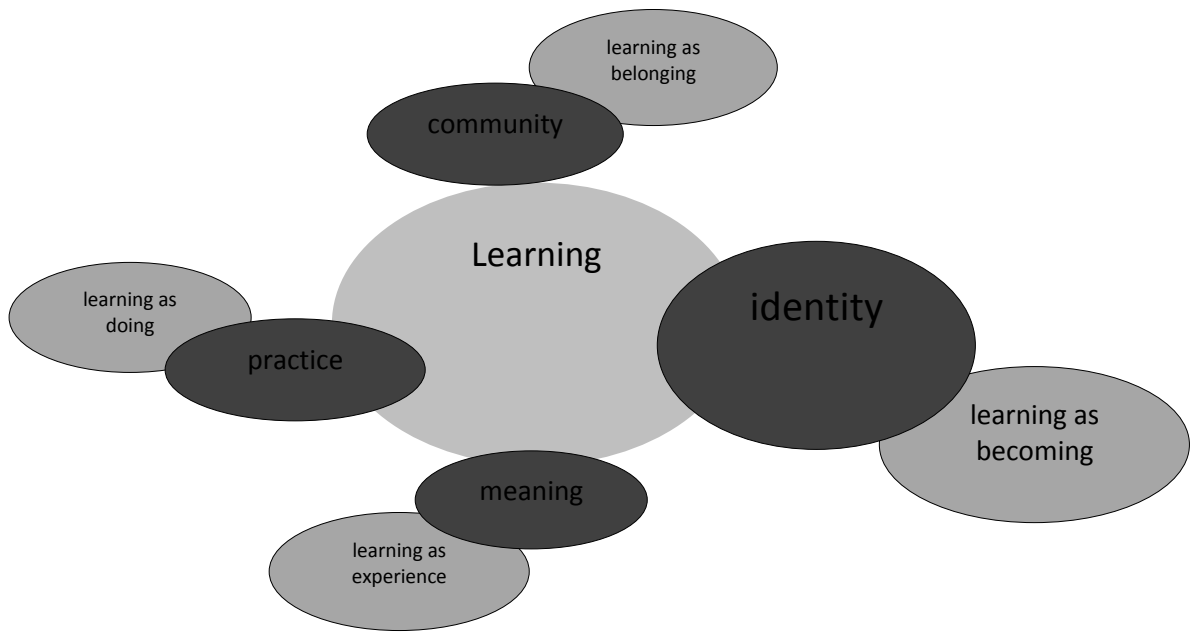


Figure 3.1: Components of the social theory of learning (Wenger, 1998, p. 5)



Figure 3.2: Highlights identity as the central element of this research

3.2.1 Lave & Wenger's notion of identity

Identity is central to this study. The notion of identity used here is chiefly influenced by Wenger's concept of identity as providing us with "a way of talking about how learning changes *who we are* and creates personal histories of becoming in the context of our communities" (Wenger, 1998, p. 5) [emphasis mine]. Embedded in Wenger's explanation of identity is how this component is essential in understanding the processes of learning and identity formation in a CoP. Both Lave and Wenger succinctly capture this notion of coupling learning with identity formation by first and principally saying that learning is "...the identity-making life projects of participants in communities of practice" (Lave, 1996, p. 157), and secondly arguing that "...learning and a sense of identity are inseparable: [t]hey are aspects of the same phenomenon" (Lave & Wenger, 1991, p.115). In fact Lave and Wenger have connected learning and identity, capturing learning within a CoP as a seamless whole, intertwined dual process transforming knowledge and 'who we are' - it is a process of becoming and involves the construction of identities of participation (Wenger, 1998; Lave, 1993b; Lave & Wenger, 1991).

Sfard (1998) identified two metaphors which describe learning: the acquisition metaphor and the participationist metaphor. While she argues that both are useful metaphors that inform our thinking about learning and educational practices (Sfard, 1998), she later indicates her preference for the 'participationist metaphor', and links identity and learning, expounding that "identities are crucial to learning" (Sfard & Prusak, 2005, p. 19). Theorists in the situative camp increasingly pair learning and identity formation (e.g. Lave 1996; Heyd-Metzuyanim & Sfard, 2012). This sociocultural-participationist notion of connecting identity formation and learning is central and key to this study. The coupling of learning and identity formation enables the study to investigate the nature of primary maths teacher learning and the processes of identity formation and construction within the primary maths teacher professional development CoP, thus enabling a focus on the overarching and 1st research questions.

3.2.2 Why I have chosen the 'Community of Practice' Social learning theory to frame this study

Traditionally educational research, and views of learning, have implied the 'acquisition metaphor', however the 'social turn' experienced towards the late 1980s saw the emergence of the 'participationist metaphor' or theories that see "meaning, thinking and reasoning as

products of the social activity” (Lerman, 2000, p. 23; Lerman, 2001, p. 47; Sfard, 1998). Within maths education the social turn had two major implications; firstly it invited a rethinking on the nature and notions of maths teacher learning, and secondly it saw the emergence and influence of social theories in maths education research. The social turn according to Lerman (2001, p. 48) developed from

...three main intellectual (re)sources: anthropology, as situated theories or communities of practice (Lave 1988; Lave & Wenger, 1991; Wenger, 1998); sociology (Walkerdine, 1988; Bernstein, 1996); and cultural/discursive psychology (Cole, 1996; Crawford, 1988; Harre & Gillett, 1994).

The conventional theories which explain learning as transmission, acquisition and assimilation (internalisation) of knowledge have been criticised for being concerned with individual differences and comparisons, privileging decontextualized abstract knowledge and the transmitter’s point of view while ignoring the process of active participation in sociocultural communities (Brown, Collins & Duguid, 1989; Lave 1993a; Wenger, 1998; Lave & Wenger, 1991; Sfard, 1998; Lave 1996; Boaler & Greeno, 2000). Compared to the traditional learning approaches, situated learning theory or the communities of practice concept offers a “fresh look at learning” (Lave & Wenger, 1991, p. 39). It proposes a frame that lends itself to more participation approaches that focus on learner participation in authentic (practice), context-related activities (Carragher, Carragher & Schliemann, 1985; Lave, 1988; Lave, 1993a; Sfard, 1998; Brown et al, 1989; Matos, 2009). In this regard Lave and Wenger’s work has given different meanings to knowledge, learning and identity (Lerman, 2000). Limitations in conventional theories and opportunities within notions of Communities of Practice consequently implied an increase in maths education research that is informed by the social learning theory to understand teacher learning or “learning to teach” (Adler, 2000, p. 36). This study follows in this trend of explaining primary maths teacher learning using the social learning or communities of practice theoretical lens.

I have also used the CoP framework because it relates with the design of my empirical field of study, namely NICLE. The NICLE professional development programme has been explicitly conceptualised as a primary maths teacher Community of Practice (Graven, 2010). Thus for this study, using the social learning theory and the Community of Practice concept

as analytical tools resonates with how the empirical field of study has been conceptualised and how teachers are perceived by the project to learn within such contexts.

3.2.3 The emergence of the Communities of Practice theory

The impetus for the emergence of the Communities of Practice notion begins with Carraher, Carraher & Schliemann (1985) and Lave's (1988) work. Lave's 1988 work followed from her early study with Murtaugh and de la Rocha (Lave, Murtaugh & de la Rocha, 1984) that highlighted the importance of learning mathematics in the context of activity (Lave, 1993a) foregrounding the value of cognition in context. Whilst these studies set the groundwork for the situated learning theory, the concept of legitimate peripheral participation in Communities of Practice arose from Lave and Wenger's earlier anthropological research on Vai and Gola tailor apprentices in Liberia (Lave & Wenger, 1991; Lave, 1996; Wenger, 1998). Other ethnographic studies of Yucatec Mayan midwifery, butchers' apprentices, nondrinking alcoholics, navy quartermasters, Egyptian Muslim law practitioners and Insurance claim processors provided Lave and Wenger with insightful perspectives of how learning is situated in social practices (Lave, 1993b; Wenger, 1998; Lave, 1996). Lave and Wenger (1991, p. 98) defined a CoP as,

...a set of relations among persons, activity, and world over time and in relation with other tangential and overlapping communities of practice.

Wenger in his later work with colleagues simplified and elaborated this definition and explained that CoPs are,

...groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis (Wenger et al, 2002, p. 4).

Since the emergence of Communities of Practice as "sites of learning" (Lave, 1993, p. 72) the concept has been used to illuminate, for example, studies and practices in literacy elementary classrooms (e.g. Brown & Campione, 1990), girl scout sales (Rogoff, 1995), street newspaper selling (Dos Santos & Matos, 2008), Guatemalan Mayan toddlers and caregivers and in a United States public elementary school (Rogoff, 1994). The CoPs concept has also been used to understand learning within business organisations (Wenger et al, 2002). However, of

relevance to this study is how the theory of situated learning, and in particular Wenger's (1998) four component theory of learning, which gives centrality to Communities of Practice, has been connected to school maths learning and most importantly to maths teacher development.

3.2.3.1 Application of the Communities of Practice theory in Maths education

The concept of communities of practices has been used to study and illuminate mathematics classroom experiences. As previously highlighted, the importance of “the context of socially situated activity” (Lave 1993a, p. 4) in the understanding and learning of mathematics (Lave, 1988; Carraher et al, 1985; Brown et al, 1989) led to the promotion of socially relevant activities in maths classrooms. Such recontextualised situated learning primary and secondary maths classrooms have also been reported in maths education literature (e.g. Winbourne & Watson, 1998; Boaler & Greeno, 2000; Brown et al, 1989). An influential study in primary mathematics in Britain undertaken by Askew and colleagues (1997) also argues for participation of learners in numeracy ‘communities of practice’ styled classes. However Adler (1998) argues that while social practice theory is difficult to apply to maths classrooms it is however a useful framework for analysing and conceptualising the continuous development of maths teachers.

Since Adler's (1998) assertion that CoPs appropriately and powerfully illuminate the continuous professional development of maths teachers, there has been a surge in professional development models employing the situated learning theory to conceptualise and describe maths CoPs from which teachers participate in and learn through active participation. Locally (Adler, 2000; Graven, 2004; Brodie, 2013) and internationally (Farmer et al, 2003; Little, 2003; 2002; Shulman & Shulman, 2004; Jaworski, 2005) there have been maths teacher professional development programmes underpinned by the community of practice framework. Besides the maths field there have been teacher communities of practice professional development models in other school-taught subjects (Grossman, Wineburg & Woolworth, 2001; Wineburg & Grossman, 1998; Maistry, 2008; Little, 2002). There has been a wide range of research into teacher communities of practice professional development models in primary mathematics (Farmer et al, 2003; Fennema, et al 1996; Heaton & Mickleson, 2002), in high school mathematics (Little, 2003; Little 2002; Shulman & Shulman, 2004) and across primary and high school mathematics (Graven, 2004, Brodie, 2013, Little et al, 2003).

Research in maths teacher education cites professional teacher learning communities as a means of enabling successful teacher learning that encourages personal growth and allows for teachers to mutually support each other, whilst giving attention to issues of subject matter, maths teaching practice and student learning. This ultimately enables educators to improve the quality of the learning experience for learners (Little et al., 2003; Adler, 1998; Farmer et al, 2003). Successful teacher participation and learning in maths professional communities has been promoted and reported in the USA (Fennema et al, 1996; Kilpatrick et al, 2001; Farmer et al, 2003; Little et al, 2003; Shulman & Shulman, 2004), European (Jaworski, 2006; Askew et al., 1997), Asian countries (Ma, 2010) and in South Africa (Adler, 2000; Graven, 2004; Brodie, 2013; Pausigere & Graven, 2014). The literature indicates that Maths teacher professional learning communities have great potential worth exploring further.

3.2.3.2 Maths Communities of Inquiry

In maths teacher education literature, teacher communities of practice are also called professional teacher learning communities (Brodie, 2013; Shulman & Shulman, 2004; Little, 2003), practice-based professional development approaches (Silver, 2009; Kazemi & Hubbard, 2008; Matos, 2009). While these terms hold some differences to Wenger's definition of a CoP they are mainly informed by the Communities of Practice concept or related sociocultural theories²⁴. Theoretically there has been a shift from teacher communities of practice into maths teacher inquiry communities. These draw from Lave and Wenger's Communities of Practice theory and the notion of Communities of Inquiry (Schoenfeld, 1996; Jaworski, 2005; Heaton & Mickelson, 2002). Communities of Inquiry are distinguished from other Communities of Practice because of the elements of inquiry, investigation, or experiment, metacognitive critical reflection and critical alignment processes which are regarded as fundamental tenets for this theoretical perspective (Jaworski, 2005, 2006; Schoenfeld, 1996; Farmer et al, 2003; Ball & Cohen, 1999; Heaton & Mickelson, 2002; Cochran-Smith & Lytle, 1999).

This approach, which is proving to be internationally popular and influential in maths professional development, has also conceptually informed the design of NICLE as it aims to create a Numeracy teacher Community of Inquiry. Documents stating design intentions of

²⁴ Another form of teacher CoPs identified in teacher education literature is school networks, or networked learning communities, which are groups of schools working collaboratively to share knowledge and promote improvements in teaching and student learning (Katz & Earl, 2010; Lieberman, 1995).

NICLE clearly locate NICLE within a Community of Practice (Wenger, 1998, Lave & Wenger, 1991) and Community of Inquiry frame, drawing explicitly on Jaworski's (2005; 2006) concept of mathematics communities of inquiry. However naming the CoP as such doesn't necessarily make it an inquiry community, thus this study will investigate the extent to which these intentions unfold in the evolution of NICLE over the period of study.

3.2.3.3 Maths Communities of Practice tools and artefacts

Literature that advocates maths communities of practice argues that teacher learning opportunities are provided if educators use artefacts deeply rooted in the context of teaching or in teachers' own practice (Little, 2003; Matos, 2009; Ball & Cohen, 1999; Putman & Borko, 2000; Kazemi & Hubbard, 2008). Lesson studies (Matos, 2009; Ball & Evans, 2009), video case studies (Ball & Evans, 2009; Silver, 2009; Ball & Cohen, 1999; Putman & Borko, 2000; Ball, 1996), narrative classroom records (Silver, 2009; Putman & Borko, 2000), examining samples/copies of student work (Little et al, 2003; Silver, 2009; Ball & Evans, 2009; Ball & Cohen, 1999), learner errors (Brodie, 2013), use of textbooks (Adler, 1998, 2000), curriculum material (Ball & Cohen, 1999; Ball, 1996), discourse/language practice (Putman & Borko, 2000; Little, 2003), discourse analysis (Matos, 2009), lesson enactment (Ball & Evans, 2009), conceptual knowledge (Brown et al, 1989), packaged programme or toolkits (Matos, 2009), open-ended problem solving situations (Adler, 1998; Brown et al, 1989, Schoenfeld, 1996) and working with a senior colleague or expert (Matos, 2009) have been enlisted as tasks, artefacts, tools, resources and activities structuring and fostering maths communities of practice professional development initiatives.

In most of the above CoPs teachers work collaboratively on aspects related to their context of teaching or authentic aspects of their instructional practice, and this allows teachers to develop knowledge of mathematics content, pedagogy and student learning simultaneously and in an integrated nature (Silver, 2009; Ball & Cohen, 1999; Matos, 2009; Little et al, 2003). The emergence of maths communities of practice professional development informed programmes, their benefits and the nature of their activities, is central to this study as it will point to practices and aspects of CoPs that might enable or constrain teacher learning that I will use to reflect on NICLE practices, thus allowing me to respond to the 2nd research question.

3.2.4 Limitations of the application of Wenger’s Communities of Practice theory in education

The use of Communities of Practice theories for explaining teacher learning and illuminating teacher professional development has challenges. One disadvantage emanates from the informing theory of Communities of Practice, which regards teaching as not necessary to produce learning (Lave & Wenger, 1991; Lave, 1996; Wenger, 1998). From an apprenticeship perspective Lave and Wenger have “argued against the assumption that teaching or ‘intentional instruction’ is necessarily prior to, or a precondition for, learning” (Lave, 1996, p. 151; Lave & Wenger, 1991, p. 41) with Wenger (1998, p. 266-267) stating that “much learning takes place without teaching...teaching does not cause learning”. Such a position undermines the role of explicit teaching in communities of practice. Graven and Lerman (2003) indeed take issue with the undermining of the role of teaching, even while arguing its potential for analysing teacher learning arguing that teaching needs to be reconceptualised rather than negated within the sphere of the work of the teachers. Another weakness raised at the theoretical level is the fact that the situated learning approach does not offer a learning mechanism or an explanation of how knowledge transfers within communities (Lerman, 2000; Adler, 2000) and attempts to do so have not been convincing (see for example Rogoff, 1995). Adler (2000) also explains that the CoP concept is too bounded a notion, insufficient to explain power relations and the macro context. Another challenge that has also been noted locally is on how maths teacher professional development communities of practice can be scaled up or reformulated to cater for larger teacher audiences while at the same time not compromising the benefits of smaller and more intimate maths teacher learning communities (Pausigere & Graven, 2013b; Brodie, 2013). The study will therefore try to address such theoretical challenges and also attempt to offer a possible illumination as to the learning mechanisms for teacher knowledge growth within the primary maths community of practice, NICLE.

3.3 The nature of learning in Communities of Practice

Within the situative perspective, learning was initially captured as “legitimate peripheral participation in communities of practice” (Lave & Wenger, 1991, p. 31), and this entailed how learners (newcomers) participate in and become (full participants) part of a community of practice. As the theory developed, and was taken up by others, learning became captured as “a process of transformation of participation” (Rogoff, 1994, p. 209), refined to “participatory appropriation” (Rogoff, 1995, p. 148), as “an aspect of participation in socially

situated practices/activity” (Lave 1993a; Lave, 1996, p. 150) and later as “social participation” (Wenger, 1998, p. 4), or simply as “participation” (Sfard, 1998). Common in all these definitions is the situative principle of learning as ‘participation’ in practice.

Researchers in maths education have also drawn on the situative perspective of defining learning as participation in communities of practice to explain maths teacher learning (Lerman, 1998, Adler, 1998; Adler, 2000; Matos, 2009; Kazemi & Hubbard, 2008).

Cochran-Smith and Lytle (1999) put forward the terms ‘knowledge-*of*-practice’ and ‘knowledge-*in*-practice’ as ‘images’ of teacher learning within communities of inquiry and communities of practice, respectively. This resonates with one of the major strands of the 15th International Commission on Mathematical Instruction (ICMI) conference which was titled ‘Learning in and from Practice’, which focused on maths teachers practice-based professional development studies (Even & Ball, 2009) and described communities of practice maths teacher learning as ‘learning in and from practice’ (Matos, 2009; Jaworski, 2009). Similar phrases have been used by Ball & Cohen, (1999) and Lampert (2010) to describe teacher learning situated in practice. Putman & Borko (2000) have further elaborated that under the communities of practice perspective, teachers’ knowledge is situated in classroom practice, with Smylie (1989, p. 551) calling this “strategic knowledge”.

From a theoretical perspective the terms ‘participation’, ‘transformation’, ‘knowledge-*of*-practice’, ‘knowledge-*in*-practice’ and ‘learning in and from practice’ have the potential to illuminate the main research focus of this study and to help describe ‘the nature of teacher learning in NICLE’. This is the key aim of this study, and by responding to the main research question I will also be focusing on primary maths teacher learning mechanisms within the communities of practice context. Key also for this study is Lave’s (1996) suggestion of using, amongst other analytical tools, the concept of *telos* to describe learning in communities of practice. Similarly within maths teacher education, Lerman (1998; 2000), Matos (2009) and Winbourne and Watson (1998) have called for the use of the notion of *telos* as an analytical tool that helps in providing a language to describe the process of coming to know in maths education communities of practice. Taking a cue from these suggestions, this study will investigate the nature of primary maths teacher learning within NICLE using amongst other theoretical tools, the notion of *telos*.

3.4 Situative-identity analytical tools to be used in the study

In this part of the chapter I outline and describe identity elements within the situative perspective that will theoretically inform this study. The participationists' identity theoretical elements will serve as analytical tools during data analysis and aid in the interpretation, organisation and presentation of the empirical findings. The situative-identity framework also provides descriptive tools to explore, and understand the nature of primary maths teacher learning and the processes of PMTI formation through participation in NICLE. Identity components from the socio-cultural perspective will illuminate part of my research findings and thus help to answer the four research question underpinning this study.

In the next section I explain the following theoretical elements that I will use in the study:

- Lave's (1996) notion of *telos* and Sfard & Prusak's (2005) definitions of learning as identity change and identities as stories will illuminate my main research question, which investigates 'the nature of teacher learning within NICLE'.
- Wenger's (1998) characterisations of identity as a *learning trajectory* and as *nexus of multimembership* will help me address the 1st research question on how primary maths teacher identities evolve, and the process of this evolvment.
- Wenger et al's (2002) fundamental elements of a CoP namely; the *domain* of knowledge, a *community* of people and the shared *practices* are used to illustrate *affordances* and *constraints* (Greeno et al, 1998) within NICLE. This CoP elements will help me interrogate the 2nd research question, which investigates activities, relations and forms of participation within the Community of Practice which enable or constrain evolving primary maths teacher identities and practices.
- Wenger's three modes of belonging, namely, *imagination*, *engagement* and *alignment* will supplement the above theoretical components and help me respond to the 1st, 2nd and 3rd questions respectively. Bernstein's (2000) pedagogic identity model (from which arises the four identity positions) is used to interpret, understand and illuminate part of the 3rd research question which relates to how teacher evolving identities and practices relate to broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP.

3.4.1 *Telos* and Sfard & Prusak's conceptions of identity and learning

Lave's (1996, p. 33) notion of *telos* will provide the study with a "liberating analytical tool" to describe "the process of coming to know" (Matos, 2009, p. 171) within NICLE. In maths teacher education, Matos (2009, p. 171), Lerman (2000, p. 33) and Winbourne and Watson (1998, p. 101) agree that the notion of *telos* offers insights on how learning occurs in social practice. Lave (1996, p. 156) defined *telos* as the "direction of movement or change of learning (not the same as goal directed activity)". In other words *telos* entails "changes implied in notions of learning" (Lave, 1996, p. 156). Lave went on to elaborate that *telos* "encourages...a focus on the trajectories of learners as they change". This firstly serves to show the close link between the two situative notions of *telos* and learning trajectories. Secondly it shows that learning within a community of practice is dually influenced by the community in as much as it is an individual initiative or motivation. Winbourne and Watson (1998, p. 101) further elaborate that *telos*

....refer to the way that an individual becomes what they are going to be within a community of practice. The learning they do is both a determinant of this direction and in part determined by the complex paths which students have taken to get where they are.

This study will thus employ the element of *telos* (as well as Sfard & Prusak's definition of learning as identity change and their identity-as-story construct) to investigate the nature of teacher learning within a primary maths teacher's in-service community of practice informed professional development programme.

Sfard and Prusak's (2005) work is key for this study mainly because of their operationalization of identity when equating identity with stories. It is for the same reasons that Graven (2012) in her later work uses the work of Sfard and Prusak (2005) to explain teacher learning within a maths teacher community of practice professional development programme. Sfard and Prusak (2005) note that Lave and Wenger (1991), following Cain's (1991) earlier study, highlighted the importance of stories in fashioning identity, but their weakness lay in their failure to operationalize identity. Sfard and Prusak (2005, p 19-20) connect learning and identity, explaining learning as "closing the gap between the actual/current³ and the designated identities'²⁵. To operationalize identity and make it a tool for educational research Sfard and Prusak (2005, p. 14 & 16) '*equated identities with stories*

²⁵ Though Sfard and Prusak initially used the term 'actual', Sfard now prefers the use of the term 'current identities' (see Graven 2012) and the term current will thus be used throughout this study.

about persons' in the process defining identities as "those narratives/stories about individuals that are *reifying, endorsable and significant*" [italics in original]. Sfard and Prusak's equating of identity with stories relates with Gee's (2001) Discursive/Discourse identity category which he argues is recognised in the discourse or dialogue of individuals.

Heyd-Metzuyanim & Sfard (2012, p. 131) define "reification as the discursive activity of rendering status of an object to something that was not necessarily treated this way so far". According to Wenger (1998, p. 58) the process of reification "provides a shortcut to communication" and also gives "form to our experiences". The reifying qualities come with the use of verbs such as "*be, have or can* and their derivatives" and also with adverbs that "stress repetitiveness of actions" such as "*always, never, usually* and so forth" (Sfard & Prusak, 2005, p. 16; Heyd-Metzuyanim & Sfard, 2012, p. 131). An endorsable story is one that "faithfully reflects the state of affairs in the world" as objectively portrayed by the 'identity-builder'. Sfard and Prusak's (2005, p. 17) explanation of the term 'significant stories' relates to the notion of Communities of Practice as significant stories are defined as "often those that imply one's memberships in, or exclusion from, various communities". From the teacher interactive interviews I would like to glean those learning stories and utterances that are reifying, endorsable and significant and these will inform the discussion and key argument of this study in Chapter 8. Sfard and Prusak therefore set specific criteria on the type of teacher narratives that we must focus on to investigate and discuss the research participants' nature of learning and their evolving identities through their utterances.

Current identities are captured in stories about the current or present state of affairs with designated identities consisting of narratives that "have the potential to become a part of one's actual identity" (Sfard & Prusak, 2005, p. 18). For teachers participating in NICLE their *designated-affinity identities* (Sfard & Prusak, 2005; Gee, 2001) as relates to NICLE are captured in the Chair's proposal document (Graven, 2010) and in the CoP forum discussion documents (SANC, 2011, 2012, 2013). These documents projects developing teachers as effective teachers of numeracy who engage learners in the mathematical discipline ensuring mathematical proficiency (Askew et al, 1997, Ball, 1993; Kilpatrick et al, 2001) and teachers who are life-long learners who take-up being leader educators. The NICLE projected numeracy teacher identity is fully analysed and discussed in Chapter 6.

Sfard and Prusak's (2005) definitions of learning as identity change and identity as stories, and the concept of *telos* (Lave, 1996), will illuminate my investigation and help me investigate, the nature of teacher learning within NICLE. In terms of making a theoretical contribution it is important to point out that, in Chapter 7, I reconstruct and combine Sfard and Prusak's (2005) connection between learning, identity and stories with the notion of *telos* (Lave, 1996) to propose a new term for learning stories -*stelos*. These situative-identity theoretical elements alongside the interview questions that I have formulated, that ask teachers to describe and explain the nature of learning that they experienced in NICLE will help me to respond to the main research question.

3.4.2 Identity as learning trajectory and nexus of multimembership

To help understand how primary maths teacher identities evolve and the processes of this evolution is Wenger's characterisation of identity as a 'learning trajectory'. According to Wenger (1998, p. 149) 'identity as *learning trajectory*' entails defining "who we are by where we have been and where we are going". A synthesised definition of a learning trajectory characterises identity as "incorporating the past and the future into the experience of the present" (Wenger, 1998, p. 158). Wenger also explained that through a succession of forms of participation, our identities form trajectories, both within and across communities. To elaborate on the concept of identity as learning trajectory Wenger (1998, p. 154) argued that

[I]dentity is fundamentally temporal...on-going... more complex than a linear notion of time and interaction of multiple convergent and divergent trajectories.

Explaining this concept Wenger (1998) alludes to the fact that trajectory suggests not a foreseen or charted path but a continuous motion – one that has a momentum of its own in addition to a field of influences. It is these characteristics of identity as learning trajectory that allow me to employ this concept to illuminate the nature of learning accompanied by the various types of trajectories explained below.

Wenger (1998) identified five different types of trajectories (*peripheral, inbound, insider, boundary* and *outbound*), which give different perspectives on the members' forms of participation and their emerging identities.

- *Peripheral trajectories* never lead to full participation. Yet they provide access to a community and its practice that becomes significant enough to contribute to one's identity.
- *Inbound trajectories* entail newcomers who join the community with the prospects of becoming full participants. Their identities are invested in future participation even though their present participation may be peripheral.
- *Insider trajectories* lead one to be a full participant in a community but however practices continue to evolve through new events, demands and generations which create occasions for renegotiating one's identity.
- *Boundary trajectories* find value in spanning boundaries and linking communities of practice. According to Wenger, boundary trajectories are akin to the concept of brokering which involves the use of "multimembership to transfer some element of one practice into another" (Wenger, 1998, p. 109).
- *Outbound trajectories* lead out of a community.

Whilst they are various types of trajectories described by Wenger, the study will use insider and boundary trajectories to illuminate and understand the processes of how primary maths teacher identities evolve and the pathways of these identities.

Wenger's characterisation of identity as a '*nexus of multimembership*' will also be used in this study to investigate how PMT identities evolve in relation to participation in NICLE and the processes through which these identities evolve. The notion of identity as multimembership shows that "our membership in any community of practice is only a part of our identity" (Wenger, 1998, p. 158). According to Wenger (1998, p. 159) identity under this aspect is "more than *just a single trajectory*; instead it should be viewed as a nexus of multimembership... (it) is not a unity but neither is it simply fragmented... (it is), at the same time, one and multiple". Wenger's characterisation of identity as a nexus of multimembership concurs with Sfard and Prusak's (2005, p. 17) assertion that "multiple identities exist for any person". Furthermore Wenger's explanation of identity as a *nexus of multimembership* builds on his notion of trajectory which I will also use in this study.

My motivation to use this theoretical component stems from the fact that amongst the sampled research participants are Foundation Phase generalists teachers whose identity is

phase-based rather than a subject-oriented teacher identity. It would be interesting to note the ways in which the primary maths teacher identities evolve in relation to these differing histories of teacher education and different contexts of teaching (i.e. FP teach across the learning areas and IP teachers teach only maths). My sample includes both Intermediate and Foundation phase teachers. Jansen (2001, p. 242) like Bernstein (1971, p. 212) argues that the ‘subject matter competence’ is ‘the lynch pin’ of an educational identity, with Bernstein (1971, p. 229) noting that “infant school teachers are not socialised into strong educational identities”. Intermediate-phase subject-specialists teachers are likely to have what Bernstein (1971) calls ‘specialised identity’ and ‘dedicated identities’.

3.4.3 Wenger et al’s fundamental elements of a CoP

As noted earlier, I read Wenger and his colleagues’ (Wenger, McDermott & Snyder, 2002) work at a later stage of this study, when I was interpreting and structuring data in Chapter 9. Wenger et al (2002, p. 27) explain that all CoPs share a basic structure consisting of a “unique combination of three fundamental elements: a *domain* of knowledge; a *community* of people who care about this domain; and the shared *practice* that they are developing to be effective in the domain” [emphasis in original]. I have used Wenger et al’s (2002) three elements of a CoP to address the question which relates to what activities, relations and forms of participation within the Community of Practice *enable* evolving primary maths teacher identities and practices. Wenger et al (2002) argues that these three elements make a CoP an ideal knowledge structure – a social structure that can assume responsibility for developing and sharing knowledge – thus these three concepts can be used as broad categories encompassing the learning affordances or enablers described by teachers in NICLE. I explore each of these elements, below.

The *domain* according to Wenger et al (2002, p. 31) creates “common ground” and is the ‘*raison d’être*²⁶’ that “brings people together and guides their learning”. It consists of “hot topics”, “the best knowledge and skills that can be found ... and key issues or problems that members commonly experience” (Wenger et al, 2002, p. 32 & 33). Members of a CoP domain may share a profession or discipline, have the same job or role and deal with the same clients. Wenger et al (2002) give an example of ‘history teachers’ as members of a CoP’s domain. In the same way primary maths teachers are members of NICLE’s domain. Thus NICLE’s domain is primary maths education. Wenger et al (2002, p. 31) also explain

²⁶ French term meaning reason for existence.

that each domain or discipline has “one or two burning questions that researchers pursue at any given time”. The element of domain relates to the component of identity as any “community maintains a sense of identity rooted in a shared understanding of its domain” (Wenger et al, 2002, p 31).

Wenger et al (2002, p.34) defines *community* as a “group of people who interact, learn together, build relationships, and in the process develop a sense of belonging and mutual commitment”. Community of practice members interact regularly or participate in issues important to their domain. Through regular interaction members develop a shared understanding of their domain and an approach to their practice. In terms of relationships, they explain that an effective or strong community is characterised by mutual respect and trust, and offers a place of exploration where it is safe to speak the truth, share ideas, expose one’s ignorance and ask hard questions. They also note that a community consists of a “‘field of experts’ who can recognise and validate innovations in a community”. The element of a community, also relates to the component of identity as participation in a community over time builds common and strong identities. The empirical field of study – NICLE - is a primary maths (numeracy) teacher CoP.

Wenger et al (2002, p.34) refer to *practice* as the “body of shared knowledge and resources that enables the community to proceed efficiently in dealing with its domain” (Wenger et al, 2002, p. 29). In fact according to Wenger et al (2002, p. 38), practice denotes “a set of socially defined ways of doing things in a specific domain”. Thus a community’s practice explores the existing body of knowledge and the latest advances in the field which enables participants to learn the craft and become practitioners. Implicit in learning a craft and becoming a practitioner is the notion of identity, with Wenger (1998) fully explaining the connection between these CoP components in his earlier book. Wenger et al (2002) mention a range of tools, resources, concepts, symbols and documents which members share as being part of practice. The resources embed meanings to practice which results from the “interplay of codification and interactions” (Wenger et al, 2002, p. 39), which Wenger (1998, p. 63) interprets as the “duality of reification and participation”. Relating all these aspects to NICLE, one can say the in-service CoP’s practice is the primary maths teaching and learning practices of teachers in NICLE. The diagram below captures the three fundamental elements of a CoP outlined in Wenger et al (2002).

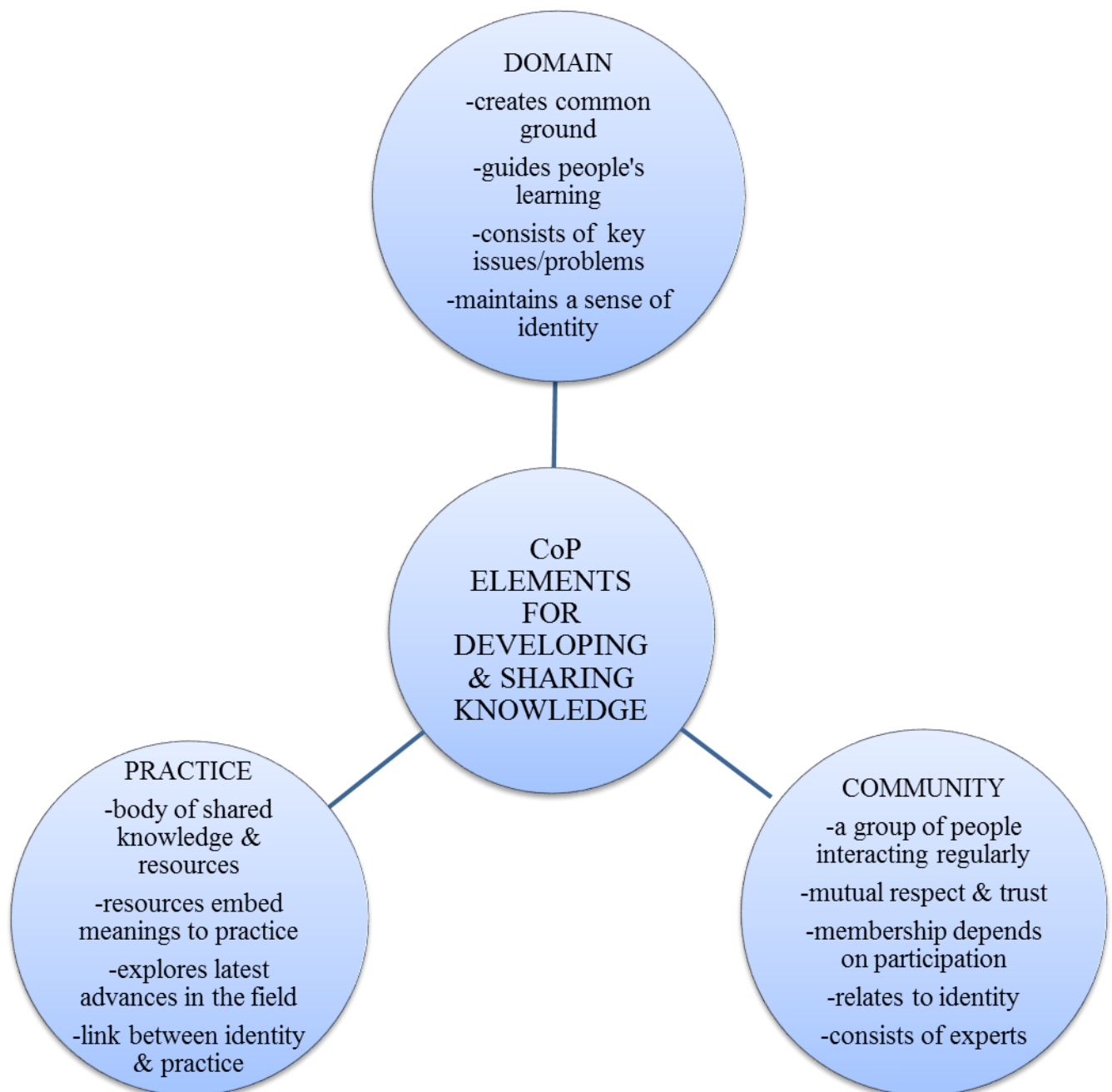


Figure 3.3: The structural and fundamental elements of a CoP

Wenger et al (2002, p. 40) also explain that these elements “provide a means to understand different ways in which participation is meaningful to members” – thus this elements can also be employed to investigate how participation in NICLE enables primary maths teachers’ learning as evolving membership and becoming in relation to this membership.

3.4.4 Wenger's three Modes of Belonging

Important in understanding identity formation and learning within Communities of Practice are Wenger's (1998) three distinct modes of belonging: imagination, engagement and alignment. According to Wenger (1998) modes of belonging are useful for making sense of the processes of identity formation and learning. This research will use the three modes as analytical tools to investigate how primary maths teachers' identities and practices evolve in the numeracy CoP in-service programme, as well as to analyse activities, relations and forms of participation within NICLE that enable or constrain evolving primary maths teacher identities and practices. The mode of alignment is particularly useful for addressing the question of how teacher evolving identities and practices align to the broader and other contextual factors external to the CoP?

NICLE is my empirical field of research and has been conceptualised as a Community of Practice and from this community of numeracy teachers I want to explore the teachers' practices and identities and how they engage, imagine and align their activities in this primary maths professional teacher development enterprise and in other broader maths education communities. In the next section I explain each mode of belonging and how I will use these modes in this study.

Wenger (1998, p. 173) defines the modes of belonging as follows:

- (i) *imagination* - creating images of the world and seeing connection through time and space by extrapolating from our own experience
- (ii) *engagement* - active involvement in mutual processes of negotiation of meaning
- (iii) *alignment* – coordinating our energy and activities in order to fit within broader structures and contribute to broader enterprises

Wenger captures the interrelationship between these in the following diagram:

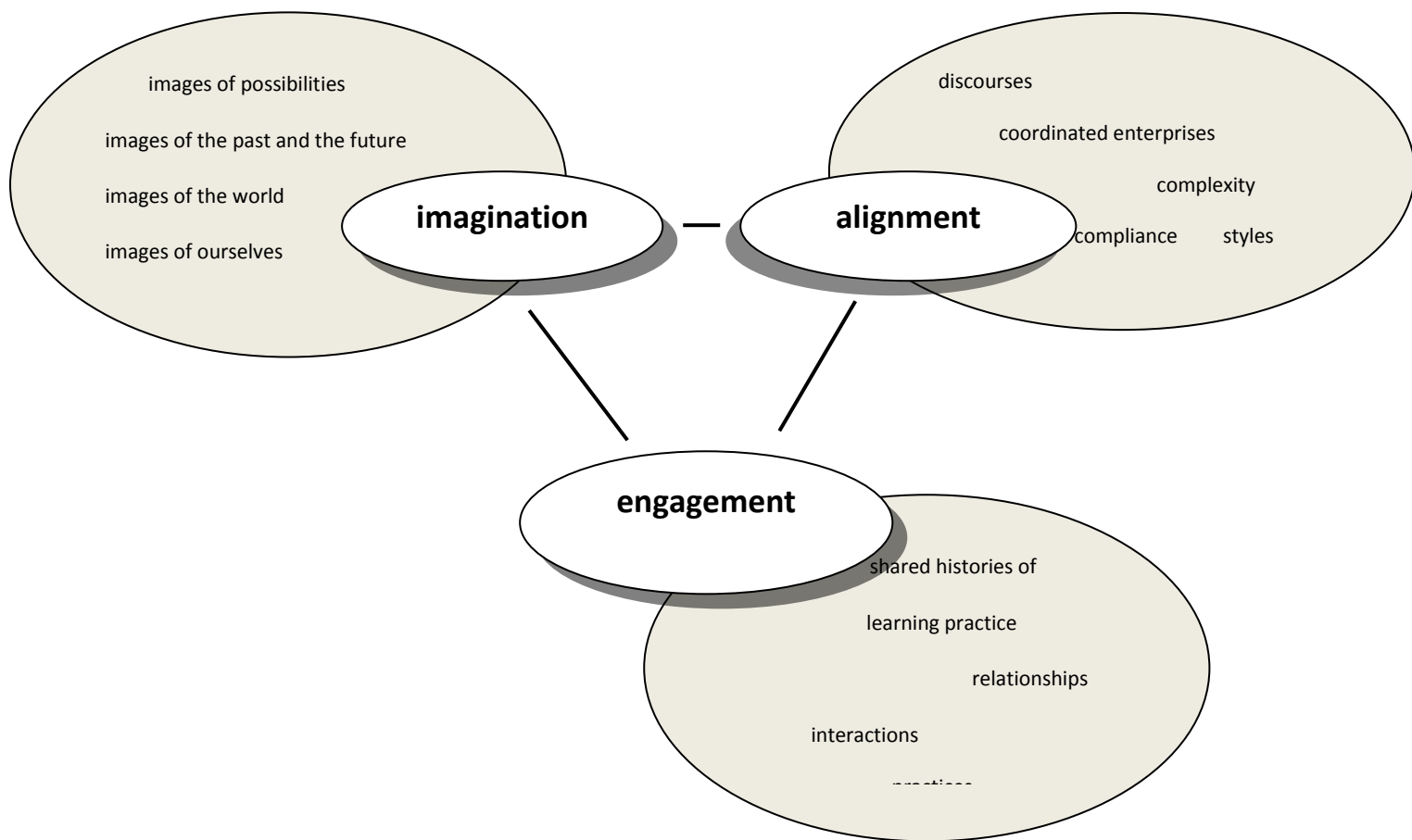


Figure 3.4: Wenger's Modes of belonging (Wenger, 1998, p. 174)

3.4.4.1 Imagination

Imagination, according to Wenger (1998, p. 176), is the “process of expanding our self by transcending our time and space and creating new images of the world and ourselves”. Imagination allows teachers to conceive of their participation in NICLE and ‘explore alternatives’, ‘other possibilities...perspectives’ and ‘envision possible futures’ that are related to the teaching of mathematics. According to Wenger (1998, p. 184) the work of imagination entails such processes as:

‘...being in someone else’s shoes,’ ‘defining a trajectory that connects what we are doing to an extended identity, seeing ourselves in new ways’, ‘conceiving of the multiple constellations that are contexts for our practices’, ‘sharing stories’ and ‘generating scenarios, exploring other ways of doing what we are doing, other possible worlds, and other identities’.

Though Wenger mentioned nine processes which the work of imagination entails, I draw on those quoted above as these are most relevant to this study and because they relate with the

theoretical tools used in this study. Of note the fourth aspect of sharing stories is similar to Sfard and Prusak's (2005) notion of identity as a narrative which is central to this study. Of the other processes listed above, the first element is akin to imagination, the second process relates to learning trajectories, whilst the third and fifth processes closely relate to the characterisation of identity as a nexus of multimembership. This provides me with the opportunity to link the situative-identity elements of *imagination*, *learning trajectory* and *multimembership* to investigate the first research question on how PMT identities evolve and the process of this evolution. Overall, I will complement Wenger's (1998) notion of *imagination* with his characterisation of identity as a *learning trajectory* and as a *nexus of multimembership* to investigate this research question.

3.4.4.2 Engagement

I complement Wenger et al's (2002) three fundamental elements of a CoP with Wenger's (1998) notion of engagement to investigate teacher learning *affordances* and *constraints* (Greeno et al, 1998) within NICLE. According to Wenger (1998, p. 184), engagement "requires the ability to take part in meaningful activities and interactions, in the production of sharable artifacts, in community-building conversations, and in the negotiation of new situations". Following this description of engagement I will use aspects of engagement shown in Figure 3.3 above to outline the *relationships* (including interpersonal relationships) and *interactions*, between the participating teachers and between the teacher and facilitators or invited presenters/guests. The notion of engagement will also help me to investigate the 'artifacts', resources or the 'repertoire of the practice' used in NICLE. Observations, audio recordings, journal entries and interactive interview data from the empirical field of study will afford me the opportunity to explore the nature of relationships and forms of participation within NICLE.

Still on engagement, I will also focus on the maths *practices* promoted in NICLE, and how teachers describe how they take up promoted teaching practices in their maths classes. The maths practices promoted in NICLE will be captured and gathered through observations, teacher hand-outs and from the Chair's documents, such as the initial proposal document (Graven, 2010) and annual reports (SANC, 2011, 2012, 2013) which implicitly and explicitly outline the promoted primary maths teaching and learning orientations. Teacher interactive interviews and journal entries will indicate which NICLE maths practices were noted by the sampled teachers as relevant or taken up in their maths classrooms. I will also investigate

other *practices* with which teachers engage in other overlapping maths education communities of practice, such as, further tertiary studies, attending and presenting at maths conferences and participation in workshops or maths education association activities such as Amesa learner maths challenges. Through the mode of ‘engagement’ I will seek to explore through participant observations ‘*shared histories of learning*’ in NICLE and how teachers describe such collective histories of learning in interviews. The described elements of engagement will help in investigating and explaining the *relationships, interactions, practices artifacts* and *shared histories of learning* within NICLE. The notion of engagement (Wenger, 1998) together with the elements of CoPs (Wenger et al, 2002) will thus illuminate what activities, relations and forms of participation within the Community of Practice enable or constrain evolving primary maths teacher identities and practices.

3.4.4.2.1 The ‘*bounded character of engagement*’

The ‘*bounded character of engagement*’, which emphasises the “physical limits in time and space” (Wenger, p. 175) will illuminate the second research question, which investigates activities, relations and forms of participation within the Community of Practice which *constrain* evolving primary maths identities and practices. The bounded character of engagement is similar to the term *constraints* (Greeno et al, 1998), which imply regularities, systems or materials of social practice that inhibit interaction or participation. Wenger (1998, p. 175) notes that the bounded character of engagement entails the

...physiological limits to the complexity that each of us can handle, to the scope of activities we can be directly involved in, and to the number of people and artifacts with which we can sustain substantial relationships of engagement.

Wenger and Trayner’s latest work also points out that time is one of the factors constraining participation in CoPs (Wenger-Trayner & Trayner-Wenger, 2011). The element of engagement, the ‘bounded character of engagement’ (Wenger, 1998) and Wenger et al’s (2002) structural elements of a CoP provide analytical and descriptive tools that help interpret and understand activities, relations and forms of participation within the Community of Practice which *enable* or *constrain* evolving teacher primary maths identities and practices.

3.4.4.3 Alignment

Alignment is the third component of Wenger’s (1998) three modes of belonging, which will be used to investigate how teacher-evolving identities and practices relate to the broader official pedagogic identities promoted nationally and to other contextual factors external to

the CoP. This will allow the study to investigate the third research question which focuses on how broader educational changes and contextual factors external to the teacher learning community influences teacher evolving identities and practices. Wenger (1998, p. 174) defines alignment as “coordinating our energy and activities in order to fit within broader structures and contribute to broader enterprises”. Alignment will help me to investigate how NICLE teachers coordinate and connect their energies, actions, competencies, viewpoints and practices with the broader primary maths education context. The broader context or enterprises, according to Wenger (1998, p. 180), can be found, for instances in the

- expectations of the employer
- demands of the institution
- governmental institutions
- educational standards

Which all proposes “broad systems of *styles* and *discourse*” (Wenger, 1998, p. 180) [italics in original]. The notion of alignment will allow for the investigation of how the sampled NICLE primary maths teachers practices align with or depart from what is expected by their schools, the school’s heads of departments, the district office and also what is articulated in primary maths education policy documents such as in the Curriculum and Assessment Policy Statement (CAPS), and how they relate to the Annual National Assessments. In addition to the local contextual expectations the mentioned policy documents articulate promoted primary maths teacher *styles* and *discourses*, and this study will investigate how participating teachers navigate their learning and practice within the national context. Wenger’s (1998) notion of alignment will provide the study with tools to investigate how teachers’ evolving primary maths identities and practices connect and position themselves in relation to primary maths education policies and local contexts. In the interviews, research questions were formulated to access how NICLE participants relate their primary maths practices within school contexts and broader structures’ expectations, demands and intentions as set in the new CAPS curriculum and in relation to ANAs. To complement Wenger’s notion of alignment I have also used, in Chapter 2, Bernstein’s (2000) pedagogic identity model which provided this study with research tools to discuss primary maths teacher identities promoted within South Africa’s education reform and curriculum change context. Both Wenger’s (1998) notion of alignment and Bernstein’s (2000) pedagogic identity model, and the four pedagogic identity positions inform the analysis to come and enable the study to address the

question of how teacher evolving identities and practices relate/align to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP.

3.4.4.3.1 Critical alignment

However according to Wenger (1998, p. 181) alignment “...can also be blind and disempowering. It can be an unquestioning allegiance that makes us vulnerable to all kinds of delusion and abuse”. Because of this limitation pertaining to the component of alignment, the study will also draw on Jaworski’s (2005, 2006) notion of “critical alignment” which argues that teacher participants, in the processes of aligning with aspects of practice, critically question the status quo, existing social norms and maths classroom practice. Critical alignment results in “critical reflection”, a process which ultimately leads to “metaknowing” – a form of critical awareness engendered in inquiry (Jaworski, 2005; 2006). In later Chapters in this study I identify and discuss how teachers critically and reflectively relate their practices to school and classroom (working context) demands and particularly in relation to recent new primary maths education policies and practices such as the new CAPS curriculum and the ANA tests.

3.5 In Summary

In this chapter I firstly explained the informing situative-participationists theoretical framework that guide and drive this study, namely Wenger’s social learning theory, with the notion of identity placed centrally. In the process I discussed the reasons for the use, the emergence, nature of learning, artefacts and limitations of the applications of the CoPs concept and the social learning theory in maths teacher education. Secondly I have outlined and described the analytical tools to be used in this study. Besides being used as an analytical lens, the participationist-identity elements, discussed herein, also provide linguistic and descriptive tools and structuring devices that will aid in the interpretation and presentation of the empirical findings. Also explaining the situative-identity analytical tools informing this study serves to illuminate the investigation of all the research questions underpinning this study and will also inform the key arguments that I will make in chapters 8, 9 and 10 that pertains to how primary maths teachers learn, how their identities, practices and forms of participation evolve in NICLE, what enables or constrains such evolvment, and how these teacher-evolving identities and practices relate to the broader contextual factors external to the CoP.

CHAPTER 4: Literature Review

4.1 Introduction

Having discussed the theoretical framework and analytical tools used in this study in the previous chapter, I now engage with a range of local and international teacher education and particularly maths teacher education literature to explore the notion of (primary) maths teacher identity and maths teacher professional development programmes. A literature informed discussion helps to illuminate the investigation of the four research questions underpinning this study and to inform the key arguments that I will make in Chapter 8, 9 and 10 relating to how primary maths teachers learn and how their identities, practices and forms of participation evolve and what enables or constrains such evolution and how teachers align to the broader contextual factors external to the CoP.

Thus this chapter reviews both local and international literature relating to teacher identity, maths teacher identity (in general) and the notion of primary maths teacher identity more specifically – and its formation and relation to curriculum reforms. I also draw on this literature to define the construct of Primary Maths Teacher Identity within the chosen theoretical framework. The chapter also engages with pertinent literature on in-service teacher education to discuss the re-orientation, challenges and the characteristic features of increasingly promoted teacher development approaches.

4.2 Maths teacher identity origins

This part of the study engages with both local and international literature to discuss the notion of maths teacher identity, which is proving to be increasingly popular in mathematics teacher education research studies. I start by explaining that the concept of identity was initially a preserve for psychology (Sfard & Prusak, 2005; Wenger, 1998). The focus on identity in the field of maths education was triggered by the maths education's late 1980s' research tendencies to draw from the social and humanistic sciences such as anthropology, sociology, psychology and cultural studies. These disciplines foreground the notion of identity (Lerman, 2000; Sfard & Prusak, 2006). Gee (2001) and Sfard & Prusak (2005) concur that identity can be used as an analytical and interpretive tool for studying both human conduct and important issues in education. With this in mind, Grootenboer et al (2006) explain that identity is a useful concept to explore and understand mathematical learning whilst connecting with the broader context of the learning environment and bringing together individual elements such

as life histories, affective qualities and cognitive dimensions. Grootenboer et al's (2006) explanation of the importance of identity coheres with sociocultural-participationists' notion of coupling identity formation and learning, a point acknowledged in local (Graven 2003; Graven, 2005a, Graven, 2012; Nel, 2012, Adler, 2000) and international (Hodgen & Askew, 2007; Sfard & Prusak, 2005; Lerman, 2012b; Brown & McNamara, 2011; Boaler & Greeno, 2000; Lerman, 2001; Heyd-Metzuyanım & Sfard, 2012) maths education literature.

Most studies on maths teacher identities have been theoretically informed by Lave and Wenger's situated theory (Graven, 2003 & 2005a; Hodgen & Askew, 2007; Nel, 2012; Pausigere & Graven, 2014), the post-structuralists (Walls, 2008; Brown & McNamara, 2011; Lerman, 2012a), discourse theory (Walls, 2008; Clandinin & Connelly, 1996; Marsh, 2002b; Sfard & Prusak, 2005) or Bernstein's sociological theory (Morgan et al, 2002, Parker, 2006; Graven, 2002b; Pausigere & Graven, 2013d) to understand maths teacher identity formation. The choice of a theoretical framework aids in formulating, understanding and defining the concept of maths teacher identity. For example studies theoretically informed by Bernstein have indicated how the State projects a particular maths teacher identity (Graven, 2002b; Parker, 2006; Johansson, 2010; Pausigere & Graven, 2013d), yet studies informed by the CoP concepts show how maths teacher identities are formed through participation in maths teacher learning communities (Graven, 2003 & 2005a, Graven, 2012; Hodgen & Askew, 2007; Nel, 2012; Adler, 2000; Pausigere & Graven, 2014). This study is informed by both the situative-participationists and also Bernstein's sociological theories (these locate identity within the social).

4.3 Primary Maths Teacher identity formation and learning

It is important to consider factors and issues that influence and affect primary maths teacher identities and learning as this will help me respond to my main and 1st research question, on the nature of primary maths teacher learning and how primary maths teachers' professional identities evolve in relation to participation in an in-service community of practice. The key issues raised in maths education literature relating specifically to *primary* maths teacher identity formation concern: the issue that most of the primary teachers do not have a specialisation in maths (Brown & McNamara, 2011; Bernstein, 1971) and have the challenging and "difficult task of teaching a range of disciplines" (Grootenboer & Zevenbergen, 2008, p. 248). Because of this primary school maths teachers have a 'generalist brief' (Brown & McNamara, 2011, p. 11; Tatto & Senk, 2011, p. 125) and need to have "a

well-developed identity in a range of subject areas, including mathematics” (Grootenboer & Zevenbergen, 2008, p. 248). These issues apply also in the South African primary maths teaching context with initial teacher education training and policy allowing for subject specialisation (in the higher grades (grade 4 to 6/7), phase specialisation (for example in the Foundation phase level, grade 1-3) or a combination of both (DOE, 2000; DHET, 2011b). On Foundation phase teacher training the policy states that “Foundation phase teachers must be capable of teaching all three subjects (Literacy, Numeracy and Life Skills) in Grades 1 to 3” (DHET, 2011b, p. 23; DOE, 2000). It elaborates that elementary primary teachers “need extensive and specialised knowledge of early childhood learning to teach reading, writing and numeracy and to develop the key initial concepts and skills that lay the foundation for learning in future phases” (DHET, 2011b, p. 23). Thus foundation phase teacher’s official identities are embedded in their phase and across a range of subjects, whilst intermediate teacher’s official identities tend to have subject disciplined oriented identity.

Literature also indicates that the teachers’ personal school (mathematics) learning experiences affect their identity (Drake et al, 2001; Van Putten, 2011; Samuel 2008) with most primary maths teachers experiencing difficulties with mathematics in their own schooling – either at secondary school, college or even elementary school (Brown & McNamara, 2011; Hodgen & Askew, 2007; Drake et al, 2001; Ball, 1996; Jita & Vandeyar, 2006). According to Lave (1993b, p. 77), this contributes to the creation of ‘devalued’ or ‘negatively valued’ (maths) identities. It is also important to note that mathematics education literature also indicates that participation in mathematics is highly gendered (Mendick, 2005), which can create negative identities for girls and women doing maths.

For some primary maths teachers the formation of valued identities (Lave, 1993b) happens through positive maths learning experiences in classrooms (Drake et al, 2001, Lerman, 2012b) or when they re-connect with mathematics (Hodgen & Askew, 2007) during further maths studies, re-skilling or professional development programmes (Drake et al, 2001; Nel, 2012; Askew et al, 1997). Nel (2012) drawing on her research of mathematical literacy teacher development in South Africa, argues that participation in carefully designed re-skilling programmes can dispel fears associated with mathematics and is conducive to maths teacher identity transformation. Drake et al (2001, p. 8) explain that participation in professional development activities or taking a college-level mathematics course can provide ‘a turning point’ in primary teachers’ learning of mathematics. Hodgen and Askew (2007, p.

482) emphasise that reconnecting with maths during professional development provides opportunities for primary teachers to “create an identity as a mathematics teacher”.

In this respect many of the issues discussed above have been acknowledged and discussed in local South African studies as influencing teacher identity (Samuel, 2008; Jansen, 2001) maths teacher identity (Van Putten, 2011; Nel, 2012; Parker, 2006; Ensor, 2001; Graven, 2002a) and primary maths teacher identity (Graven, 2003; Botha, 2012; Pausigere & Graven, 2014; Jita & Vandeyar, 2006). Jansen (2001, p. 242) explains that “subject matter competence, levels of training and preparation and formal qualifications” are the professional basis for teacher identity. In my earlier work with Graven I have also explained how the issue of subject and phase specialisation affect local primary maths teacher identity (Pausigere & Graven, 2013a). Also prominently featuring in the South African teacher education literature are the effects of school learning experiences (Van Putten, 2011; Botha, 2012; Jita & Vandeyar, 2006), school context/setting (Botha, 2012), macro context (Samuel, 2008), curriculum reform and education policy (Graven, 2002a; Pausigere & Graven, 2013d; Harley & Parker, 1999; Parker, 2006; Graven, 2002b; Samuel 2008; Jita & Vandeyar, 2006), professional development (Graven, 2004, Graven 2003; Adler, 2000) and pre-service training (Van Putten, 2011, Botha, 2012) in the formation and transformation of primary maths teacher identity. In later chapters I will reflect on how some of the teacher identity aspects raised in South African primary maths education studies relate to the data of this study.

4.4 Maths teacher identity and curriculum reform/change contexts

Given the new South African CAPS curriculum and the introduction of universal standardised ANA tests it is important to analyse literature on how maths teacher identities relate to curriculum changes and policy reforms. This study intends also to investigate how primary maths teacher identity and practice is affected or influenced by reforms, especially given the fact that South Africa has a new curriculum (CAPS) and recently introduced universal standardised numeracy learner tests (ANAs). The following literature-informed discussion of key maths teacher identity literature will enable me to relate some of the teacher identity-influencing factors to this study’s empirical findings.

Many of the studies on teacher identity within education change or reform contexts have been carried out locally (Harley & Parker, 1999; Parker, 2006; Jansen, 2001; Graven, 2002a & 2002b; Samuel 2008; Pausigere & Graven, 2013d; Jita & Vandeyar, 2006) or in Britain (Morgan, 2005; Day et al, 2006; Woods & Jeffery, 2002) partly due to the nature of national curriculum change in these countries. Of the local studies, the work of Parker (2006) and Graven (2002b) has investigated maths teacher identity within South Africa's first post-apartheid curriculum change context. Jita and Vandeyar (2006) investigated the envisaged primary maths teacher identity under the second NCS curriculum reforms. However since the current CAPS curriculum was only implemented in 2012 there is little published on this to date. A key issue arising locally relates to how curriculum reforms in South African have projected and promoted particular official pedagogic identities or roles (Harley & Parker, 1999; Graven, 2002a; Jansen, 2001). This has also been a common theme in the British curriculum reform context (Woods & Jeffrey, 2002; Day et al, 2006; Morgan, 2005). To this effect, the work of both Pausigere & Graven (2013d) and Woods and Jeffrey (2002), which focused on primary teacher identities, has postulated that both South African current reforms and Britain's have represented a more instrumental-market outlook. Besides identity being affected or influenced by external government policies, the internal institutional or organisational setting also impinges on teacher identity (Samuel, 2008; Day et al, 2006). It is worth noting that most of the local literature on maths teacher identity has been informed by Bernstein's theory (Harley & Parker, 1999; Parker, 2006; Graven, 2002a; Pausigere & Graven, 2013d).

There has also been local and international literature on how maths teacher identities are constituted in relation to standardised testing regimes (Morgan et al, 2002; Walls, 2008; Johansson, 2010; Pausigere & Graven, 2013c). Two key and common issues arising from this literature are how maths teachers position themselves in relation to universal testing (Pausigere & Graven, 2013c; Morgan et al, 2002), and how maths teacher identities are inscribed within the standardised test process (Walls, 2008; Johansson, 2010). Particularly relevant to this study is Morgan's maths teacher positions adopted by UK maths teachers as they assessed students' coursework (Morgan et al, 2002). I relate and connect Morgan et al's (2002) maths teacher positions and Bernstein (2000) pedagogic identity model to explore local primary maths teacher identities and position in relation to the new CAPS curriculum and the ANA tests.

The local and international literature reviewed in this section will inform the argument and the discussion in Chapter 10, as I address the third research question that relates to how teacher evolving identities and practices align to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP. Below I provide a working definition of the construct of Primary Maths Teacher Identity drawing from key teacher identity literature related to the chosen theoretical framework.

4.5 A working definition of Primary Maths Teacher Identity

One major hurdle in researching the notion of teacher identity concerns the definition of this construct (Beauchamp & Thomas, 2009; Walls, 2008; Lerman, 2012a; Sfard & Prusak, 2005). My conception of teacher identity will be streamlined and will zoom in to what will be termed throughout this study Primary Maths Teacher Identity (PMTI). My theoretical framework, supplemented with insights from maths identity literature, will help in defining the construct of PMTI. Similar between the social learning and the sociological theories is how they define identity, with Wenger (1998, p. 5) defining identity as “a way of talking about how learning changes ‘*who we are*’”, while Bernstein defines identity as “what I am, where, with whom and when” (Bernstein & Solomon, 1999, p. 272). I complement these general definitions with Grootenboer et al’s (2006) definition of identity in relation to mathematics and Bishop’s (2012) *mathematics identity* term. Grootenboer et al (2006, p. 612) defines identity as “how individuals know and name themselves...and how an individual is recognised and looked upon by others”. Grootenboer et al (2006) and Bernstein’s definitions of identity (Bernstein & Solomon, 1999) closely relates to Gee’s (2001, p. 99) exposition of identity as “being recognised as a certain ‘kind of person’ in a given context”. Bishop (2012, p. 39) uses the term *mathematics identity* to “mean the ideas...one has about who he or she is with respect to the subject of mathematics and its corresponding activities”. Synthesising these definitions my working definition for this study is that PMTI can be regarded *as a way of talking about* how primary teachers know and name themselves and how they are recognised by others with respect to the subject of mathematics and its corresponding activities.

This working definition of PMTI also meets the *endorsability*, *significant* and *reifying* aspects of identity mentioned by Sfard and Prusak (2005) and Gee’s (2001) explanation that identity involves how one is recognised by others. The PMTI working definition meets the endorsable criteria which allow for the portrayal of the primary teacher from the perspective of the

researcher whose story of the participant must be objective and “faithfully reflect[ing] the state of affairs...” (Sfard & Prusak, 2005, p. 16). This endorsability aspect of identity also closely relates with Gee’s (2001, p. 99) defining of identity as “being recognised as a certain ‘kind of person’, in a given context”. The proposed working definition of PMTI also relates to the *significant* aspect of identity, for it provides the opportunity for the study to discuss the ‘most significant stories’ on how primary teachers relate to the subject of mathematics and how those stories “imply one’s membership in, or exclusion from”, primary maths education communities (Sfard & Prusak, 2005, p.17). Thirdly the study will reveal, in Chapter 8, how teachers’ utterances concerning their maths histories and their NICLE participation experiences meet the reifying qualities mentioned by Sfard and Prusak (2005) and elaborated by Heyd-Metzuyanim & Sfard (2012). The teacher utterances concerning their maths learning stories and as discussed in Chapter 8 indicates endorsable, significant and reifying qualities. Thus the use of the working definition of PMTI in this study meets the identity operational criteria set by Sfard and Prusak (2005).

Such an identity perspective is different and diverges from the broader and everyday use of the term. For this study, which derives the core of its data from primary maths teachers participating in NICLE, I must consider the empirical setting and theoretical inclinations which argue that PMT identities are formed and reconstructed through participation in CoPs during which teachers ‘engage’ in professional primary maths teaching and learning activities. The professional development programme (NICLE) aims for teachers who will become maths *leader educators*, *workshop presenters* and *life-long learners*, and develop primary maths teacher identities that support them in effectively teaching numeracy leading to learner mathematical proficiency (Graven, 2010). However one’s teacher identity is directly or indirectly influenced by official positions (Bernstein, 2000), thus my notion of primary maths teacher identity, as has been explained in Chapter 2, will also be guided and illuminated by the current South African educational reforms characterised by a new curriculum policy (CAPS), and standardised assessment practices (ANA). Furthermore informed by my theoretical frame my understanding of identity is that it is complex, dynamic, multifaceted and constantly evolving. Thus through participation in NICLE my assumption is that the primary maths teacher identities are evolving. (Though there might be instances of identities involving in unintended ways and possibly in ways that weaken mathematical identities). Whilst the study primarily focuses on teachers evolving identities within NICLE I will also consider the broader contextual forces impacting on the evolution of teacher

identities as well as the research participants' perspectives with regard to the processes of their primary maths teacher identity transformation.

4.6 Teacher professional development

In this part of the Chapter I engage with relevant key literature on in-service teacher education so as to enlighten the investigation of the 2nd research question which concerns researching the empirical field of study - NICLE. I will initially discuss how literature on teacher education has called for a shift from the “fatally flawed” (Wineburg & Grossman, 1998, p. 353 & 351) district-mandated in-service teacher training models that – “provide teachers with new information to keep them up-to-date” to more ‘effective’ teacher professional development approaches. I will discuss features foregrounded in literature that characterise effective approaches to staff development so that I can relate these to the empirical field of research, and thus illuminate part of my second research question which investigates activities within NICLE which *enable* primary maths teacher learning and evolving identities. Within the purview of teacher education literature I will also discuss structural challenges facing in-service teacher education programmes so as to interrogate constraints facing both local and international teacher professional development and will relate these to the empirical field of research (NICLE). This will assist in my analysis of activities, relations and forms of participation within the Community of Practice that *constrain* evolving primary maths teacher identities and practices.

4.6.1 Historically prevalent forms of professional development

The common form district mandated once-off information giving teacher development has been under attack by teachers, educational researchers and teacher educators, who regard these as irrelevant and ineffective and have instead argued for collaborative approaches of in-service training. Many studies have heavily criticised the formal mandatory one-shot ‘workshops’ sponsored by the school districts as being unproductive, intellectually superficial, fragmented, unrelated to classroom practice-too theoretical, the least effective source of teacher learning, lacking in intensity, content and follow up and having little effect on teacher practice (Wineburg & Grossman, 1998; Smylie, 1989; Wilson & Berne, 1999; Abdal-Haqq, 1996; Askew et al, 1997; Ball & Cohen, 1999; Lieberman, 1995; Kretchmar et al, 2012; Graven, 2012; Maistry, 2008). Besides the criticisms levelled against traditional forms of professional teacher development these remain the most prevalent and widely used approach to staff development (Cochran-Smith & Lytle, 1999; Garet et al, 2001). Under the

traditional ‘training-model’ of professional development teachers are presumed to learn from training and coaching provided by officially certified trainers or outside experts (Matos, 2009, p. 167, Cochran-Smith & Lytle, 1999). This model relates to Sfard’s (1998) acquisition metaphor of learning and focuses on the “knowledge-for-practice” conception of teacher learning (Cochran-Smith & Lytle, 1999, p. 250) which conveys “propositional knowledge” (Shulman, 1986, p. 10) or foundational and applied domains of knowledge needed by teachers for classroom instruction and organisation. In South Africa the Chisholm review strongly criticised the cascade training model as an inadequate approach for preparing and delivering effective teacher training (Chisholm et al, 2000). Poor in-service teacher development has been noted as one of the key reasons for our crisis in education. Conventional professional development training models’ shortcomings and their limited impact on influencing teacher practices have resulted in the call for more effective in-service teacher training approaches. Indeed one can see movement from C2005’s cascade model to a new discourse of developing subject specialist learning communities to enable in-service learning for CAPS (discussed in Chapter 1).

4.6.2 Characteristic features of successful teacher professional development approaches

There seems to be some consensus emerging in both local and international teacher education literature on the features and characteristics of ‘successful’ teacher professional development approaches, and what this entails or implies for classroom practices. By identifying teacher learning *affordances* or features that characterise effective approaches to staff development I can investigate the presence or absence of these factors in the empirical field of my research. Table 4.1 below summarises the features of effective professional development models noted in key local and international teacher education and maths teacher education literature:

Features that characterise effective approaches to staff development	Teacher education and maths teacher education literature that discusses such features
<ul style="list-style-type: none"> • on-going/longer-term/extended 	Abdal-Haqq, 1996; Graven, 2005b; Graven, 2012; Hill et al, 2008; Garet et al, 2001; Wineburg & Grossman, 1998; Ma, 2010; Askew et al, 1997; Wilson et al, 1996; Adler & Reed, 2002
<ul style="list-style-type: none"> • with a mathematics focus content 	Askew et al, 1997; Ma, 2010; Hill & Ball, 2004; Hill, 2004; Adler & Reed, 2002
<ul style="list-style-type: none"> • volunteering participants 	Ball & Cohen, 1999; Smylie, 1989; Hill, 2004, Garet et al, 2001; Little, 2003; Putman & Borko, 2000; Shulman & Shulman, 2004; Brodie, 2013; Wilson et al, 1996; Ball & Even, 2009
<ul style="list-style-type: none"> • that learn in and from practice 	Ball & Cohen, 1999; Smylie, 1989; Hill, 2004, Garet et al, 2001; Little, 2003; Putman & Borko, 2000; Shulman & Shulman, 2004; Brodie, 2013; Wilson et al, 1996; Ball & Even, 2009; Fennema et al, 1996; Jaworski, 2009
<ul style="list-style-type: none"> • emphasises teacher collaboration/shared work 	Garet et al, 2001; Abdal-Haqq, 1996; Hill, 2004; Hill et al, 2008; Ma, 2010; Hill & Ball, 2004; Lieberman, 1995; Wineburg & Grossman, 1998
<ul style="list-style-type: none"> • regards teachers as professionals active life-long learners 	Garet et al, 2001; Hill, 2004; Abdal-Haqq, 1996; Graven, 2005b; Graven, 2012; Wilson et al, 1996; Lieberman, 1995
<ul style="list-style-type: none"> • are school-based and support teacher initiatives, needs and goals 	Abdal-Haqq, 1996, Kennedy, 1998, Askew et al, 1997; Putman & Borko, 2000; Wilson & Berne, 1999; Ball, 1996; Lieberman, 1995; Kretchmar et al, 2012
<ul style="list-style-type: none"> • provide adequate time and follow-up support 	Abdal-Haqq, 1996; Ball, 1996; Kretchmar et al, 2012
<ul style="list-style-type: none"> • offer opportunities for individual reflection and inquiry into practice 	Farmer, Garretson & Lassak, 2003, Abdal-Haqq, 1996; Jaworski, 2006; Wilson et al, 1996; Shulman & Shulman, 2004; Cochran-Smith & Lytle, 1999; Adler & Reed, 2002; Kretchmar et al, 2012
<ul style="list-style-type: none"> • are facilitated by mathematically knowledgeable individuals 	Hill & Ball, 2004; Matos, 2009

Table 4.1: The features of effective professional development approaches

Many leading numeracy teacher educators and researchers agree that such features afford teachers opportunities for mathematical learning and understanding, have a powerful effect on raising standards, and are highly influential in developing teaching practices (Hill et al, 2008; Ma, 2010; Askew et al, 1997; Hill & Ball, 2004; Hill, 2004; Wilson et al, 1996). In the discussion in Chapter 9 I compare and discuss the literature-informed features of successful teacher professional development approaches and those characteristics or *affordances* emerging in NICLE.

4.6.3 Challenges facing teacher professional development

Both the historically prevalent and newer (emerging) forms of teacher professional development are susceptible to an array of challenges or *constraints*. The greatest challenge to successful staff development programmes is the unavailability of time to engage in professional work (Farmer et al, 2003; Abdal-Haqq, 1996; Graven, 2005b; Adler & Reed, 2002). Another dilemma pertains to the site of which teacher development - whether it is district, university or school-based (Garet et al, 2001; Graven, 2005b; Adler & Reed, 2002), with school-based programmes being convenient and most favoured by teachers for primary maths professional development initiatives (Askew et al, 1997; Ma, 2010). Garet et al (2001) and Graven (2005b) both point out that another impediment to providing high quality professional development experiences is financial cost and the related issue of resources. However Kennedy (1998, p. 25) is of the opinion that the structural or organisational challenges have little effect on in-service teacher education and on student learning compared to the dimension of the “content of the program”. The extent to which time, site and structural challenges constrain teacher development in NICLE will be explored in Chapter 9.

4.7 In Summary

Engaging with local and international literature the study discussed the notion of maths teacher identity, aspects relating to primary maths teacher identity formation and how maths teacher identities relate to curriculum reforms. Drawing on this I have provided a working definition of Primary Maths Teacher Identity that I will use in the study. Finally, within the purview of relevant literature the chapter discussed the structural and content challenges - *constraints*, and features of successful teacher professional development approaches – teacher learning *affordances*. The literature I have reviewed in relation to maths teacher identity and teacher professional development initiatives support my investigation of the research

questions underpinning this study, and inform the analysis of teacher learning, affordances and constraints in Chapters 8, 9 and 10.

Chapter 5: Research methodology, methods and data collection

5.1 Introduction

In carrying out this research, I employed a longitudinal qualitative interpretive approach to explore the nature of primary maths teacher learning, and thus provide rich ‘thick descriptions’ (Geertz, 1973 in Miles & Huberman, 1986, p. 10). In the next chapters, I use these thick descriptions to elaborate on how primary teachers learn and fashion their maths identities and practices through participation in NICLE. The research study sample consists of 8 primary teachers drawn from the NICLE. Interactive interviews, participant observations, reflective journals and document collection and analysis were the four primary strategies for gathering data, with the unit of analysis being the ‘numeracy teacher-in-NICLE’. Data obtained through observations of NICLE and document collection will inform the analysis of the NICLE CoP and the promoted PMTI in Chapter 6, whilst data primarily from interactive interviews provide the teacher learning stories in Chapter 7 with both sets of data analysed and discussed in Chapter 8, 9 and 10. This chapter concludes with a discussion on key methodological issues concerning ethics, the validity and reliability of data, the data analysis strategies used and also explores the notion of the generalisability and relatability of the study’s findings.

Since NICLE provides the empirical field of research to this study, in the next part of this chapter I briefly discuss the conceptualisation and design of this Community of Practice-informed in-service teacher development initiative.

5.2 The Empirical field of Study-NICLE

The primary maths in-service teacher education professional development programme, called the Numeracy Inquiry Community of Leader Educators (NICLE) forms the empirical field of research to this study. The NICLE initiative focuses on numeracy teacher development in the critical transition from foundation to intermediate phase (that is Grade 3 and 4)²⁷ in selected primary schools in the Grahamstown greater area (SANC, 2013; SANC, 2012; SANC, 2011). This numeracy teacher professional development programme was developed by the South

²⁷ The rationale for focusing on Grade 3 and 4 teachers is meant to improve interaction between teachers in these phases as pre-service education is structured around phase specialisation (SANC, 2011; SANC, 2012).

African Numeracy Chair, at Rhodes University and is part of the six FirstRand Foundation Numeracy and Mathematics Chairs initiatives that are tasked with searching for sustainable ways forward in navigating the many challenges of mathematics education in South Africa (Graven, 2011a).

NICLE is articulated and conceptualised as a long-term partnership between in-service teachers and the Chair and partners of the Chair, and aims to improve numeracy education and finding solutions to the challenges faced in numeracy education (Graven & Schafer, 2011; Graven, 2010). The intended duration of the NICLE programme is five years, which is from 2011 to 2015. At the start of its first year, NICLE had 57 Foundation and Intermediate phase teachers from 15 participating schools who attended NICLE's fortnightly seminars and inquiry sessions (SANC, 2011). In 2012, 45 of these continued as regularly participating teachers from 12 core participating schools (SANC, 2012; SANC 2013). I gathered data and carried out research in NICLE, during these first two years (from 26 March 2011 to 9 October 2012). Of a total of 25 NICLE sessions (excluding end of year celebration sessions) in 2011 and 2012 I attended and observed 23 sessions. (Thus I missed only two sessions when I attended the SAARMSTE Research School and a Department of Higher Education, Teacher Education Conference). I also attended other NICLE-related events such as a maths family event. In addition I attended two 'Teacher Relays' alongside several NICLE teachers during the National Maths week and three local and regional teacher conferences. Several NICLE teachers attended and participated in these mathematical activities, conferences and events as these are part of on-going opportunities supported by the SANC. Thus the primary maths professional development initiative's core programmes and activities includes teachers attending NICLE's fortnightly sessions and additional participation in overlapping communities of practice such as local, regional and national conferences (Graven 2010; SANC, 2011).

Since NICLE is the empirical field in which teacher learning and teacher identity is explored it is important to analyse and describe in detail the nature of the NICLE Community of Practice and the promoted and projected Primary Maths Teacher Identity, as this will inform data gathered from teacher interactive interviews. This is provided in the following chapter. Below I engage with my positioning in the research.

5.2.1 My role in NICLE and in the SANC research community

The Chair's project work is conceptualised as two overlapping CoPs of NICLE and post graduate researchers. Thus besides NICLE, the Chair also focuses on the establishment and the growing of a numeracy/primary maths education research community, which has been developed in parallel with the teacher community (Graven, 2010; SANC, 2011; SANC, 2012; SANC, 2013). To this effect I applied and was recruited as a full time PhD fellow, in January 2011, by the Chair, Professor Mellony Graven who is also my Supervisor. I was interested in the research initiatives of the Chair because her work draws from Communities of Practice theory and interpretive methodology. As a PhD fellow in the project, my doctoral research focuses on primary maths teacher learning within the NICLE program.

I am a Zimbabwean citizen, and have taught mainly Humanities and Languages at Secondary level in my home country for seven years. I migrated into South Africa in 2007 and briefly taught at an Independent private college in Johannesburg's inner city, before enrolling as a full-time student for a Bachelor of Education Honours degree and thereafter a Masters in Curriculum Studies at the Wits School of Education. I also taught curriculum studies, professional studies and the school in context courses to full-time undergraduate and in-service teacher education students at Wits. I speak English, and during my six years in South Africa I have learned the two main indigenous languages: isiZulu and isiXhosa. Some of the sampled participants speak and teach in isiXhosa, Afrikaans or English but all the NICLE sessions were conducted in English, as were the interviews. All the NICLE teachers and the sampled teachers speak and understand English. In this research the language of interviewing, which is English, did not emerge as a source of problem or tension with the participants, although it should still be noted that for some of the sampled teachers English was not their home language.

I have participated in NICLE for the purposes of carrying out research. I thus attended the NICLE sessions as a *participant observer*, who also sat with the teachers and participated in the NICLE activities as a learner alongside the primary maths teachers. I would jointly work out mathematical problems with the teachers as I sat amongst them. I do not have post school mathematics training and so was a learner alongside teachers. The NICLE participant observations are one of my data collection methods for my PhD research. Activities and events I observed in NICLE were written in my field work notes, which were compiled from 26 March 2011 to 9 October 2012. I audio-recorded several of the NICLE sessions for further

analysis to understand the nature of teacher learning and the projected NICLE primary maths teacher identity. I also collected NICLE teacher hand-outs which were given by presenters to participating teachers. Alongside other Chair team members we would jointly arrange the logistics (e.g. seating, compilation of hand-outs) in preparation for sessions and help in distributing NICLE teacher hand-outs and resources.

From the NICLE teachers in 2011 I purposively sampled ten teachers, whom I interviewed twice (once in 2011 and once in 2012). These interviews were audio-recorded and transcribed. However during the interviews carried out in 2012, the sample size came down to 8 after 2 of the participants withdrew from the programme because of other commitments and challenges²⁸. I elaborate below on my interpretive research methodology.

5.3 Qualitative educational interpretive research methodology

In carrying out this research I used a qualitative educational interpretive approach. This research approach combines both qualitative and interpretive methodologies to make interpretations within the educational field.

Epistemologically the interpretive approach has an anti-positivist orientation, as it emphasises that knowledge and understanding can be obtained through the experiences of the actors in their social context (Merriam, 2001; Neuman, 2009). The anti-positivists aim at understanding the subject's lived experiences and interpreting and giving meaning from a subjective perspective.

The interpretive methodology is one of the different types or varieties of qualitative research (Merriam, 2001; Neuman, 2009). The educational interpretive approach involves understanding people's meanings, purposes and behaviour within an educational community (Cohen, Manion & Morrison, 2010; Merriam, 2001). The interpretive approach is also called basic, descriptive or the constructivist/constructionist approach and is one of the methodologies subsumed under the term qualitative research (Best & Kahn, 2006, p. 261; Cohen et al, 2010; Andrade, 2009). Qualitative studies provide exploratory and detailed narrative descriptions that use the context and setting to search for deeper understanding of the phenomenon being studied (McMillian & Schumacher, 2001; Best & Kahn, 2006). By employing the qualitative educational interpretive methodology this study aimed to provide

²⁸ Brenda transferred from Martindale to another farm school, Sidbury and could no longer attend NICLE, whilst Swallow only sporadically attended the NICLE 2012 sessions, citing increased administrative responsibilities.

rich ‘thick descriptions’ (Cohen et al, 2010, p. 169; Miles & Huberman, 1986, p. 10) on how primary teachers learn and fashion their maths identity through participation in NICLE.

A synthesised definition of interpretive is that it is a form of qualitative research employed to understand, describe and interpret in-depth the participant’s lived experiences from their point of view (Merriam, 2001; Neuman, 2009; Cohen et al, 2010; Andrade, 2009). Under the interpretive approach the phenomenon or the subject’s ‘lived experience’ and their view of reality is paramount (Andrade, 2009, p. 43; Cohen et al, 2010). Thus the interpretive approach provides an opportunity to gain deep insight into the participant’s experiences with the researcher becoming the vehicle by which this reality is revealed (Cohen, et al 2010; Andrade, 2009; Neuman, 2009). According to Andrade (2009, p. 45) “interpretive research makes it possible to present the researcher’s own constructions as well as those of all the participants”. The sampled primary teachers’ point of view, their voices and thus their learning stories will therefore be central in this qualitative interpretive research study. Foregrounding the experiences of the teachers will enrich and enhance my description and interrogation of the nature of teacher learning within the primary maths professional development programme.

The qualitative interpretive approach involves prolonged fieldwork and employs a variety of field methods, with the three primary strategies for gathering data being participant observation, in-depth interviews and document collection in the context of a single study (Neuman, 2009; McMillan & Schumacher, 2001; Miles & Huberman, 1986; Best & Kahn, 2006). This study therefore gathered data across a two-year period of the programme, from March 2011 to December 2012, using the following strategies: interactive interviews/narrative interviews (Corbin & Morse, 2003, p. 339), participant observations, reflective journals and document collection and analysis. I elaborate on each of these in the next section.

Using different data collection strategies enhances both the internal validity of data through triangulation and the generalisability of the research findings by providing in-depth and rich data (Merriam, 2001; Cohen et al, 2010; McMillan & Schumacher, 2001). According to Connelly and Clandinin (1990), using different data sources also promotes different temporal orientations, with the data gathering strategies used in this study being located and emphasising on the past, present and the future. On the other hand interactive interviews and

reflective journals helped in bringing the voices of the teacher to the forefront of this study. This provides richness for the study and also enabled the voices of the teachers to be heard. The data gathered through participant observations, interactive interviews, document collection and journal entries alongside the theoretical framework; the research questions and pertinent literature illuminate the discussions in Chapter 8, 9 and 10. Overall the interpretive research methodology assists me to understand and describe as accurately and richly as possible the sampled NICLE teachers' experiences (Chapter 6 & 7) and how this impacts and affects primary maths teacher learning and identity formation (Chapter 8, 9 & 10). In doing so I will address the overarching and the three research questions that investigate the nature of primary maths teacher learning and how identities and practices evolve through participation in NICLE and also in relation to the broader context.

Three key reasons inform my choice of this research approach. Firstly the qualitative interpretive approach relates well with the sociocultural theory and the empirical field of research (that is NICLE's views on learning). Social learning theorists have used qualitative approaches and interpretive methods (such as ethnography, observations, diaries, interviews etc.) to explain how learning is perceived as participation in communities of practice (Lave, 1996; Wenger, 1998; Lave & Wenger, 1991; Lave et al, 1984). Thus my research methodology coheres with the theoretical framework informing this study and its perspective on learning, which concurs with Andrade (2009) and Neuman (2009) definitions of the interpretive approach that "knowledge and reality is gained only through social construction" (Andrade, 2009, p. 43) or that "reality is socially created" (Neuman, 2009, p. 108). Secondly, and following the participationists' research methods and the above quotations, the qualitative interpretive approach is considered the most suitable methodology to investigate the overarching research question which interrogates the *nature* of teacher *learning* within NICLE. Thirdly my use of the interpretive research methodology is also motivated by the Chair's perspective on primary maths teacher learning within NICLE, which is explained as "active participation of all members in the community" (Graven, 2011b, p. 3). In this regard the Chair's situated view of learning, the theoretical framework informing this study and the main research question has influenced my methodological choices. Thus I have used the qualitative interpretive approach because it resonates with the sociocultural theoretical framework, the learning design of the empirical field and the key research question underpinning this study.

In this study my unit of research analysis is the *'numeracy teacher in-NICLE'*. The *'numeracy teacher in-NICLE'* unit of analysis is informed by Lave's suggestion that in Communities of Practice "knowledge and learning will be found distributed throughout the complex structure of persons-acting-in-setting" (Lave, 1993a, p. 9). It incorporates Vygotsky's goal, that of "person-in-activity" which can be extended to "person-in-practice-in-person" or to "mind-in-society-in-mind" (Lerman, 2000, p. 38). Thus the study can also extend its unit of analysis to the *'numeracy teacher-in-NICLE-in-numeracy teacher'*. Secondly Miles and Huberman (1986, p. 25) definition of the unit of analysis as the "focus or heart of the study" also helped me in delineating the study's basic element of research. Thus the main focus of this study is on *'how primary maths teachers learn in relation to participation in NICLE'*. This unit of analysis is informed by the overarching research question underpinning the broader PhD study. Defining the unit of research analysis helps in delineating and determining the boundary of the case and what will not be studied (Miles & Huberman, 1986). Both Shulman and Shulman (2004) and Borko (2004), who have studied teacher learning in communities of practice-informed contexts have simultaneously identified 'the individual teacher' and his or her learning on the one hand, and the 'group/community of teachers' on the other hand as their fundamental units of analysis. Similarly Wenger (1998, p. 146) explains that, "it is therefore a mistaken dichotomy to wonder whether the unit of analysis of identity should be the community or the person. The focus must be on the process of their mutual constitution". Borko (2004) and Shulman and Shulman (2004) went on to identify policy and context as other levels of analysis. Thus whilst the study's unit of research analysis will be the *'numeracy teacher-in-NICLE'* I will also investigate how national curriculum policies and other contextual factors enable or constrain teacher evolving identities and practices.

Having outlined the research methodology used in this study, below I discuss the research study sample. Thereafter I explain the four data collection strategies used to gather data and the kind of data collected through each of the methods.

5.4 Research study sample

The overall selection of the participating schools was done by the Chair, with advice from the district office. The selection criteria were that schools should be identified as 'functional' (which loosely implied schools with a timetable that had a maths slot in which classes were held during school time) (Graven, 2011a). Additionally schools or a significant portion of

learners in schools should be from previously disadvantaged backgrounds. These criteria are laid down by funders. Following a meeting with Principals on the 10th of February 2011, and visits to schools by the Chair, volunteering grade 3 and 4 (Foundation and Intermediate phase) teachers were invited to participate in NICLE's professional development exercise. By the second NICLE seminar 15 schools and 57 educators attended and committed themselves to regular participation in NICLE (SANC, 2011; Graven, 2011b). The four clusters of the NICLE participating schools are:

Grahamstown: urban/town area

Alexandria: small coastal town

Kenton (and Bathurst): coastal town and commercial farming area

Alicedale: small rural residential town

The use of criteria to identify the participating primary schools and teachers is characteristic of the purposive sampling strategy.

Within this sample of invited and willing teachers I used a combination of purposive and stratified sampling strategies to select 10 primary maths teachers who were part of this study. Two of these teachers withdrew from NICLE after 2011; Brenda transferred from Martindale to another farm school and could no longer attend NICLE, whilst Swallow only sporadically attended the NICLE 2012 sessions, citing increased administrative responsibilities. I did not have full data sets for these two teachers, and I thus chose to exclude them from the final study sample analysed here. I intentionally selected teachers who actively participated and frequently attended NICLE sessions and additionally those teachers who were willing to be part of this longitudinal research study. I thus purposively sampled the 8 teachers who form part of this study (McMillian & Schumacher, 2001). In my quest to have a relatively representative sample of the general population of primary maths teachers in South Africa, I used the stratified sampling method (Neuman, 2009). In this respect teachers in the sample are from four different types or categorisations of schools in the South African education system. Two are from a *Farm school*, called Martindale Primary, which has multi-grade classes; two are from an *African township school* – Bongani Primary; two are from historically *coloured schools* (Delta Primary and Delta Combined School) in a historically

coloured area, and two are from an *ex model C*²⁹ preparatory school, Heritage, in a formerly white area. From each school type I purposively selected the sampled 8 primary teachers. Whilst Heritage Preparatory is located in the Grahamstown urban area, Bongani Primary, Delta Primary and Delta High School are in a coastal village in the Alexandria cluster, which is 85 kilometres from Grahamstown, with Martindale located 80 kilometres from Grahamstown in a farming area in the Bathurst/Kenton district. All School and teacher names are pseudonyms.

I also chose my sample to be representative of a range of grades across NICLE teachers. In this sample therefore there are Grade R teachers, Grade 1 to 3 FP teachers, multigrade teachers and IP teachers. In this purposively-stratified sample of teachers, two are intermediate phase male teachers, (Calvin and Robert), with the former only teaching Grades 5 and 6 maths classes at his school at which he is the deputy principal, whilst the latter teaches Grade 4 to 7 mathematics, Grade 6 and 7 technology and grade 7 English. One of the participants is an all-subjects multi-grade teacher of grades 4-5 (Everton). Of the five FP teachers, two are Grade R teachers (Mary and Edna) with the other three teachers teaching Grade 3 classes (Ruth, Melania & Pamela). Notably all the foundation phase teachers in the sample are female. This is also the case for the larger group of NICLE teachers - that is, all Foundation Phase teachers in NICLE are female, while there are 5 male NICLE teachers, all of whom teach in the Intermediate Phase. For this reason my sample has more female than male teachers.

The sampled teachers were invited to participate in my research, after I explained that participation was voluntary and could be terminated at any time. I also explained the nature of my research and what would be involved. The letter inviting the sampled teachers to voluntarily participate in this research is included in Appendix 2. The table below provides background information on the teachers, as captured at the end of 2012. Pseudonyms have been used.

²⁹ Former model C schools are public schools that were reserved for whites during apartheid.

School Name & Type	Teacher Pseudonym	Gender/ Age range	Phase/Grade (subject/s) taught & School position	Teaching years experience	Qualifications
Martindale - Farm school with some multigrade classes	Everton	F/51-60	IP – 4 & 5	16	B. Ed. (Secondary)
	Mary*	F/31-40	FP - 0	6	Matric Final Year - National Primary Diploma in Education
Heritage - Preparatory public school (Ex-model C) in a historically white middle class suburb	Ruth	F/51-60	FP - 3	27	B. Ed. (Honours)
	Melania	F/41-50	FP - 3	11	Higher Diploma in Education
Bongani - Historically African school in a historically black township	Calvin	M/41-50	IP – 5 & 6 (maths) <i>Deputy Principal</i>	25	B. Ed. Maths
	Pamela	F/41-50	FP - 3	17	Further Diploma in Education
Delta High - Historically coloured Combined school in a historically coloured area	Edna	F/31-40	FP - 0	6	Matric Final Year - National Primary Diploma in Education
Delta Primary - Historically coloured primary school in a historically coloured area	Robert	M/41-50	IP – 4-7 (Maths), 6-7 (technology), 7 (English)	19	B.Ed. Honours in Maths Education Currently studying for a Masters in Maths Education

Table 5.1: Sample Teachers' background information

*Mary transferred at the beginning of the third term in July 2012 from Martindale to Port Albert School, which is a former model C combined school and continued to teach a Grade R class.

The range and diversity of the sampled teacher group assists in providing breadth to exploring the processes through which primary maths teacher identities evolve in relation to the grade(s) taught or phase specialisation, thus helping to illuminate the first research question.

5.5 Data Collection Methods

5.5.1 Observation

Observation is a data collection strategy on which qualitative interpretive research heavily depends (Andrade, 2009; Merriam, 2001; Cohen et al, 2010; Neuman, 2009), and was a primary data collection method in this study. Observations consist of detailed notation of behaviour, events and interactions and the contexts surrounding these (Best & Kahn, 2006; Cohen et al, 2010; Miles & Huberman, 1986). During data collection in the empirical field my observations focused mainly on the events and interactions in NICLE. Observations, fieldwork notes and document collection allows me to describe and analyse NICLE sessions, and the projected PMTI in chapter 6. Analysing the NICLE sessions' activities in which teachers engaged helps to understand the nature of primary maths teacher learning within NICLE and activities, relations and forms of participation within the CoP which enable or constrain teacher maths identities and practices, thus gathering data to answer the key and the 2nd research questions to this study.

Both McMillan and Schumacher (2001) and Bell (1989) agree that observations reveal characteristics and elicit data that is nearly impossible to gather with other means or approaches. Thus observational data represent a first-hand encounter with the phenomenon under study 'in situ', which affords the investigator the opportunity to gather 'live' data from naturally occurring social situations (Cohen et al, 2010, p. 397; Merriam, 2001). Observations thus enabled me to gather data concerning the nature of NICLE sessions and forms of participation in activities - information which I could not collect through document collection. The observations also provided me with the opportunity to collect first-hand data on the interactions and mathematical activities of the *teachers-in-NICLE* within the natural empirical site of research. My 2 years of observations within NICLE also helped me as researcher to be familiar, aware and "internalise the basic beliefs, fears, hopes and expectations of the people under study" (Fetterman, 1997, p. 480).

As explained earlier, my observation was as a participant observer, what both Merriam (2001, p. 101) and Cohen et al (2010, p. 404) call "Participant-as-observer". This for me entailed being actively involved in NICLE's primary maths teacher activities and documenting and recording NICLE sessions. My participation in the NICLE activities involved working mathematical problems and tasks and finding solutions together with the NICLE participants with whom I would randomly sit with. As a Participant observer I also compiled notes of the

observational accounts in my field work notebook. I compiled field work notes from 26 March 2010 to 9 October 2012 across 26 sessions. Furthermore I recorded several NICLE sessions using an audio-recorder which enabled revisiting data and refining field notes where relevant.

5.5.2 Document collection and analysis

One of the four methods I used for data gathering was document collection. Document collection is a valuable alternative source of data used to supplement information obtained (Bell, 1989). According to McMillan and Schumacher (2001), document collection provides an internal perspective as well as the values of the organisation (the NICLE community in this case). During the research study I gathered and analysed both local primary documents and national official documents. Local primary documents are those that come into existence during the period of the project under research (Bell, 1989). In my case these included documents and reports compiled by the Chair and NICLE hand-outs given to teachers. The SANC documents and reports analysis helps in identifying the promoted and projected NICLE numeracy teacher identity. I also analysed national government official curriculum policy documents (see Chapter 2) to investigate the officially sanctioned and projected version of the South African primary maths teacher identity (Tyler, 1999, Bernstein & Solomon, 1999). The collected NICLE hand-outs help in describing the key NICLE activities and the promoted PMTI which are analysed in the following chapter.

5.5.3 Interactive Interviewing

The third data collection technique I employed is interactive interviews, sometimes referred to as narrative interviews, used in qualitative interactive studies (Corbin & Morse, 2003; Connelly & Clandinin, 1990; Cohen et al, 2010; Neuman, 2009; Miles & Huberman, 1986). Narrative interviews are mainly used in narrative inquiry research and focus on the participant's lived experience (Connelly & Clandinin, 1990; Clandinin & Connelly, 1994). Generally interviews have been used as a research tool for eliciting specific information from the respondent that allows the interviewer to access the perspective of the person being interviewed (Neuman, 2009; Best & Kahn, 2006). However interviews can give prominence to the Interviewer who can dominate the interview process and silence the voice of the interviewee. Interactive interviews reverse such hierarchical interviewing relations, with participants retaining considerable control over the course of the interview, thus giving them the time and space to tell their story (Corbin & Morse, 2003; Connelly & Clandinin, 1990).

Interactive interviews are defined as “shared experiences in which researchers and interviewees come together to create a context of conversational intimacy in which participants feel comfortable telling their story” (Corbin & Morse, 2003, p. 338). I used interactive interviews so as to afford and privilege the teachers’ voices in the research and to reduce my influence over the interviewing process. Key also for this study is the fact that (interactive) interviews also allow the sampled primary teachers to tell their (maths) learning stories as they see, feel and experience them (Corbin & Morse, 2003; Connelly & Clandinin, 1990; Clandinin & Connelly, 1994). As the teachers told their learning stories, I gleaned information about the changes in the teachers’ maths teaching identity stories (Sfard & Prusak, 2005), their learning trajectories (Wenger, 1998) and how they learn in NICLE (that is their *telos* – Lave, 1996), and what they enlist as enabling or hindering their learning in NICLE and in the broader educational context. Thus the sampled primary maths teachers’ learning stories together with the above-mentioned sociocultural theoretical elements illustrates my creation of the term ‘stelos’, which I define as teacher learning stories. This enables the study to address mainly the overarching question and the other research questions underpinning this study. The teacher learning stories (stelos) from the narrative interviews also provide the study with key data that will be discussed in chapter 8, 9 and 10.

For the interactive interviews I used semi-structured schedules with open-ended questions to enable interview conversations, and in the process hear the learning stories of the selected teachers. Both the first (2011) and second (2012) interactive interviews with the 8 sampled primary maths teachers were carried out at the end of each year (November and December), with the average time for each interview being 1 hour. Thus the 8 sampled teachers were each interviewed twice during the two year period of my data gathering. To elicit key issues raised by the teachers in the interactive interviews, I designed participant-specific questions which were prepared for particular participants. The 2011 and 2012 interactive interview schedules are available in Appendix 1.

While the topics, issues and questions discussed were selected in advance through a semi-structured interview schedule, I always gave room for the participants to narrate what they felt important and relevant both to the study and their learning stories. All the questions in the interactive interview schedules, including the participant-specific questions, were worded in an open-ended format (Best & Kahn, 2006). Open-ended items suit interactive interviews as they encourage co-operation, help establish rapport, and give opportunities for participants to construct their stories (Cohen et al, 2010, Corbin & Morse, 2003). All the interviews were

conducted at the respondents' schools and were audio-recorded and fully transcribed for analysis.

5.5.4 Reflective Journals

The study also used teacher reflective journals as a way of strengthening the teachers' voices in the research. Reflective journals have been commonly used in psychotherapy and in the broader medical and health field and are gaining popularity in educational research (Chirema, 2006; Connelly & Clandinin, 1990). To differentiate educational research reflective journals from personal diaries I explained and gave guidelines to each of the 8 sampled NICLE participating teachers. I explained that their thoughts and feelings should be centred on topics related to key research questions posed by this study. A copy of the *Reflective Journal Guidelines* given to each teacher is given in Appendix 3. In the Reflective Journals the teachers were encouraged to reflect deeply and write their opinions, feelings and experiences in NICLE, in their primary maths classrooms, in maths departments, in schools and in overlapping communities of practice related to how they learn as teachers and how their primary maths professional identity and practices evolve within such contexts. Clandinin and Connelly (1994, p. 421) explain that journal writing is a "powerful way for individuals to give accounts of their experience". Furthermore Chirema (2006) and Cunliffe (2004) explain that journal writing is a useful tool for promoting critical reflection of experiences. It is a means by which teachers engage in learning, and allows them to discuss the link between theory and practice. Through this they explore new possibilities for being and acting.

I gave the 8 sampled teachers journals in the form of a special bound notebook in November 2011. I collected the copies of the journals in February 2013. The study thus focuses on journal entries made between November 2011 and December 2012, which marked the end of my data collection period for this research. However in some of the journal entries teachers reflected on NICLE events that happened before November 2011. The extent, frequency, depth of engagement and style of journal writing differed across the sampled participants.

An analysis of the teachers' journal entries reveals that most of the teachers wrote about NICLE activities and materials that they took up and used in their classes. Edna, Pamela, Melania, Mary and Calvin included journal writings about participating in overlapping mathematics communities of practice such as the AMESA regional conference, in further studies, in Steve's maths magic shows, in the Science-festival show, during the Maths Fun

day, and the desire to form maths teacher clusters. Such information informs the discussions in Chapter 8 and 9 and assists in addressing the 1st and 2nd research questions. It is interesting to note that both Pamela and Mary additionally wrote about their mathematical fears which illuminate the findings in Chapter 8 concerning the nature of learning of primary teachers with initially negatively valued maths identities being ‘remediated’ through participation.

Generally the journals entries are key for strengthening, enriching and triangulating the data gathered through the other three collection strategies, (participant observations, interactive interviews and document collection). This serves to improve both the internal validity of data through triangulation and the external validity of the research findings by providing rich thick descriptions which enhances the reliability of the study. Whilst I have provided a brief summary of the journal entries above, the direct quoting of the participants’ journal entries will be done in the data analysis chapters 8, 9 and 10.

5.6 Ethical Considerations

Ethical issues in research concern beliefs about what is wrong and what is right from a moral perspective in the conduct of research (McMillan & Schumacher, 2001). Research ethics imply compliance with acceptable research norms, morals, standards and principles. To comply with the University’s research ethics codes, guidelines, protocols and practices, my PhD research proposal, with ethical deliberations, was presented on 15 June 2011 and approved by the Education Higher Degrees Committee in July 2011. This research linked to the SANCP, applied for ethical clearance with the Eastern Cape Provincial Education office and this was granted in 2011. A copy of the ethical clearance and authorisation to conduct research is attached (see Appendix 4). Before entry into the sampled primary schools to interview teachers I sought permission from the School heads to carry out my research. I also ensured that the research participants selected the most convenient time and place at their schools from which to carry out the interviews.

In line with the principle of ‘informed consent’ I explained honestly and openly to all participants the nature, aims, purpose and intended educational benefits of my study. I further indicated that participation in the research was voluntary, and that participants could withdraw from the study at any time without prejudice. To indicate their willingness to participate in the study, the teacher participants signed the Participant Information and Informed Consent forms. Copies of these documents are available in Appendix 2. In these forms I explained my research relationship with the SANC project and the data collection

methods I planned to use. I explained how the participants would assist in the study's data-gathering exercise through being interviewed and journaling. As a token of my appreciation I provided participating teachers with a small gift voucher at the end of each year.

To ensure confidentiality, names of the participants and their school names have been changed. These remain anonymous and will not appear in any publications arising from this study. However I do not rule out the possibility of some of the NICLE teachers being able to recognise the sampled individuals in this report. The nature of the data however, in my opinion, doesn't put any of the participants at risk, nor does it cause tension within the group. However, as noted by McMillan and Schumacher (2001), I have the responsibility of ensuring the protection of the participants from the general reading public. It is for this reason that this study has protected the names of the participants by using pseudonyms. I have however used the first names of facilitators and guest speakers who presented sessions in NICLE since these were listed in NICLE documentation and the website.

The research data gathered in this study are appropriately stored under lock and key. Such confidentiality initiatives and data storage measures are in the interest of ensuring and protecting the privacy and anonymity of participants. McMillan and Schumacher (2001) and Neuman (2009) agree that guaranteeing privacy, anonymity and confidentiality means that access to participants' responses, behaviour and information is restricted to the researcher and kept secret from the public. I have thus made all the necessary effort and commitments to ensure both the informants' privacy and research ethics principles during the fieldwork and in the compilation of this thesis.

5.7 Validity and Reliability of data

This research employed multiple strategies to ensure and enhance the internal validity and reliability of data. Reliability connects with internal validity, which is concerned with the accuracy of the research findings and how they match reality (Best & Kahn, 2006; Merriam, 2001). This study employed various strategies to enhance the truth value or trustworthiness of the research findings (Miles & Huberman, 1986; Merriam, 2001). Participant observation and fieldwork research within NICLE lasted for 21 months from March 2011 to November 2012. Such prolonged engagement, that also entails persistent observation in the field, supports the validity of findings (Cohen et al, 2010; McMillan & Schumacher, 2001). Furthermore according to McMillan and Schumacher (2001) the use of mechanically recorded data such as

audio recordings also enhanced the validity and reliability of the research findings. All the teacher interactive interviews were transcribed and I thoroughly revised all the transcriptions cross-checking the interview transcripts.

Additionally, as discussed above, triangulation allowed me to compare and cross-check data from participant observations, interactive interviews, collected documents and reflective journals. The study thus employed both multimethod strategies (methodological triangulation) and multiple sources of data (data triangulation) to confirm the emerging findings and to triangulate data across inquiry techniques (Merriam, 2001; McMillan & Schumacher, 2001; Cohen et al, 2010). In NICLE my supervisor also observed and independently collected data within the Community of Practice-Inquiry setting, some of which has been used to compile reports (Graven & Schaffer, 2011) and the Discussion documents for the Annual Community of practice forum (SANC, 2011; SANC, 2012; SANC, 2013). I have also compared notes and checked for agreements and disagreements between the Chair's documents and my empirical findings. This allows for "agreement on descriptive data collected by the research team" (McMillan & Schumacher, 2001, p. 408), which in this case happens to be the Chair and myself.

Another way that I used to ensure information dependability was through participant reviews/member checks or respondent validation (McMillan & Schumacher, 2001; Merriam, 2001), under which the sampled primary maths teachers reviewed, checked and signed their interactive interview transcriptions. So as to provide readers with the opportunity to assess the validity of my interpretation of data, I have used direct quotes. Verbatim accounts or direct quotations enhance data corroboration and helps the study to provide a rich thick description of events and to illustrate participant's experiences and meaning (McMillan & Schumacher, 2001) within NICLE. This resonates with the qualitative educational interpretive methodology.

Another important dimension for achieving validity and reliability is through reducing bias in reporting the empirical findings. I have endeavoured as much as possible to be neutral in the collection of data and in reporting, discussing and analysing my findings in the five following chapters. Critical reflection on NICLE is valued by the Chair and seen as an essential part of on-going improvement. Thus the Chair conducts end-of-year teacher evaluations, where teachers are encouraged to critique NICLE. Such feedback is analysed and changes are made. So for example in year three, the programme shifted time slots to full days based on teachers'

input of time constraints, rushed sessions and being tired after school. A welcoming stance to critique has enabled my analysis of NICLE sessions and thus I did not feel constrained in what I was able to write and say about my observations.

All the above strategies were continuously used during the data-gathering and data analysis exercises to support validity and reliability of data analysis.

5.8 Data Analysis

The four research questions, Communities of Practice and social-cultural theoretical elements (discussed in Chapter 3) and Bernstein and Tyler's pedagogic identity model generated four positions (explained in Chapter 2) are key to structuring the analysis of data and the presentations of my findings in Chapter 8, 9 and 10. LeCompte (2000, p. 152) states that "analysis that is meticulously done, based on clearly articulated theories, and responsive to research questions can be good analysis." Also central to my interpretation of the empirical data is key literature that informs this study. Thus a deductive data analysis approach that is research questions-informed and theory-driven is used to synthesise, interpret and make sense of the extensive amounts of data obtained from NICLE-participant observations, fieldwork notes, document collection, interactive interviews and teacher reflective journals. This method involved coding, categorising (grouping) and interpreting empirical data through provisionally preconceived categories (Bell, 1989; McMillan & Schumacher, 2001; Miles & Huberman, 1986). In this study the preconceived categories used to guide analysis of data and presentation of my research findings are the four research questions and the theoretical framework components and positions. This results in patterns of meanings emerging, and these are related to the conceptual framework selected for the inquiry and the research questions. Besides providing analytical tools, the sociocultural theoretical elements also provide a language to describe and explain how primary maths teachers learn and how their practices and identities change in relation to engaging in NICLE. A deductive approach is used for developing and refining the socio-cultural approach theoretical elements used in this study and to illuminate how teachers learn and how their identities and practices evolve in relation to participation in NICLE.

Using the deductive data analysis strategy my discussion in Chapter 8 is structured to interrogate the overarching and the 1st research questions, Chapter 9 investigates the 2nd research question and Chapter 10 addresses the 3rd research question. The discussion in Chapter 8 is guided by Lave's notion of *telos* and Sfard and Prusak's (2005) identity-as-story

construct (reframed *telos*) to illuminate the overarching research which investigates ‘the nature of teacher learning within NICLE’. Also to structure the discussion in Chapter 8 and address the 1st research question on how primary maths teacher identities evolve, and the process of this evolution, I use Wenger’s (1998) characterisations of identity as *nexus of multimembership* and as a ‘learning trajectory’ and the component of ‘*imagination*’. To assist in organising gathered data on activities, relations and forms of participation within NICLE and how these enable or constrain evolving primary maths identities and practices the discussion in Chapter 9 is illuminated by Wenger et al’s (2002) structural elements of a CoP and Wenger’s (1998) theoretical component of *engagement*. Bernstein’s pedagogic identity model (Bernstein, 2000; Tyler, 1999) and Wenger’s (1998) notion of *alignment* helps address the 3rd research question - on how teacher evolving identities and practices relate to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP and illustrates the discussion in Chapter 10.

Whilst the outlined theoretical framework elements guide the organisation and presentation of data, the study does not ignore emerging themes from the teachers’ learning stories. This consequently resulted in modified and revised categories (Neuman, 2009; LeCompte, 2000) which more appropriately fit the gathered evidence and from which new patterns of meaning emerged that are informed but not restricted by the research questions and the theoretical framework. Such structuring and presentation of information pays attention to the teachers’ voices and key emerging themes arising from the empirical data and relates with the study’s unit of analysis which is the ‘numeracy teacher-in-NICLE’. Furthermore such data analysis strategies provide the study with rich thick descriptions on how teachers learn and how their primary maths identities and practices evolve and what enables or constrains such evolution illuminated by the theoretical elements. The table below illustrates how data was analysed and how information was organised and presented in the discussion chapters.

Chapters	Research question (RQ) addressed	Theoretical elements used in data analysis	Main sources of data used
Ch8	Main RQ - what is the nature of primary maths teacher learning within an in-service CoP	Lave's (1996) notion of <i>telos</i> Sfard & Prusak's (2005) identity-as-story construct	Interactive interviews Journal entries
	RQ 1 - How do primary maths teachers professional identities evolve in relation to participation in an in-service community of practice-inquiry (as well as in other overlapping communities of practice)? What are the processes through which primary maths teacher identities evolve?	Wenger's (1998) characterisations of identity as <i>nexus of multimembership</i> , as a 'learning trajectory' and the component of ' <i>imagination</i> '	Interactive interviews Journal entries
Ch9	RQ 2 - What activities, relations and forms of participation within the Community of Practice enable or constrain evolving teacher maths identities and practices? How do these enable or constrain?	Wenger et al's (2002) three fundamental elements of a CoP Wenger's (1998) concept of ' <i>engagement</i> '	Interactive interviews Journal entries Document collection (NICLE hand-outs) Observation fieldwork notes
Ch10	RQ 3 - How do these teacher evolving identities and practices relate or align to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP.	Bernstein's pedagogic identity model (Bernstein, 2000; Tyler, 1999) Wenger's (1998) notion of ' <i>alignment</i> '	Interactive interviews Journal entries Document collection (official documents)

Table 5.2: Data analysis and structuring of analysis thesis chapters

5.9 Generalisability, Relatability and Generativity

Generalisability is a contentious and problematic issue in qualitative interpretive research, with many qualitative researchers being unconcerned about it, yet it is critical in quantitative research. However it is important that researchers and readers are aware of this aspect and at times determine for themselves whether generalisability is possible (Cohen et al, 2010; Best & Kahn, 2006). The issue of generalisability is closely connected to the notion of external validity, which is concerned with the extent to which findings of one study can be related to other settings (Best & Kahn, 2006; McMillan & Schumacher, 2001). Generalisability is faced with the problems of representativeness, transferability and comparability, that is, how can we replicate the study and its findings, or are the study's findings typical of other population groups, cases or situations? (Bell, 1989; Best & Kahn, 2006; McMillan & Schumacher, 2001).

This study, which investigates the nature of teacher learning within a community of practice-based teacher professional development initiative, also faces the challenges of generalisability. That is, how can its findings be connected to other population groups? In the discussion and conclusion chapters I explain how some of the findings of this study can be related to teacher learning communities, for primary maths teachers and the socio-cultural theory. The diversity of my sampling to include FP and IP teachers, female and male, and across four different types of schools encourages broader applicability (Miles & Huberman, 1986). However Merriam (2001) and Cohen et al, (2010) argue that the onus of the relatability and generalisability of the study's findings rests with the readers and users of the research. I also agree, though to a certain extent with this assertion.

Closely related to relatability and generalisability and emerging more often as important in qualitative research is the notion of generativity. This aspect concern the extent to which a research's findings can generate further research questions and provide explanatory models for a research topic (Graven, 2002a). Thus the findings of this study are generative of rich insights into the ways in which primary maths teachers learn. It also informs and stimulates debate in exploring alternative in-service primary maths teacher education models in South Africa. In Chapter 11 I discuss how the findings of this study can be generative, connected and generalised in primary maths teacher education.

5.10 In summary

This chapter discussed how the empirical field of study (NICLE) was conceptualised and described the research study sample. The study has drawn from a qualitative educational interpretive research approach which combines both qualitative and interpretive methodologies, to gather in-depth and detailed data within the educational empirical field. This data forms the basis of the next chapters which investigate how primary maths teachers learn, how their identities and practices evolve in relation to participation in NICLE, and what enables or constrains such learning. The study employed participant observations (and fieldwork notes), interactive interviews, document analysis and reflective journals as the primary data collection strategies. These data gathering methods enable describing and analysing, in Chapter 6, the NICLE CoP, and the promoted primary maths teacher identity. Additionally they enable presenting teacher learning stories in Chapter 7 and allow me to address the research questions in the Chapters 8 to 10 that follow.

Finally, this chapter explored research methodological issues concerning ethics, validity and reliability, data analysis and the generalisability, reliability and generativity of the study.

Chapter 6: Describing and analysing the NICLE Community of Practice and its promoted Primary Maths Teacher Identity

6.1 Introduction

Since NICLE provides the empirical field of this research I discuss four purposively selected NICLE sessions presented by mathematics education specialist guest speakers. In addition I provide two constructed session vignettes combined from eight NICLE presentations by the Chair and/or staff in the Chair. These NICLE sessions describe and illuminate the nature of activities that teachers engaged in across the two-year period of the study. These sessions and compilations of sessions are reconstructed from data obtained from NICLE audio-recordings, fieldwork observational notes and hand-out documents given to participating teachers.

I intentionally selected to describe activities in these four NICLE presentations and in the two Chair team compilations of sessions because during the interviews the sampled primary maths teachers particularly pointed to having taken-up what they learned in these sessions into their maths teaching practice. I have also purposively chosen sessions from across the 2-year period and across different speakers and topics to give breadth to the description. The NICLE sessions in this chapter highlight key aspects pointing to the promotion of particular types of primary maths teacher identities.

6.2 The NICLE Community of Practice and sessions

As described in the previous chapter, the primary maths in-service teacher education professional development programme, called the Numeracy Inquiry Community of Leader Educator (NICLE), forms the empirical field of research to this study. The numeracy teacher development programme, by its intention, is explicitly designed and conceptualised as both a Community of Practice and a Community of Inquiry teacher development approach. It is framed by Wenger's Communities of Practice perspective (Wenger, 1998, Lave & Wenger, 1991) and by Jaworski's (2005, 2006) concept of mathematics Communities of Inquiry (Graven & Schafer, 2011). In relation to the concept of identity, NICLE focuses on strengthening numeracy/mathematical professional teacher identities with the inclusion of intermediate phase teachers who mainly teach mathematics, helping to foreground opportunities for the evolution of mathematical identities for the community as a whole

(SANC, 2011; SANC, 2012). NICLE also aims at providing leadership in the field of numeracy education by creating opportunities for the development of *life-long learners* who actively participate in on-going inquiry (SANC, 2011). It also aims to support teachers to be *leader educators* and *workshop presenters* (Graven, 2010; SANC, 2011).

Table 6.1 below shows the range of NICLE sessions presented in 2011 and 2012. Most of the NICLE sessions were presented in venues at the Rhodes University's Department of education. The sessions were presented by a combination of guest speakers, several key partners, primary maths education specialists and sessions run mostly by the Chair (Mellony) and the NICLE Teacher development co-ordinator (TDC) – (Zonia) and a full time project team member, (Debbie). Archived session outlines and hand-outs are available on the SANC website: www.ru.ac.za/sanc/ across sessions from 2011 to date. In 2011 the sessions lasted for 2 hours and were held from 3pm to 5pm (followed by snacks) and this increased to 2 hours 30 minutes in 2012, with sessions starting 30 minutes earlier. Teachers' transport costs to NICLE sessions were reimbursed. The table shows that in each year about half the sessions were presented by SANC project team members and half by invited guests.

I have chosen to refer to all presenters only by their first names throughout this study. While the presenters are listed publicly on the Chair website only using their first names for this study fits well with the ethos of NICLE where participants engaged on a first name basis and teachers mostly refer to presenters using their first name.

Session	Date	Topic	Presenter(s)
1	Sat 26 March	Orientation - Motivation	Diane (Maths Education specialist) & SANC team
2	Tues 12 April	Sense-making	Aarnout (Maths Education specialist)
3	Tues 10 May	Alphabet maths/Baseline Assessment	Mellony/Zonia (SANCP)
4	Tues 24 May	Classroom Culture – D. Ball Videos	Mellony/Zonia (SANCP)
5	Tues 7 June	Mental calculation strategies	Tom (Maths teacher educator)
6	Tues 21 June	Mental calculation strategies	Tom (Maths teacher educator)
7	Tues 19 July	IT – Websites & material development	Debbie (SANCP)
8	Tues 16 Aug	Zero Concept	Zonia (SANCP)
9	Tues 30 Aug	Patterns, Functions & Algebra	Zonia/Mellony (SANCP)
10	Tues 13 Sept	“Number Sense” Book Series	Aarnout (Maths Education specialist)
11	Tues 27 Sept	Singapore Maths	Bev (Teacher & Rhodes Masters student)
12	Tues 11 Oct	Melania’s flard card demo lesson & Place Value in the curriculum (RNCS/CAPS)	Melania; Zonia/Mellony (SANCP)
13	Tues 25 Oct	NICLE Pair Maths Challenge	Mellony/Zonia (SANCP)
14	Tues 15 Nov	Closing Session & End-of-year Celebration (17h00-19h00)	Mellony (SANCP)

Table 6.1: NICLE 2011 Sessions

Session	Date	Topic	Presenter(s)
1	Tues 28 Feb	Orientation, reflection on 2011	Mellony/Debbie (SANCP)
2	Tues 13 Mar	Homework Drive	Mellony/Debbie (SANCP)
3	Tues 24 Apr	Resource selection & Dice and Card games for numeracy fluency	Mellony/Debbie (SANCP)
4	Tues 08 May	Exploring Fractions	Lisa (FP maths teacher educator)
5	Tues 22 May	Exploring Fractions	Lisa (FP maths teacher educator)
6	Tues 05 Jun	Number lines	Lisa (FP maths teacher educator)
7	Tues 19 Jun	Emotional Literacy	Lisa B (Educational Psychologist)
8	Tues 24 Jul	Resources Hand-out & Grade 4 Maths Challenge Relay	Mellony/Debbie (SANCP)
9	Tues 07 Aug	Practical Demonstration lesson and Lesson Planning	Glynnis (FP Teacher & part-time lecturer)
10	Tues 21 Aug	Dice and Card Maths Games	Mellony/Debbie (SANCP)
11	Tues 04 Sept	Using Language as a resource in a multi- lingual mathematics classes and problem solving using RUCSAC	Lyn (Maths Education Specialist)
12	Tues 09 Oct	Making Maths Fun and Magical	Steve (Managing Director of Living Maths)
13	Tues 11 Nov	End of Year Celebration with Guest speaker	SANCP & Di (Education Specialist)

Table 6.2: NICLE 2012 Sessions

The tables show a combination of topics exploring primary maths content and developing teachers' pedagogic content knowledge or their practices. In terms of numeracy content NICLE prioritised: number sense, including focusing and promoting sense making, mental mathematics fluency, efficient strategies, mathematical progression, problem solving, using conceptual key resources, language practices (and multilingualism) as a resource for teaching and learning, homework practices and second sites of learning (see figure 6.3 below). In relation to primary maths teaching, NICLE promoted teacher practices that encourage active learning and learner-driven mathematical exploration that develops learners' productive

disposition (SANC, 2011; SANC, 2012). The 2013 Communities of practice slides from the Chair’s PowerPoint presentation illustrates NICLE priorities across the sessions as follows:

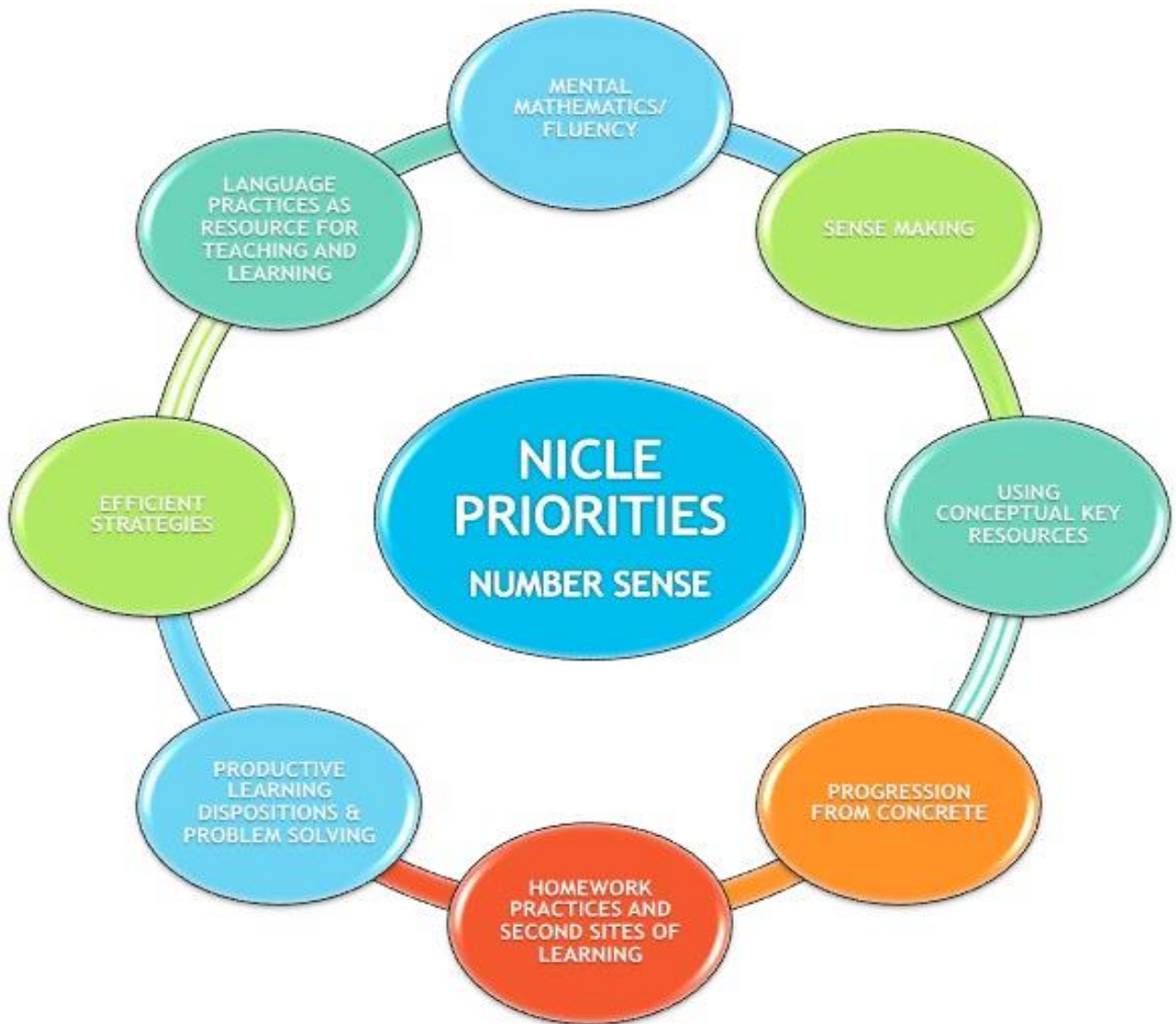


Figure 6.3: SANCP, 2013 NICLE priorities slide

6.2.1 NICLE 2011-2012 sessions and compilations of sessions

Below I discuss four NICLE sessions presented by Aarnout, Tom, Lyn and Lisa in 2011 and 2012. I also present two compilations of the SANC team presentations across 2011 and 2012 NICLE sessions. All the 2011 NICLE sessions are reconstructed from fieldwork, observational notes and teacher hand-outs, whilst the 2012 NICLE sessions are additionally constructed from audio-recordings. Of the 2012 NICLE sessions the only exception is Lyn’s presentation. Since I was unavailable during her session I reconstructed it with the help of

information provided by one of the sampled teachers, Calvin, who attended this session and also from the video, power point presentation slides and materials given to me by Lyn.

In describing each NICLE session I have focused on the key themes foregrounded in each presentation and linked these with NICLE's priorities and the NICLE promoted teacher identity. The key themes in each presentation are derived from the main primary maths concepts and issues highlighted by each presenter or presenters. The discussed NICLE sessions prefaces and contextualises the type of PMTI envisaged in NICLE. The discussed NICLE presentations will thus be analysed across sessions to explain the type of primary maths teacher identity promoted and projected in NICLE.

6.2.1.1 Aarnout's NICLE session – Tuesday 12 April 2011

Foregrounding sense making

Mellony introduced Aarnout, who is the founder and head of Brombacher & Associates, a consultancy in the field of mathematics education. Aarnout is a renowned primary maths specialist whose work focuses on teacher training and development, material development and research.

Aarnout started the session, emphasising that mathematics “is a sense-making activity” (Fieldwork notes, 12 April 2011). Aarnout went on to show a video clip of a learner who was incorrectly solving maths problems. In the video the learner had correctly solved addition sums that did not need carrying over, for example $15 + 31$, but when given a subtraction problem he continued to add, at times incorrectly, and could not correctly perform addition problems that needed carrying over. Thus the learners wrote:

47	45
<u>-25</u>	<u>+37</u>
612	712

Aarnout emphasised that mathematics needed a community of people who reflect on and ask “Why is the child doing this?” According to Aarnout the videoed learner showed a lack of number-sense and sense-making. He argued that in the new maths ‘reform’, there was need to emphasise ‘sense-making’ and problem-solving which ‘liberates’ learners, as opposed to the traditional procedural approach which prioritised the memorisation of facts, rules and formulas which ‘damage’ learners (Fieldwork notes, 12 April 2011). To re-emphasise this point Aarnout went on to quote Guy Brousseau (1984) who said “the more we drill them the less they think”.

During the session the presenter also remarked that teachers must desist from teaching mathematics in a procedural manner but must promote all of Kilpatrick et al's (2001) five strands of mathematical proficiency, thus enabling learners to think mathematically. He also highlighted the need for primary maths teachers to move from the concrete to the abstract

through gradual sophistication and compression. Aarnout also outlined that it is critical in maths classes for learners to discuss and explain what they are doing and how they got solutions to mathematical problems. Lastly the presenter encouraged particularly Grade 1 and 2 teachers to focus and work with small groups on the mat as opposed to whole class teaching.

The session included a range of activities for teachers to engage with and respond to including working with flard cards (place value cards). In the following NICLE session teachers were given multiple sets of cards for use in their classrooms.

6.2.1.2 Tom’s NICLE session – Tuesday 07 June 2011

Focus: Mental maths efficient strategies and number sense

Mellony introduced Tom as a well experienced, committed and passionate maths teacher educator from Rhodes University’s Maths Education Programme (RUMEP). Tom’s organisation, RUMEP, is one of the key partners of the Chair (SANC, 2011). Tom encouraged teachers to have 10-15 minutes of mental maths daily in their classes (as is recommended in CAPS) and emphasised that educators must “focus on the thinking process of how to reach an answer” as this improves the learners’ number-sense (NICLE hand-outs, 7 June 2011). Tom asked the answer to $25 + 16$, and many teachers immediately shouted out the correct answer to this sum. Tom explained that the teachers got the solution to this problem so quickly because they were familiar with number facts, in the same way the learners also needed to have computational fluency and number-sense. Tom emphasised that the development of number sense and the rapid recall with understanding of known number facts like bonds and multiplication tables is enabled through mental mathematics (NICLE hand-outs, 7 June 2011).

Tom encouraged teachers to use flash cards to promote mental arithmetic as this assists learners to know their ‘number bonds’. He explained and demonstrated (through mock lesson activities) that flash cards help learners to improve their calculating strategies, problem solving and encourages classroom interaction and communication. When using flash cards Tom emphasised the need for teachers to ask the learners their thinking processes and explain how they got solutions to any given mental maths problem. He also expounded that after reading a maths problem, teachers must give the learners adequate “thinking time” to allow them to mentally work out a sum. He suggested a system where those learners who quickly get an answer put their thumbs up against their chest rather than raise their hands which is distracting to other learners. Tom went on to do several mental maths activities using flash cards (Fieldwork notes, 07 June 2011).

Tom also introduced the teachers to ‘Rapping mental maths’ which is a rap music activity for learners to practice multiplication. During this activity, for example, Tom rhythmically asked the teachers “who has the answer to $7 \times 7!$ ” and the teacher with card number 49 would respond “I have the answer – it’s 49, who has...” (NICLE hand-outs, 7 June 2011). After several rap maths music activities he gave the teachers “Rapping mental maths” sheets and encouraged the teachers to go and practice this mental maths multiplication technique with

their learners. Tom recapped the presentation re-emphasising the importance of mental maths in ensuring computational fluency and that learners do accurate, efficient and flexible calculations.

6.2.1.3 SANC project's 2011 compilation of NICLE sessions³⁰

Mellony and Zonia, outlined that they had analysed the needs and expectations of the teachers, and these would inform future NICLE presentations. Mellony remarked that she had funding for primary teachers who were interested in furthering their studies in the field of Numeracy Education at the Honours or Masters level. Zonia was also pleased to announce that two learners from Martindale and Bongani had proceeded to the finals in the AMESA maths challenge. Mellony announced that the Maths Education 21 Century Conference would start on Sunday with a teacher- focused mathematics day and invited and encouraged all to attend. She announced that Aarnout would be hosting a Developing Number Sense Workshop for Foundation and Intermediate Phase teachers in Port Elizabeth in two weeks' time and all were welcome.

Zonia, outlined the beauty of maths in the year *2011*. She explained that this year had four unusual dates all with the digit 1. That is, 1 January 2011 (1/1/11), 11 January 2011 (11/1/11), 1 November 2011 (1/11/11), 11 November 2011 (11/11/11). Zonia also explained that if you add the year in which you were born and your age to this year, the sum of the years would come to 111. For example, if I was born in 1975, in 2011 I would be 36 years and if I add 75 and 36 that comes to 111. Most teachers appeared excited by this as indicated by the chatter and their testing of this. Zonia went on to point that this year's October had 5 Sundays, 5 Mondays and 5 Saturdays, with this happening only once every 823 years.

Zonia and Mellony went on to do a joint activity on the 'Alphabet Maths' game. This involves using numbered alphabet letters (1 to 26 for A to Z) and decoding numbers into words or words into numbers (Fieldwork notes, 10 May, 2011). The presenters together with the teachers went on to decipher several words into numbers. For example the word "Attitude" was converted to 100. Groups were given Alphabet maths activities to do, such as finding the shortest three- and two-letter words with the highest number value and constructing words and finding their values from a given set of letters. Many teachers said that this was a very interesting and fun game which they would use in their classes, and that furthermore the game closely links with literacy. One teacher suggested modifying the game to include decoding the learners' names. At the end of this activity teachers were given yellow alphabet letter cards with the letters A to Z, and blue cards with numbers 1 to 26 for use in their classrooms.

Mellony showed the teachers a short 'youtube' Hillbilly maths video clip³¹ that involved Uncle Pa who erroneously divided 25 by 5 to get 14. He persisted and argued that his working was correct. In the video clip Uncle Pa and his wife show that 14 multiplied by 5 is 25 to prove their answer, they use erroneous procedures. Mellony pointed out that Uncle Pa lacked an understanding of number sense and the basic operations and did not differentiate between tens and units in his working with numbers. The NICLE teachers then discussed mathematical strategies that they could have used to convince Uncle Pa, such as introducing him to the notion of place values, concrete objects and grouping into fives.

³⁰ I have created this compilation based on four NICLE sessions that were presented by Mellony (Chair) and Zonia (the NICLE TDC), on Tuesday 10 May, 24 May, 16 August and 30 August 2011.

³¹ The video clip can be viewed from www.youtube.com/watch?v=MCM9iwkz8bc

Mellony began by asking teachers to define even and odd numbers in their groups. She then showed the teachers a short third grade classroom episode from Deborah Ball's video on teaching odd and even numbers. In the video clip the learners were engaged in the ensuing classroom discussion, arguing and explaining with relevant examples on the difference between even and odd numbers. Of interest and mathematical significance was Ofala's proposal for a definition of odd and even numbers, which was similar to the formal mathematical definition and representation of even numbers as $2n$ and odd numbers as $2n+1$, where 'n' is an integer. Following the discussion on the video, Mellony encouraged the NICLE teachers to provide opportunities for learner-driven mathematical explorations in their classes, thereby creating learner-engaging classroom culture (Fieldwork notes, 24 May 2011; SANC, 2011). Mellony also explained that the use of the video enabled teachers to reflect on their practices and to engage with student learning and student opportunities to learn and that the classroom videos of their own practices (that were happening in their schools) would enable such reflections (SANC, 2011). The teachers were given an article by Ball³², a verbatim transcription of Deborah Ball's video, and a sheet with definitions of even and odd numbers.

Zonia provided a PowerPoint presentation of the history of the zero concept and how it featured in our everyday life, for example, in phone numbers, secret banking pin numbers, thermometers, measurement and as an integer/whole number. Zonia discussed learning opportunities that teachers can provide for understanding the concept of zero, such as using a calculator, multiplying and dividing by zero and exploring number patterns, number bonds and inverse operations that include zero. Zonia went on to give teachers excerpts from the RNCS and CAPS Foundation phase curriculum document so that they could discuss how the concept of zero features in the curricula. The teachers explained that in the RNCS, learners were not supposed to know how to read and write the zero number symbol (see DOE, 2002c). The teachers also discovered that though the concept of zero had been introduced in Grade R, 2 and 3 under the new CAPS curriculum, Grade 1 learners were not expected to know how to read and write this number symbol. Zonia explained that this was problematic and hindered the development and progression of the zero concept. Thus while the curriculum documents were given to teachers Zonia drew attention to perceived challenges and encouraged critical alignment and adaptation to these documents. Each teacher was given a booklet entitled "Developing the Concept of Zero", compiled by Zonia based on her Master of Education research.

6.2.1.4 Lisa's NICLE session – Tuesday 08 May 2012

Focuses on conceptual understanding of fractions

The session started with Mellony giving a set of playing cards to each NICLE participating school. This followed from the previous NICLE presentation in which the Chair project team had explained the benefits of learning numeracy using playing dice and cards. Mellony went on to remind teachers to order their choice of resources³³ through the SANC Project Manager. She then introduced Lisa, as a "very passionate, wonderful and knowledgeable" Foundation phase maths teacher educator. Lisa explained that her presentation would focus on Fractions

³² Ball, D. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *Elementary School Journal*, 93(4), 373-397.

³³ Each teacher was given the opportunity to select and order through the SANC Project Manager R1 000 worth of teaching resources following one year of active participation in NICLE.

and how they relate to the new CAPS document using Malati³⁴ material developed by Hanlie Murray, one of the Curriculum developers of the fraction component in the recently-introduced primary maths curriculum.

Lisa gave the teachers an apple tart fraction problem in which she asked the teachers to find the number of apple tarts that could be made from 20 apples if $1\frac{1}{2}$ apples are used to make 1 apple tart. The teachers worked this problem in pairs or groups of three and shared their different solutions and strategies. Mary and Ruth presented their solution to the NICLE group. Their strategy involved physically drawing the apples and coming with $13\frac{1}{2}$ tarts as the answer, so did the other teacher groups. Everton and her group worked this problem differently and got the answer $13\frac{1}{3}$. Everton worked the problem as follows:

$$20 \div 1\frac{1}{2} \longrightarrow 20 \div \frac{3}{2} \longrightarrow 20 \times \frac{2}{3} = \frac{40}{3} = 13\frac{1}{3}$$

The differences in solution and appropriateness of solutions were discussed at length. The teachers explained different issues and aspects that they had learnt from this fraction problem. The teachers said that they had learnt how to introduce fractions using context-relevant examples, to encourage learners to discuss their solutions and strategies or to explain their thinking and make sense of their answer and also to differentiate the levels of strategies and solutions used by the learners. Concerning the last issue, Lisa explained that all the solutions reached by the different groups were good depending on the phase and level at which one teaches. The answer of 13 is more appropriate to Foundation phase learners, whilst the strategy used to get $13\frac{1}{3}$ (above) is more suited to the Intermediate phase learners.

Lisa also explained how to introduce Foundation phase learners to fractions using Malati material. She remarked that the Malati resources were developed out of research done in the Western Cape and were aimed at improving learners' understanding of the fraction concept using word problems. In groups the teachers looked at and discussed different Grade 3 children's strategies and solutions to different types of fraction problems. The key issue emerging from the group discussions was the fact that it is critical that children explain the strategies and solutions they use to solve fraction problems so as to make sense of the ideas and that different representations can be used to help learners solve problems.

Using the Malati material booklet Lisa asked the teachers to work out: "The children make a small duck from $\frac{1}{3}$ of a metre of thin wire. They have $5\frac{1}{2}$ metres of thin wire. How many small ducks can they make?" (NICLE hand-outs, 8 May 2012). Whilst all the teachers got the correct answer to this problem they used different strategies and these were discussed and compared.

To conclude this session Lisa asked each table to discuss one thing that stood out in the session. Several issues were raised. One teacher explained that she had learnt to use other shapes like rectangles when teaching fractions and not to rely only on circles. One group explained their learning of the importance of using visual or pictorial representations to enable learners to understand fractions. Following one of the group's suggestions Lisa explained that we should use the simple strategy to *think pair* and *share* strategy with learners. Lastly the teachers reiterated the importance of making the learners explain their mathematical strategies and solutions.

³⁴ Malati stands for Mathematics learning and teaching initiative.

Lisa encouraged the teachers to try out some of the fraction problems with their learners and to come back and give feedback on how their learners solved these problems. On the issue of language, Pamela, who teaches in a school whose language of learning and teaching is isiXhosa, explained that they at times used isiXhosa words to teach fractions. Following this the SANC developed fraction wall charts in different languages, which were given to teachers in the next session.

6.2.1.5 Lyn's NICLE sessions - Tuesday 04 September 2012

Language as a resource in multilingual classes and problem solving

Lyn's presentation focused on using language as a resource in multi-lingual mathematics classes. She outlined that discourse in the classroom is multifaceted and can lead learners to be *receptive*, whereby they listen, read and interpret. It can enable learners to be *expressive*, thus speak, write gesture and imagine. Lyn went on to distinguish between formal and informal spoken mathematics in main language and formal and informal spoken mathematics in the English Language of Learning and Teaching³⁵.

Lyn showed a video clip of a Grade 6 class at a School in Cape Town during an experimental science lesson. The lesson was conducted by a black female teacher in isiXhosa, which was the third language for most of the white learners in the class. There was only one black student in the class who could understand and respond to the questions posed by the teacher in isiXhosa. All the white learners could hardly respond to the questions posed by the teacher and incorrectly pronounced the isiXhosa scientific terms. During the post-lesson reflections in the video, the four white students said that they could not understand the teacher's questions and could not answer the questions posed, so it would be hard for them to write tests in isiXhosa. The presenter explained how, in this video recording, language could be seen to both inhibit and promote learning. The presenter also explained that teachers of multilingual classes have to think carefully about issues of language and how this affects the understanding of mathematical concepts. Drawing on Setati's work she encouraged teachers to use code-switching and multilingualism as a resource in the classroom.

Teachers of multilingual classes were encouraged to make correct translations of mathematical terms into isiXhosa, Afrikaans and English so as to improve the learners' understanding of mathematical concepts, symbols and terms. Lyn encouraged teachers to use operation flower templates in which they could fill in the equivalent translation of mathematical operations in the learners' first languages. During the NICLE session the teachers gave the equivalent translation of the four mathematical operations in isiXhosa, Afrikaans and English. To help the teachers in translating the mathematical terms, each participating school was given a multilingual mathematics dictionary entitled "Mathematics terms in English, Afrikaans and isiXhosa for use in Eastern Cape Schools". Following Mercer (1995), Lyn explained that the talk between the learners can be characterised as disputational, cumulative and exploratory. The presenter encouraged teachers to foster classrooms that encourage exploratory talk amongst learners and that allow learners to use their home language to develop sense making.

Lyn also explained the importance of teachers using pre-intervention assessments in their classes through mathematics baseline tests. She urged teachers to give maths baseline assessment tests to their learners at the beginning and end of the school year. She directed teachers to the South African English maths baseline assessment tests for Grade 3 to 7 on the

³⁵ The presenter acknowledged that these categories of languages were adapted from Setati (2005) p. 84.

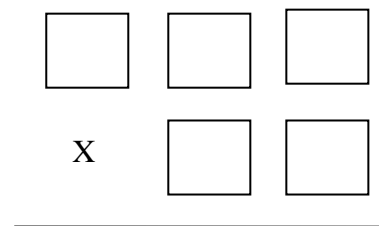
website: <http://www.gmsouthafricafoundation.com>. The teachers were also encouraged to analyse the baseline assessment tests using learner performance bar graphs, which present the results of each learning outcome visually on a graph. Each school was also given a hard copy of the Grade 3 to 7 English maths baseline assessment tests. Lyn also encouraged the teachers to visit the SparkleBox teacher resources website: <http://www.sparklebox.com>, which provides free downloadable primary mathematics teaching resources.

The presenter also introduced the NICLE teachers to the acronym RUCSAC which is a step by step approach used to solve word sums or word problems. RUCSAC stands for Read, Understand, Choose, Solve, Answer and Check. It prompts the learner to *Read* the question carefully, *Understand* the question, *Choose* the correct operation and method to work out the sum, *Solve* the problem, *Answer* the question in a full sentence and finally to *Check* their answer by usually using the inverse operation. Using the RUCSAC strategy the NICLE teachers, together with Lyn, solved three word sum problems. The teachers responded that the RUCSAC approach was a valuable strategy which they would use in their classes to solve word problems.

6.2.1.6 SANC project team’s 2012 compilation of NICLE sessions³⁶

The session began with housekeeping, with Mellony introducing Mr Deliza who joined the project as a full time Masters student. Elna a DOE District Official whose work focuses on Foundation Phase numeracy and regularly attended NICLE sessions also made an announcement on the forthcoming National Maths and Science week (30 July to 4 August 2012) that was to be co-ordinated by her Department with partners RUMEP, SANC and the FRF mathematics education Chair for teachers in the Grahamstown district. Teachers were handed a copy of the National Maths and Science week programme as well as the day’s NICLE maths challenge³⁷.

The session started with teachers working out the “I hate maths”³⁸ March 2012 challenge which instructed the teachers to put the numbers 2, 3, 6, 7 and 8 (using each number once) into the blocks below to create the largest product



(NICLE hand-out, 13 March 2012)

³⁶ I have created this compilation based on four NICLE sessions presented by Mellony and Debbie on Tuesday 28 February, Tuesday 13 March, Tuesday 24 April and Tuesday 24 July 2012.

³⁷ In 2012 all sessions began with a mathematical challenge on the tables to be worked out as teachers arrived and while waiting for others. Following usual housekeeping and announcements Mellony discussed with teachers various ways they approached the challenge.

³⁸ The “I hate maths challenge” is a monthly primary school mathematics problem introduced by the South African Numeracy Chair at Wits University and aimed at encouraging Foundation phase teachers to love mathematics.

After several attempts by different groups the group I was participating in found the largest product to this challenge and provided the numbers 786×32 whose product was 63 246. Various strategies for finding the largest product were discussed.

After the Numeracy warm-up challenge, Debbie made a PowerPoint presentation on the results of the Grade 3 and Grade 4- 2012 written and orally administered tests. She alongside Mellony explained that the 2012 learner test data showed an average 2% increase across the NICLE participating schools. Mellony and Debbie also reported that analysing the 2011 and 2012 learner tests data generally indicated that learners had improved in their accuracy and there was a shift from using manipulative and concrete strategies to using more abstract and sophisticated maths solving strategies. From their data analysis it also emerged that problem solving was the greatest challenge facing the learners. Debbie also introduced and encouraged the teachers to visit the SANC web site at: www.ru.ac.za/sanc/ and the web page: <http://livebinderscom/play/presented=138288>, for primary maths teaching and learning resources. Both presenters encouraged the teachers to read the “Ukufunda” series in the local Grocotts newspaper which is a SANCP contribution that provides numeracy activity pages for learners to work at home with their parents, siblings and/or caregivers.

Mellony and Debbie went on to outline numerous benefits of learning numeracy games using the dice and playing cards. As part of a demonstration on the mathematical games that can be played with cards, Mellony introduced the NICLE teachers to the *pyramid game*, in which 15 cards are laid out face up, in the shape of a pyramid, with the rest of the pack facing up on the table. These games had been trialled in the SANCP maths clubs. The game is used to promote numbers bonds, with players looking for pairs of cards in the pyramid or on the top of the pile that make up 10. We were also introduced to *Dingaan’s kraal game*, in which the cards are spread out into a kraal shape, with players taking turns to turn over one random card and lay it in the middle of the shape. As a new card is laid down, players find pairs/sets of cards that add up to 10; (or 12, 13 or 20 depending on the level). The player with the most cards wins.

Mellony and Debbie went on to demonstrate various mathematical games that can be played using dice. During this demonstration teachers practised and familiarised themselves with some of the mathematical games that can be played with a die. After the presenters’ demonstrations, teachers in their groups talked about and shared other numeracy games that can be played with cards and dice, sometimes demonstrating them. The teacher groups provided feedback and mentioned several numeracy games that can be played using dice and cards. Mellony and Debbie said they were grateful to the teachers for the ideas and that they would use the teachers’ and their own ideas to compile a booklet³⁹. This booklet was handed out to teachers with multiple sets of dice and cards in the following session.

In another session teachers were given sets of wooden blocks. Mellony mentioned that the SANC project had ordered plastic boxes of wooden cube blocks which were to be given to each NICLE-participating school. The teachers were asked to demonstrate and discuss in groups the different mathematical activities that could be used with the cubic blocks on their tables. Teachers mentioned that different 2D and 3D shapes could be constructed with the cubes; the blocks could also be used for counting in groups and developing the area, volume or perimeter concepts; the blocks could also be used as counters for addition, subtraction, division and multiplication and they can also be used for making up and breaking up numbers, developing fluency with or simply for number bonds. The teachers were given a building block activity involving patterns and constructing various shapes. In groups they

³⁹ SANC (2012). *Numeracy Games with Dice and Cards* – see www.ru.ac.za/sanc/resources

constructed different shapes using the blocks and then drew the floor plan of each shape⁴⁰. The teachers also constructed rectangular prisms following a set of instructions in a worksheet and went on to discuss the side view, back view and the floor stamp of each prism.

As the next week was to be the national maths week the teachers went into pairs and answered the Grade 4 Mathematics Challenge paper⁴¹, which was to be written by learners during the week. After completing the National Maths Relay competition Mellony revised the questions considering teacher solutions and explaining some methods for solving problems. Teachers discussed how the solutions and the strategies used to solve some of the mathematical problems can inform the teaching and learning of maths in their respective classes. Mellony encouraged the teachers to go and “enjoy” the Maths Challenge with their learners and teachers were given multiple sets of question papers for use in their classes in preparation for the AMESA challenge.

Mellony requested feedback from the teachers on the NICLE homework research drive, an initiative by the SANC project to encourage learners to do regular homework and improve their performance. NICLE-participating teachers had been given Chair-published mathematics homework learner books in earlier sessions that focused on the importance of setting homework for use in their classes. Mellony had noted that regular homework provided a second site of learning and promoted independent maths learning (NICLE hand-outs, 13 March 2012). The teachers reported that the learners were excited by the homework workbooks and they were proving to be useful, with teachers encouraging the learners to mark their work amongst themselves so as not to “pressurise” them with more work. Some teachers suggested that the booklets be translated into isiXhosa to cater for schools whose language of learning and teaching is Xhosa. (This was done for the 2nd homework book). Teachers from Heritage and St Magdalene who had been visited by Steve⁴² for the Mathemagic show reported that his assembly mathematical activities were fun, exciting and of educational value. The Chair hinted that Steve would be brought again towards the end of the year to present a NICLE session and for a family maths fun event and that it would be arranged for him to visit all other NICLE schools in the future.

6.3 Analysis of NICLE sessions, SANC documents and reports for the projected and promoted PMTI

Having described various NICLE sessions over the two years, presented by invited guest speakers, primary maths education specialists and by the Chair and staff in the SANC project, I now analyse the promoted PMTI within NICLE. Besides analysing across the discussed NICLE sessions I also examine SANC documents and reports to reveal the projected ‘positive professional’ primary maths teacher identity. A list of the SANC documents and reports analysed is available in Appendix 6.

⁴⁰ These activities were later compiled into a booklet by the South African Numeracy Chair Project (2012) entitled, *NICLE teacher block activity ideas booklet*.

⁴¹ AMESA (September 2006). Mathematics Challenge: Grade 4 First Round.

⁴² Steve’s maths fun shows had been financially supported by the SANC.

6.3.1 Positive numeracy professional teacher identity

My analysis of the initial proposal document (Graven, 2010), orientation and invitational letters (Graven, 2011a; Graven, 2011b), joint advisory meeting reports (Graven & Schafer, 2011) and Community of Practice forum discussion documents (SANC, 2011; SANC, 2012; SANC 2013) compiled by the Chair reveals that the primary maths teacher development initiative focuses on strengthening and developing a more *positive numeracy professional teacher identity*. A positive identity is one that is invested, committed, passionate and competent in teaching numeracy, with a professional teacher operating within professional activities such as access to broader professional communities, conferences, national maths competitions and math weeks etc. (SANC, 2012; SANC, 2013).

The SANC (2011, p. 4; 2012, p. 2) documents explicitly state that NICLE focuses on “strengthening numeracy/mathematical identities of teachers [with] the inclusion of intermediate phase teachers, who mainly teach across learning areas helping foregrounding opportunities for the evolution of mathematical identities”. Similarly NICLE aims to “create opportunities for the development of more positive numeracy professional teacher identities (especially with the Grade 3 teachers who teach across the curriculum) and through this [enhance] their passion and competence for focusing on this area of their classroom work” (SANC, 2012, p. 5).

It is important that I unpack further constituents that comprise the positive numeracy professional identity projected in NICLE. The future primary maths teacher identity promoted in NICLE is that of an ‘effective teacher of numeracy’ who has a ‘connected understanding of mathematics’ which enables learners’ ‘mathematical proficiency’ (Graven & Schafer, 2011, p. 20; SANC, 2012, p. 4; SANC, 2011, p. 20). Such a notion of a PMTI is informed particularly by international and influential primary mathematics research carried out by Askew, Rhodes, Brown, William and Johnson (1997) and Kilpatrick et al’s (2001). This work focuses on developing effective teachers of numeracy who promote learner mathematical proficiency as overlaid in the five intertwined strands of numeracy proficiency. In relation to the promoted PMTI, NICLE’s sessions notably provided opportunities that enable participating teachers to have a “connected understanding of maths and mathematical knowledge for teaching...that encourages active learning and sense making and...teachers to use key resources for the development of conceptual understanding” (SANC, 2012, p. 4).

NICLE also promoted teacher practices that encourage “productive learning disposition and problem solving”, the use of “language as a resource for teaching and learning” and the “establishing of homework practices and second sites of learning” (SANC, 2012, p. 4). The SANC (2012) CoP discussion document and the Chair’s 2013 PowerPoint slides at the Community of Practice forum (presented earlier in Figure 6.3) shows the key numeracy concepts and practices prioritised in NICLE and illuminated in several of the sessions described above. I elaborate briefly on key themes I noted in my fieldwork notes from NICLE sessions and Chair documentation.

6.3.1.1 Number sense, sense-making and computational fluency

NICLE prioritised the development of number-sense amongst learners, with the participating teacher group having been exposed to several sessions that promote the teaching of this key numeracy concept. Central and relating to number sense and also part of numeracy content prioritised in NICLE is sense making, mental maths and the ability to use efficient calculating strategies. Aarnout’s NICLE sessions (Tuesday 12 April & 13 September 2011) encouraged teachers to support the development of number-sense through progressive development of concepts, thus helping children experience mathematics as a meaningful and sense making activity. Tom’s two NICLE sessions (June 2011) highlighted the importance of developing number-sense through mental maths. As number sense closely relates to computational fluency both Aarnout and Tom’s first NICLE sessions also emphasised the importance of learners having efficient calculating strategies. Mellony and Debbie’s presentation (February 2012) had also accentuated the importance of promoting learners’ mathematical proficiency, especially their computational fluency. Thus four of NICLE’s 13 sessions in 2011 and the first NICLE session in 2012 focused on the importance of developing number-sense, sense-making, mental maths and efficient strategies. Such emphasis relates with NICLE prioritisation and promotion of primary teachers whose identities foreground sense-making and progression towards the use of efficient strategies.

6.3.1.2 Developing conceptual and connected understanding of mathematics and the use of key resources

Also evident from the analysis of the NICLE sessions and the SANC (2012, 2013) documents is that NICLE supported teachers in using key resources for the development of conceptual understanding. During the two-year period of this study teachers were exposed to and provided with a variety of resources for use in their maths classes. Teachers experienced the

use of the resources in NICLE sessions. Following the sessions outlined above the following resources were given to teachers:

- Playing cards
- Dice
- Building cubes with laminated activities
- Laminated games and oral activities
- Progressive number-sense workbooks
- Edupeg problem- solving resources (sponsored)
- Individual learner laminated charts (e.g. fraction charts, hundred grids, number lines)
- Chair- published homework books
- Various mathematical competitions (Fests, relays, challenge)
- Boxes of matches with laminated pattern activities and puzzles
- Height measurement charts
- Plastic clocks
- Poster size fraction charts, number lines etc.

(SANC, 2012, p. 6)

Tom's sessions introduced teachers to the use of flash cards. Melania's (NICLE teacher) demonstration lesson (October 2011) with a group of learners also emphasised the importance of using Flard cards (place value cards) to promote the development of the concept of place value and to encourage efficient calculating strategies. Aarnout's second NICLE session had also highlighted the importances of Flard cards, with teachers participating in group activities involving this resource. Debbie's presentation on information technology websites and materials development exposed teachers to appropriate numeracy websites and free online numeracy games resources (NICLE hand-outs 19 July 2011). The Singapore maths model discussed in Bev's (September 2011) session emphasised the importance of producing and using pictorial/visual images and engaging material in developing learners problem solving and analytical skills. Lisa had also exposed participating teachers to use of visual representations through fraction charts and number lines in her three consecutive NICLE sessions that explored fractions. (Teachers were given multiple sets of laminated fraction-charts by the SANC project for use in class). The Chair had also given NICLE teachers edupeg-sponsored problem-solving books. On 24 July 2012 teachers were

handed out their personally selected R1 000 worth of teaching resources which they had ordered. The SANC project had also organised an online resource binder called South African Chair Online Resources which teachers could access through the SANC website. The key resources that teachers had been exposed to and given in NICLE were meant to support teachers teaching numeracy concepts and in the development of conceptual understanding. The NICLE resources prioritisation aimed at creating teachers whose identities encompass a profound and connected understanding of mathematics (Ma, 2010; Askew et al, 1997) and who overcome the “dilemma of representing content” when teaching elementary school mathematics (Ball, 1993, p. 377). Thus NICLE prioritised “strengthening teachers connected understanding of mathematics and mathematical knowledge for teaching” (SANC, 2012, p 4). Such a projected NICLE primary maths teacher identity intended to develop in teachers an in-depth understanding and multiple ways of representing content.

Besides giving teaching resources, NICLE also focused on the teachers’ understanding of mathematics through some of its sessions that directly focused on deepening the participating teachers’ content knowledge. In 2012 NICLE had started numeracy warm-up challenges, which involved teachers solving and discussing solutions to given mathematical problems. At times the mathematical problems posed in NICLE drew on the South African Numeracy Chair at Wits University’s ‘I hate maths challenges’. The NICLE sessions of October 2011 and July 2012 had teachers participating in the NICLE pair maths challenge. Both challenge items were from the AMESA Grade 4 mathematics challenge multiple choice questions. Teachers revised the problems together and with the Chair discussed effective strategies for solution. These sessions aimed at deepening and extending teachers mathematical knowledge as well as developing teacher confidence to get their learners participate in the annual AMESA maths challenge. During the 2011 AMESA national maths week programme (1 to 5 August) NICLE teachers in the Grahamstown and Alexandria clusters attended and participated in the Maths Challenge Bonanza. The AMESA maths challenge bonanzas are overlapping activities supported by the SANC. The NICLE numeracy warm-up challenges, NICLE pair maths challenges and the maths challenge bonanzas were all aimed at strengthening the teachers’ mathematical identities in terms of competence and confidence (SANC, 2012).

6.3.1.3 Encouraging active learning

Several NICLE sessions, run by both guest speakers and Chair staff outlined the importance of encouraging active learning and providing opportunities for learner-driven mathematical

explorations. Thus both Aarnout and Tom's presentations had highlighted the role of classroom discussions and encouraged teachers to ask learners to explain 'why' in relation to the tasks they were doing. To improve learner engagement Aarnout's sessions had also encouraged teachers to work with small group of learners. Mellony's use of Deborah Ball's video (May 2011) was also meant to promote an engaging maths classroom culture and encourage pedagogical practices that engage learners in discussion. Both Melania's (NICLE teacher in the sample) and Glynnis' (local teacher and lecturer) practical demo lessons had illustrated the value of learner active engagement. Lisa had also explained throughout her three NICLE sessions the importance of learners explaining their mathematical strategies and solutions. NICLE thus promoted teacher practices that actively engaged learners, with the projected teacher identity as being one who provides opportunities for learner-driven mathematical explorations (SANC, 2011; SANC, 2012).

6.3.1.4 Engaging learners in maths concepts in an exciting and fun way

The SANC project is defined in documents and on the website as a "hub of mathematical activity, passion and innovation that blends teacher and learners numeracy development with research in mathematics education" (SANC, 2012, p. 2; SANC, 2013, p. 3). A fun energy-creating ethos is promoted. Some NICLE sessions and the SANC's sponsored mathemagic assembly shows, the family maths event and the 'fun with maths-Ukufunda' Grocotts newspaper series exemplify the Chair's aims to support teachers to engage learners in various maths concepts in an exciting and fun way. Several SANC project-run sessions had a "have fun with maths" part such as during Zonia and Mellony's alphabet maths game, the humorous Hillbilly maths video and the maths games with dice and cards. Similarly the NICLE wooden cubic block activities explored fun and exciting ways in which the blocks could be used in the maths classroom. Steve's NICLE presentation also explicitly highlighted the importance of encouraging learners to interact with numbers in a fun and exciting way. In March and October 2012, Steve (one of the key partners of the Chair) had also facilitated mathemagic assembly shows in all NICLE participating schools in the Grahamstown urban area and a family maths event (October 2012) which also foregrounded the playful element when engaging with numeracy concepts. Starting from June 2012 the SANC had introduced the 'fun with maths' page called Ukufunda in the local Grocotts newspaper which aimed at getting learners, parents and teachers to engage learners with various numeracy concepts in a fun way (SANC, 2013). Also in 2012 Mellony had shown the teachers a Ken Robinson video entitled 'Do schools kill creativity?' as a way of invoking teachers to transform teaching and

learning and explore their capacities for creativity. In the two-year research period of this study, some NICLE sessions and various overlapping and parallel initiatives of the SANC project had highlighted and encouraged NICLE teachers to engage learners in their maths classes in a fun and exciting way, thus promoting teacher identities that embraced the playful element in teaching numeracy concepts. Linked to this was the promotion of productive disposition. The SANC project supported teachers to promote their learners' mathematical productive dispositions by encouraging learner-engaging and exciting maths classes. During the first 2012 NICLE session, when Debbie discussed learner tests data using Kilpatrick et al's five strands of mathematical proficiency, she explained the importance of developing and supporting the learners' mathematical productive dispositions. Thus in relation to encouraging fun ethos in teaching numeracy, NICLE also promoted primary teachers who supported learners' mathematical productive dispositions.

6.3.1.5 Supporting language practices as a resource and using language for developing problem solving

An analysis of the NICLE sessions and SANC documents also reveals promotion of the use of language (multilingualism) as a resource for teaching. Closely related to this prioritisation was NICLE's effort of ensuring that teachers are comfortable with problem-solving. Lyn's session had highlighted how language could be used as a resource in multilingual maths classes. (In 2014 teachers were invited to a seminar on multilingualism as a resource by Professor Setati-Phakeng – local and international renowned researcher in language and mathematics).

During this session Lyn had also introduced the RUCSAC word problem-solving approach as a way of encouraging teachers to solve word problems in their classes. Bev's presentation (September 2011), of the use of Singapore maths in schools in the Eastern Cape had also foregrounded the use of pictorial models in solving mathematical word problems. The numerous warm-up challenges, which marked the beginning of NICLE sessions, introduced in 2012, and the NICLE pair maths challenges exposed teachers to problem-solving challenges and provided insights on how to engage word sums in maths classes. NICLE thus promoted numeracy teachers whose identities and practices used language as a classroom resource and were comfortable with problem solving.

6.3.1.6 Homework practices and second sites of learning

The NICLE CoP also encouraged and supported teachers to establish homework practices and second sites learning. In 13 March 2012 Mellony and Debbie launched the NICLE homework research drive, which was a SANC project initiative to develop in learners independent study habits and to increase learner time on task and activities. Following the launch of the homework research drive teachers were given learners' homework books and journals to make entries and provide feedback on the successes and challenges of this initiative. The NICLE numeracy dice and card games booklet, number bond books and the Grocotts Ukufunda supplements encourage opportunities for learners to work independently, or with their parents or guardians, on mathematics and numeracy outside of school time (SANC, 2013). The SANCP is also involved in developing and establishing after-school maths clubs which are aimed at strengthening groups of learners to become resources within their classroom as they may be drawn on to help and to explain to others. Most of the after-school maths clubs have been established in schools whose teachers are NICLE participants, with some of the teachers taking the initiative to establish and facilitate in the clubs. NICLE and the SANCP therefore promote teachers who become involved in after school learner support and teachers who develop independent learners through the practice of giving regular homework.

6.3.1.7 Critical engagement with national primary maths curriculum policies

The NICLE initiative was developed within the context of a new CAPS curriculum and the introduction of standardised Annual National Assessments (ANAs) in numeracy and literacy in 2011. My analysis of the NICLE sessions reveals that NICLE supported teachers to critically engage with primary maths national curriculum policies. Zonia and Mellony's presentations on 'Developing the Concept of zero' and on 'Developing the concept of Place Value' had discussed with teachers how the zero and the place value concept featured in both the RNCS and in the new CAPS curriculum. The teachers and the SANC project team presenters critiqued the new curriculum for not adequately promoting the development of the zero concept in Grade 1. Lisa's sessions on Fractions had also introduced the Malati material which was developed by Hanlie Murray who also developed the fraction component of the CAPS curriculum. Lisa extended the teachers' knowledge of this concept by discussing the various representations teachers can use when teaching fractions and the limitations and strengths of writing fractions as words in the foundation phase. The SANC had also given teachers copies of a Mail and Guardian article dated 8 September 2012 written by Henning

and Dampier (2012), which argued that the language and level of difficulty in some of the ANA maths tests greatly exceeded the ability of the children who wrote them. The Chair had expressed her personal, similar discomfort with the ANAs tests. Together with the Numeracy Chair at Wits they had gathered data across project teachers and jointly submitted a discussion paper based on the NICLE and Wits teachers' views to the national department of education which was critical of the national maths tests and provided input to the process (Graven & Venkat, 2013). Both the Chair and the NICLE teachers had raised several issues that are problematic with the ANA tests. In their engagement with national primary maths curriculum policy documents the Chair and key partners of the Chair supported teacher identities that critically engaged with educational policies.

6.3.1.8 Developing life-long learners and teacher leadership roles

NICLE also emphasised developing teachers as life-long learners and leader teachers. It encouraged teachers to be workshop or seminar presenters (Graven, 2010; Graven, 201b; Graven & Schafer, 2011; SANC, 2012) and suggested that teachers participate in several local and national conferences. Developing teacher leadership was considered important for sustainability. It also resonates with the design and intentions of NICLE which emphasises a two way partnership rather than a top-down teacher development programme, where solutions to numeracy challenges are provided (SANC, 2012; Graven & Schafer, 2011). NICLE thus intended to foster leader educator roles and identities amongst the NICLE participants with its long-term intention being to support teachers to develop the confidence to lead in some of the sessions (SANC, 2012).

However in the first year of observation only two clear examples of leader roles within NICLE activities or NICLE-promoted activities were noted. These were Melania's Flard cards demonstration lesson and Pat's (another NICLE teacher) 'How I teach it' presentation at the Eastern Cape AMESA regional conference at Fort Hare in 2011. In 2012 two of the NICLE teachers had registered for further degrees (Honours and Masters) supported by the Chair. In 2013 many more roles have emerged as presented in the SANC - 2013, indicators report, perhaps pointing to time needed for such leadership roles to emerge (see Appendix 6). In 2013 and 2014 Mary and Edna both registered to complete their Education degrees. In 2013 I supported two of the sampled teachers (Mary and Edna) to present in 'How I teach it' sessions at the AMESA national conference in Cape Town. Furthermore in 2013, two of the sampled teachers, Calvin and Everton had indicated interest in taking up leadership roles in

their clusters and nearby school communities, respectively. These roles coheres with the life-long learner roles and identities promoted in NICLE.

6.4 In summary

Considering that the notion of identity is foregrounded in this study my analysis across the NICLE CoP sessions and Chair's documents reveals that NICLE provide opportunities that prioritize the projection of a particular primary maths teacher identity. Overall the NICLE CoP creates opportunities for the development and strengthening of more positive numeracy professional teacher identities that have a conceptual and connected understanding of mathematics that encourages active learning and number sense-making. NICLE also develops teachers whose identities and practices use language as a classroom resource, encourages problem solving and the establishment of second sites of learning. Furthermore NICLE also encourages teachers to engage learners in their maths classes in a fun and exciting way, thus helping in the formation of teacher identities that embrace a playful element in teaching numeracy and in the process support learners' mathematical productive learning dispositions. In relation to current national curriculum reforms NICLE encouraged a critical engagement with primary maths curriculum policies. NICLE also promoted and developed various forms of teacher leadership roles. The diagram summaries the numeracy professional teacher identities promoted and projected in NICLE emerging from my description and analysis above.

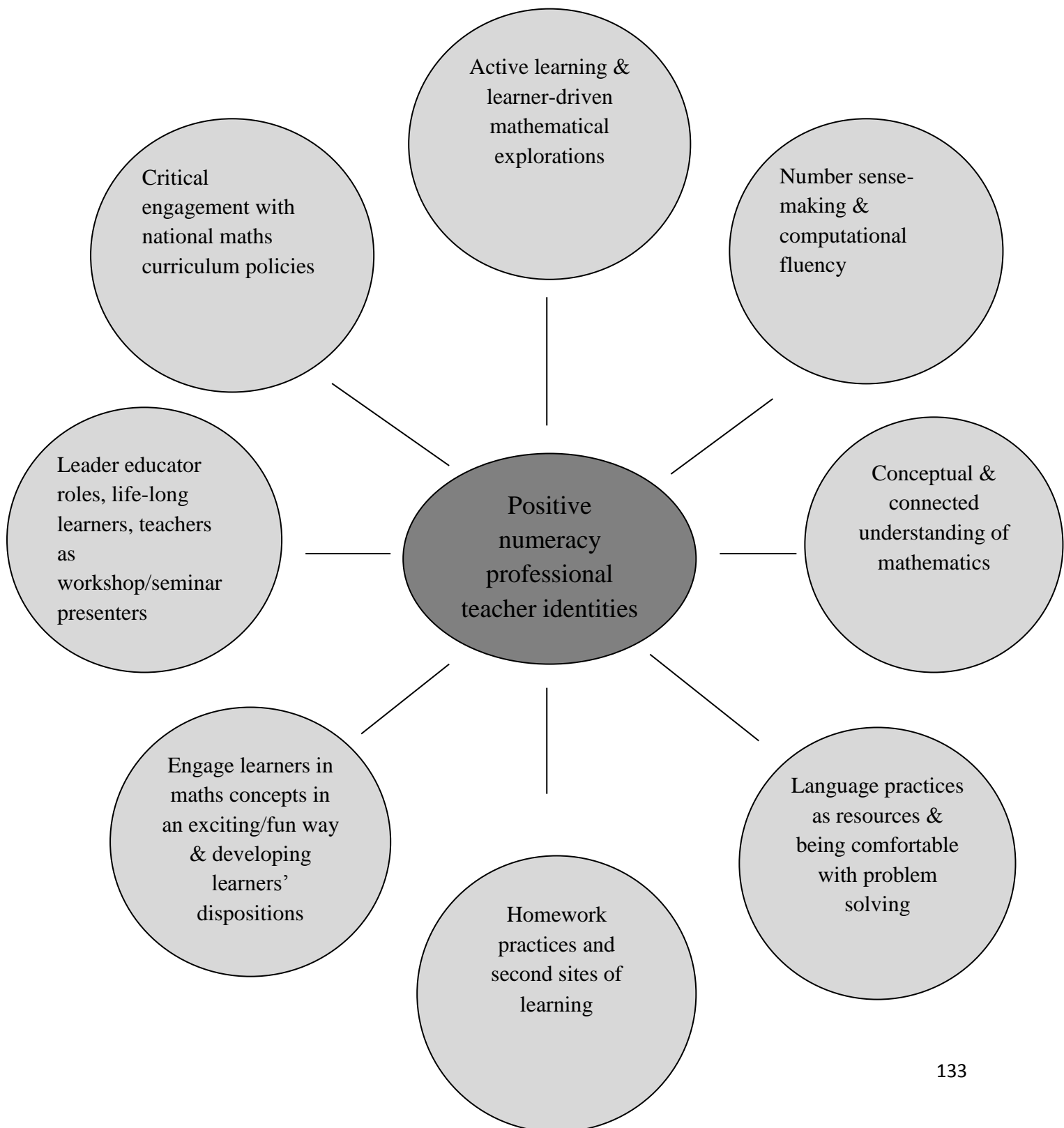


Figure 6.4: The promoted NICLE numeracy professional teacher identities

The promoted identities discussed above closely connect with teacher data gathered in interviews showing alignment of teachers articulated learning and NICLE intentions. In Chapter 8 and 9 I note that data from the teacher interactive interviews and journal entries indicate that *all* the sampled participating teachers said they had improved their maths classroom pedagogical practices as they felt the need to engage learners in their maths classes. Secondly *most* of the teachers acknowledged an improved understanding of mathematics with *some* of the teachers' identities and practices using language as classroom resources, encouraging productive learning dispositions, problem solving and establishing second sites of learning mathematics. In the second year *all* the sampled teachers explained how NICLE had supported them to engage learners in various maths concepts in a fun way. *Some* of the NICLE teachers and in the sampled study population were also starting to embrace leader educator roles. I will fully discuss how teachers take up the future promoted NICLE primary maths teacher identities in Chapter 8 and 9 when I deal with the overarching and the first two research questions.

6.5 Concluding remarks

This chapter described key professional development activities and sessions in which NICLE teachers participated over the two-year period of the study, which were facilitated by invited guest speakers, primary maths education specialists and also by the Chair and staff in the SANC project. I selected sessions which the sampled 8 teachers explained in the interview as having influenced their learning and which they took up from NICLE and appropriated in their maths classes. I also highlight key aspects of sessions that relate to ideas prioritised in NICLE and that point to the promotion of positive professional numeracy teacher identities and practices. The NICLE CoP activities alongside the SANC documents and reports provide the backdrop for analysing the projected and future NICLE primary maths teacher identity. In chapters 8 and 9 I discuss the extent to which NICLE teachers respond to the promoted NICLE primary maths teacher identity.

Chapter 7: Teacher learning stories

7.1 Introduction

This chapter provides the learning stories of the sampled teachers as gleaned from interactive interviews. As described in Chapter 5, interactive interviews enable participants to share accounts of their experiences and tell their stories (Clandinin & Connelly, 1994; Corbin & Morse, 2003). The teacher learning stories provide detailed descriptions of each sampled participant and qualitative data on how their mathematical learning unfolded prior to and during participation in NICLE. The teacher learning stories also contain a brief personal and professional biography, their primary maths teaching practices and orientations, NICLE teacher learning affordances opportunities and constraints and the teachers' responses to the recent changes in local primary maths education.

Based on the teachers' mathematical histories and their NICLE learning and participation experiences, the teacher learning stories provide the background needed in Chapter 8 to explain how the sampled primary maths teachers dialectically learn within the CoP-informed teacher in-service programme. Thus the stories provided in this chapter will support the reader to engage with the discussion in Chapter 8, which contains the main arguments and the empirical contribution of this study. Also important is that the narrative explorations presented in this chapter, together with data from teacher journal entries, fieldwork notes and document analysis will illuminate the discussions in Chapters 8, 9 and 10, and will help to address all research questions underpinning this study.

7.2 Teachers' maths learning stories

The concept of stories or participants telling their 'personal story' or 'life story' is central in the social practice theory as it has implications for understanding how learning takes place and identity changes within communities of practice (Lave, 1993b, p. 73; Cain, 1991, p. 215; Lave & Wenger, 1991). The notion of coupling learning with identity formation using

narratives is gaining prominence in education (Clandinin & Connelly, 1994 & 1996; Day et al, 2006; Drake et al, 2001; Marsh 2002a) in maths education (Sfard & Prusak, 2005; Lerman, 2012a; Graven 2003; Graven, 2005a; Graven, 2012; Brown & McNamara, 2011; Heyd-Metzuyanim & Sfard, 2012), with this study specifically referring to primary maths teacher learning stories. Stories are also key for capturing the participant's experiences (Clandinin & Connelly, 1994). The sampled primary maths teacher learning stories together with Sfard & Prusak's (2005) definition of learning as narratives and identity change, Lave's (1996) notion of *telos*, Wenger's (1998) characterisation of identity as a *learning trajectory* illustrates my creation of the term 'stelos'. I define 'stelos' as learning stories or stories about learning changes in one's identity through participation in a community of practice. The term stelos was firstly coined in my early work with Graven (Pausigere & Graven; 2014) and is fully elaborated in the following chapter. The notion of 'stelos' will enable the study to address mainly the overarching research question which relates to how the sampled teachers describe their NICLE participation and learning experiences, from which arise the two distinct learning synonyms – *reinvigoration* and *remediation* used to explain the mechanisms of learning through participation within the primary maths in-service programme.

I present below the 8 sampled teachers' *maths learning stories* and experiences as taken from the teacher interactive interviews. Taking a cue from Sfard & Prusak (2005) and Clandinin & Connelly (1994), I posit that the narratives presented herein are the researcher's written stories of the teacher stories and experiences. However each teacher's learning story relates both the key concern and experiences of each participant, and highlights significant emerging themes derived from the analysis of the interactive interviews. Thus each teacher learning story is both personally unique and yet shows the influence of the NICLE-lived experiences.

7.2.1 Everton's Learning Story

Everton is a 59 year-old, grade 4 and 5 multigrade teacher at Martindale School with 15 years teaching experience, of which the first 6 were at a high school in Durban. She trained as an English and Drama teacher at an Eastern Cape University in 1974. Everton explained herself as "an above average numeracy teacher" who had never stopped in her maths classes using the drilling methods and always "insists upon the basics, the bonds and the tables" and yet "allows the children to explore things to the ultimate". In teaching primary maths she drew support mainly from a former Martindale principal and Science graduate and from her current principal, Swallows.

Her participation in NICLE had broadened her understanding of mathematics, given her insights and helped her on maths teaching, especially with regard to getting it “across to the children” and “to look at things from a child-centred point of view”. She had enjoyed her participation in NICLE and she “worked hard at trying to get children to enjoy maths”. Her two years of participation in NICLE had resulted in her saying that she “specialised in maths” and she intended, with the help of SANC, to share her primary maths knowledge with teachers in other schools. Over her two year participation in NICLE she had particularly enjoyed the sessions on Singapore maths, the concept of zero, mental maths, fractions and the language sessions. She had used the edupeg books, the dice, the cards, the flard cards, the flash cards, the wooden blocks, Malati worksheets and the fraction boards in her maths classes. She described the nature of her learning in NICLE as “learning by doing”, “learning from other people...they are reinforcing what I have, what I already put into practice (its practical)...it’s kind of like a support system”. To her, participation in NICLE had also been “a point of growth”.

She supported the use of ANAs and said that “they are good” and “pretty broad” and during her maths class lessons exposed the learners to the ANA “problems put in a different way”. She admitted that the ANAs had influenced her maths teaching. However she had found some inconsistencies in some of the Grade 3, 4 and 5 ANA maths papers. The new CAPS document was considered good for her, as it specified content. However she noted that its whole class teaching approach seemed to ignore the learners’ individual methods. With Martindale being a farm transport school⁴³ her NICLE participation constraint was the travelling distance and her school’s driving responsibilities.

7.2.2 Mary’s Learning Story

Mary is a 37 year-old grade R teacher with 6 years teaching experience, who in 2012 was in her final year of studying for a National Primary Diploma in Education at the NMMU. At the beginning of the third term in 2012 she had transferred from Martindale Primary to Port Albert School and continued to teach grade Rs. Prior to a teaching career she had been working for 7 years as a bank agent. Mary described herself as a holistic teacher, integrating all the three FP learning areas and allowing the children to learn by doing with the aid of concrete objects. In teaching the pre-primary maths classes her approach was mainly influenced by the traditional and the Montessori perspectives, as she explained that she

⁴³ At this farm school the teachers bus in learners in the morning and drop them at bus stops/homes when school finishes. All teachers at this school share in this driving commitment.

preferred concrete, holistic, flexible and integrated learning through play and creative activities.

Mary mentioned several times that she had lost interest in maths and “never had a very good foundation for mathematics especially in High school” where she “had something like 4 mathematics teachers in one year”. She had also “lost the whole essence of mathematics” through gender stereotyping tendencies that “girls...don’t have to worry about maths...as long as you can cook”. However her “mother’s mathematical mind” had triggered a numeracy teacher identity and her participation in NICLE had made her “see the potential to actually call herself a numeracy teacher”. She also said that she was “ten times better” than she was before participation in NICLE and if she was to get her “confidence right” she would choose to specialise in maths. In teaching pre-primary maths classes Mary drew support from Edna, with whom she attended both her diploma classes at NMMU and NICLE sessions. She also drew support from Everton, with whom she travelled mostly to attend NICLE sessions, and from other NICLE overlapping activities, such as the 2011 National maths week’s AMESA maths challenge held at Delta High.

Her studies at NMMU and participation in NICLE had made her “enjoy mathematics” though she had always “been stronger with the life-skills and the literacy”. She hoped that her participation in NICLE would enable her to create democratic classes in which she could allow the children to explain their calculating strategies. She also explained that her participation in NICLE was helping her “develop professionally” and was for her “own enrichment” so that she could develop the “confidence with mathematics” and “transfer that knowledge” to her “learners”. She described her nature of learning within NICLE as “practical” and “enriching the basic knowledge” that she had, making it easier for her to “put into practice in her own classroom”. She had also explained that NICLE involved practical participation and learning by doing which “motivated...inspired...excited” and made her “enthusiastic” and “enjoy” maths.

She had requested at Martindale to be allocated sessions to teach the Grade 3 classes so as to put into practice what she learned at NICLE. She had also put in a similar request at her new school. Thus one of her disadvantages was not being able to put into practice the Grade 3 ideas she was learning in NICLE. The other disadvantage pertained to her former school, Martindale, in which they had also the responsibility of transporting the learners, which would result in their school teachers arriving late for the NICLE sessions. Mary also

remarked that NICLE needed to accommodate more teachers than its current participants, as she perceived a great need for other teachers in her area.

According to the teachers with whom she had had conversations, the ANAs weren't popular. However she said that if she was teaching the grade 1s she would have no problems with the ANAs, because it also evaluates teachers' performances. She liked the new CAPS document for providing lesson plans, being user-friendly and straight forward and covering all the key primary maths concepts. In the pre-primary stage her teaching practices resonated with the CAPS' emphasis on teaching using concrete examples.

During her two year participation in NICLE, Mary had particularly enjoyed the sessions on the zero concept, mental maths, fractions, Singapore maths, languages, computer maths games and Glynnis' practical demonstration lesson. In teaching her pre-primary maths classes Mary said she had used the dice games, card games, wooden blocks, edupeg material and the Grocott's "Ukufunda" maths challenge exercises.

7.2.3 Edna's Learning Story

Edna is a 38 year- old female Grade R teacher who taught at Delta High School (a combined primary and secondary school) and had 6 years Foundation phase teaching experience. In 2012 she was completing her National Diploma in Education at NMMU. Edna had worked before in the entertainment and security industries, which involved engaging and working with 'a lot of numbers'. Though she taught the Grade Rs, through her participation in NICLE she had requested from her school Principal extra maths time, twice a week after school with the grade 3s. She explained herself as having "the passion and love for numbers" and tried to actively engage the learners to enable them to enjoy maths. Her strongest teaching subject was maths on which she said she spent more time teaching and integrating it with games so that it could be fun for the learners. On teaching maths she drew support from Naidoo, a female teacher at Delta Primary who also attended NICLE.

NICLE had also provided her with the opportunity to relate with the learners and encourage them to explain their strategies. She looked forward to specialising in maths education and teaching the senior primary grades. She had applied and intended to study for a Bachelor of Education degree in 2013. Both with the Grade Rs and the Grade 3s Edna mentioned that language constrained her maths teaching as she could hardly speak isiXhosa, yet some of her learners' first language was Xhosa.

She supported the ANA tests because they provided a ‘yardstick’ to measure both the teacher’s and the learners’ performances and felt that the ANAs influenced her in a positive way. Though she hadn’t familiarised herself with CAPS primary maths practices she felt that learners must be encouraged and be given the opportunity to explore and to reason. She also said that NICLE had provided her with the opportunity to join and attend the AMESA Eastern Cape regional conference, the Mathematics Education 21st Century conference’s teacher focused day and Aarnout’s workshops⁴⁴. On the nature of her learning Edna explained that in NICLE all the teachers were “actually involved and engaged” with NICLE, enabling her to “grow in that field (of primary maths)” and had enriched her so as “to carry over better to the learners”. During her two years of participation in NICLE she had particularly enjoyed the sessions on the zero concept, number sense, language, maths fun evening and the problem-solving sessions. She was also using NICLE’s games and the eduepeg books in her Grade R classes and during her Grade 3 after- school maths sessions.

7.2.4 Robert’s Learning Story

Robert is a 40 year-old male teacher who mainly teaches maths and at times Technology and English in the Intermediate phase grades. He completed training as a high school teacher in 1992, specialising in Afrikaans and History. He has been teaching maths from Grades 4 to 7 for the past 19 years at Delta Primary and heads the school’s maths learning area committee. He studied for an ACE qualification and later enrolled for a Bachelor of Honours in Education, specialising in Intermediate phase mathematics. He began studying for a part-time Masters in Maths education in January 2012, specialising in Numeracy, after receiving a scholarship from the SANC project.

Robert describes himself as someone with the “pure love of teaching mathematics”, who is an “authority in the intermediate phase mathematics” and “confident and comfortable” in this field. In teaching maths he drew support from his former lecturers at RUMEP, Rhodes Education department and also “through reading”. He regarded participation in NICLE as providing an “opportunity to interact with other maths teachers” and people “who have an interest in mathematics” and through such interactions develop different strategies to implement and teach concepts. Ultimately his interest was to give “the best” to his learners and to make maths enjoyable and interesting. To this effect one of his learners had done

⁴⁴ Edna had attended both Aarnout’s Maths Education Conference’s workshop on 11 September 2011 and the Developing Number Sense workshop hosted on 27 August in Port Elizabeth.

“tremendously well” in the Conquesta Olympiads maths competition and he said they all looked forward to participating in the AMESA learners’ maths challenge.

Robert described his experiences in NICLE as involving “active participation” that “supported”, “refreshed” and “stimulated” his “understanding of mathematics” leading to “a deeper understanding”, “personal enjoyment” and growth in learning. He described the nature of learning in NICLE as a “socio-cultural learning perspective” with teachers “learning together with other people in group sessions...a social set-up...interacting” and as “cooperative learning” in which you learn about how to improve your teaching, “how learners should learn”, and “how learners can learn”. According to Robert, NICLE also connected theory and practice.

He had particularly enjoyed the zero concept, number sense and the language sessions and had used mathematical games, 3D shapes, dominoes, card games, dice, matchstick patterns and the Grocott’s “Ukufunda” series’ exercises in teaching his maths classes. His only disadvantage mentioned in participating in NICLE was the distance he had to travel from his school to the site of NICLE, in Grahamstown (a 50 minute one-way trip).

Though Robert said that his teaching had been influenced by the ANA tests, he also took a critical approach to the ANAs and said he would not be “blindly lead” but would “manage” his teaching. He explained that the ANAs are a good way of measuring performance and benchmarking learners, but to improve the validity and reliability of the ANA results, Robert suggested that the test papers “should be marked externally”. Robert also remarked that the ANA tests were a “burden” to learners in terms of the number of questions to be answered and the amount of reading it involves. He supported the new CAPS curriculum for drawing from the Cognitively Guided Instruction perspective, which he commented as a good way to approach problem solving that connects theory and classroom practice.

7.2.5 Calvin’s Learning Story

Calvin is a 48 year-old Grade 5 and 6 maths male teacher and Deputy Principal at Bongani Primary School with 26 years teaching experience. Calvin is both a member of the School Management Team and the School’s maths learning area committee. Calvin particularly remembered his primary school teacher, Mr Boyce, whom he described as having been “very good in maths”. He did maths up to Standard 7 (Grade 9) at primary level and had to drop it when he enrolled for secondary education at Glendale High because of the subject

combination restrictions which led him to do Woodwork and History, yet he said he would have preferred doing Maths and Woodwork. He completed his Diploma in Education at Grammy College, specialising in Woodwork, handicraft and some academic subjects. He first taught at Delta Primary in 1997 and remarked that being the only male teacher at the school at the time, the Principal allocated him to teach the subject of maths, which was how he became “a maths teacher”.

Calvin emphasised that he likes and enjoys maths teaching and is well acquainted with the maths content of the phase that he teaches. He attributes his good maths knowledge to his primary school teacher Mr Boyce. When OBE was introduced in 1998 he trained teachers in the then learning area of Technology. He also attained a Bachelor of Education degree, specialising in Intermediate phase mathematics at RUMEP, where he learned about constructivism, which he said changed his approach to teaching and learning. Because of personal and technical challenges he had refused an invitation from the Department of Education to train maths teachers on the new CAPS curriculum. In teaching his maths classes Calvin felt severely constrained by his learners who struggled with English.

He had particularly enjoyed and was using in his maths classes’ activities from NICLE sessions on Singapore maths, mental maths, Melania’s demonstration lesson, zero concept, fractions, language and problem solving and sense-making sessions. He had also used the fraction charts, card games, die, dominoes, the homework books, 3D paper cardboard shapes and the wooden blocks activities in his classes. He said he wanted to form a primary maths teachers’ cluster in his area were they could share maths knowledge and teaching strategies with other educators. During the 2011 cluster meeting for primary maths teachers he had presented a demonstration lesson to other teachers. He drew support from, and discussed maths issues with neighbours, colleagues and primary teachers in surrounding schools.

He remarked that the ANAs had influenced his teaching practices and were good because they provide learners’ baseline information and can be used to measure a teacher’s performance. He noted that the CAPS curriculum is better for it specifies content and concepts supposed to be taught, and aligns with the constructivists and cooperative learning practices he had learnt at University. He described the nature of learning in NICLE as “Maths-driven”, which involved “learning and sharing” new strategies, experiences and opinions that link to “classroom experience” and “how to impart that knowledge to learners”. He also said that NICLE tested his mathematical senses both in terms of content and

classroom management styles. His administrative position constrained him in both attending all the NICLE sessions and carrying out his maths teaching responsibilities. He also wished NICLE could accommodate a larger number of teachers as the need for such development in his area was great.

7.2.6 Pamela's Learning Story

Pamela is a 45 year-old Foundation phase-trained teacher who has taught for 18 years across this phase. She taught a Grade 3 class at Bongani Primary School. She said that she had a fear of maths which she first encountered during her primary education when other learners told her that “maths is difficult”, and this led her to do “functional maths” instead of “real maths” at secondary school. During her 3-year teaching training diploma she had specialised in English and isiXhosa and other subjects but not maths. She expected that her participation in NICLE would enable her to discuss primary maths problems with other teachers and to change her “mind” so that she could share her experiences with her classes, “teach maths correctly” and improve the learners’ performance. Her participation in NICLE changed her teaching approach, leading her to introduce new mathematical concepts to learners on the mat before doing whole class teaching.

In teaching maths she drew support from other Grade 3 teachers, and mainly from Calvin, the School’s Deputy-principal. Her participation in NICLE had made her “confident” and had given her the insight to appreciate the learners’ own strategies and to encourage them to explain their answers. She also explained that her participation in NICLE had changed her “perception on how to do mathematics” with her learners and enabled her to create liberal maths classrooms in which learners develop their own understanding and “enjoy the mathematics period”. Pamela described being caught in a dilemma concerning the ANAs as she wanted to teach the learners the five learning outcomes, yet felt she needed to “adapt and teach...according to ANA style”. She suggested that the ANAs be set at the provincial level so that some of its test items are context-relevant. She also noted that the ANAs did not cover all five learning outcomes. She liked the new CAPS policy document because she saw it “easy to interpret...very friendly”, had a “flexible approach” and had good mathematical outcomes.

During her two years of participation in NICLE she had particularly enjoyed the mental maths and both demonstration lessons. In teaching her maths classes she had used flashcards, playing cards, games and the fraction boards. She described NICLE as being a platform that

invites “experts/specialists in mathematics” who engage teachers in discussions addressing their mathematical “fears”. She elaborated that NICLE had changed her “thinking” and helped her to “love mathematics” and in the process took “some fears” that she had and made it “easy” for her to teach maths. Furthermore NICLE enabled her to share her challenges and problems with other NICLE teachers. She also felt that the NICLE initiative should be extended both to include other primary schools in the district and nationally.

7.2.7 Ruth’s learning story

Ruth is a 58 year-old female Grade 3 teacher at Heritage Preparatory School. She has a Bachelor of Education Degree in which she specialised as an Intermediate Phase teacher in History and Geography. She has a total of 26 years teaching experience across primary and secondary school. She had also studied further and acquired a Bachelor of Education Honours Degree in 2006. In 2011 she had just completed a UNISA course in Art. Her first “teaching experience with numeracy” was when she taught at a German primary school in Durban with a learning approach emphasising the importance of “basic bonds” and “mental maths”. Ruth had also taught in another German school in Cape Town and had later relocated to Botswana where she taught at a multi-racial international school. On return from Botswana she taught in the Northwest province, then Bophuthatswana, at an English medium school that enrolled many foreign students whose parents came from other African countries, America, Britain and Israel. She remarked that these phases in her career greatly influenced her teaching.

She explained herself as a “very practical person” who liked “integrating topics” and “making the world real to primary children”. She had done “matric maths” and had “very good number sense” though she admitted to struggling with teaching at the Foundation phase. Prior to joining Heritage Primary she had been teaching Geography and Art at lower high-school level. In teaching maths she drew support from her Principal who “is passionate about maths” and also from her colleague and Grade 3 “direct partner” with whom she had daily preparation and teaching meetings. In her current position she felt limited and restricted by the school’s imposition and prescription of the preferred teaching approaches and also what has to be taught. She felt her participation in NICLE had “awakened...inspired...stimulated...enlightened...freshened” her interest in maths developing her understanding and made her “enjoy” and think about “the process and steps of teaching” which made “learning enjoyable for the learners”. NICLE had also “broadened [her] interest”, given her the “energy” and “enthusiasm” in maths again by keeping her “on

track” and taking her back to what she knew “is right”. She explained her learning in NICLE as “participation” in practices that relate to “how one can teach in the classroom”.

With regard to the ANAs influencing her maths teaching practices Ruth expressed a tension. Her concern was giving the children a well-grounded understanding in maths, with her ultimate intention being to let the learners both understand maths and do well in the tests. She felt that the Grade 3s had difficulties in reading both the instructions and the questions in the ANA tests papers. She later explained that the ANA tests had influenced her teaching especially “in the third term” when she spent most of the time practising and revising ANA type problems. She explained that the new CAPS curriculum document was “very user-friendly...detailed” and gave prominence to “practical experience” and promoted “real understanding of numbers”. Because of its emphasises on the practical, Ruth felt that the CAPS curriculum related to her beliefs about how maths must be taught, however she also critically explained that the new document was not good “for the average and the whole group teaching situation”.

She said she had enjoyed NICLE sessions relating to the zero concept, fractions, number sense, mental maths, Melania’s demonstration lesson and Pa and Ma’s video clip. She mentioned the alphabet game, playing card games, the dice, mental maths games, number lines, fraction problem solving and the edupeg materials as among those she had used in her maths classes. Ruth also mentioned that “time and convenience” were the most limiting factors in attending NICLE as they were not relieved of their teaching duties and extra-curricular responsibilities.

7.2.8 Melania’s Learning Story

Melania is a 43 years old female teacher with 12 years teaching experience in the foundation phase. She teaches grade 3 at Heritage Preparatory Primary school and has a Higher Diploma in Education. She described herself as someone who understands the concepts she teaches, enjoys and is excited to do maths, mainly uses concrete apparatus to teach and still “believes that there is a place for drilling”. In teaching maths she drew support from Ruth, her Grade 3 direct partner, and her principal, whom she described as “a very good maths teacher” who provides guidance and resources.

She explained that participation in NICLE had “saved” her teaching because she now “communicated more with the children about how they are doing things and why they are

doing things and the need to explain the reason behind what they are doing". Because Melania enjoyed maths and knew the "subject well enough" she tried to "carry over that element of enjoyment" to the learners. Melania also explained that through participation in NICLE she had "got a more excited approach of (sic) teaching... a better understanding of what you need to do in respect of the learners". She explained the nature of learning that she experienced in NICLE as refreshing, revitalising, boosting her enthusiasm and giving her "new fresh ideas". Relating to this is Melania's comment that participation in NICLE prevents one from getting "into a rut of doing things". She also described the nature of learning in NICLE as "learning that you'll take with [you] forever...you try to think about it often and try to apply yah it's a continuous thing".

She explained that the ANAs had not influenced her practice but had made her aware of the "correct maths language" used in the ANA questions. She believed that it was "more important for the children to have a well-rounded understanding" of mathematics. To improve the reliability of the ANA test scores she suggested that the tests not be marked at the school at which they were written. She liked the new CAPS document for being user-friendly, straight forward, having a clear evaluation point system and for emphasising problem-solving, number sense and learners explanations of their calculation strategies. However she preferred that the children be encouraged to use vertical calculating strategies rather than the horizontal method emphasised in the CAPS document.

During her two-year participation in NICLE she had particularly enjoyed sessions involving number sense, mental maths, fractions and language NICLE sessions. Melania also said that she had used the alphabet game, the card game, the dice games, flashcards, the wooden cubes and the homework books in teaching her maths classes. Her only challenge to attending NICLE was the time factor, and she also wished more teachers could participate and "benefit" from the programme.

7.3 In summary

The teacher learning stories-*stelos* presented in this chapter provide the backdrop for addressing the research questions underpinning this study, and inform the discussion that follows in Chapter 8 9 and 10. Key also for this study is that the teacher learning stories, together with some sociocultural theoretical elements, illuminates how primary maths teacher learning and identity formation unfolds in the NICLE empirical field. Thus the teacher learning stories presented above help to address the main research question and provide the

contextual background used in the following Chapter to explain the nature of primary maths teachers' dialectical learning within the CoP informed primary maths teacher in-service programme.

Chapter 8: Analysis of primary maths teacher learning stories (stelos)

8.1 Introduction

In this chapter I analyse the study's research data, using socio-cultural theories as described in Chapter 3. I explore and analyse the process of evolvment of teacher learning and identities in relation to participation in NICLE. The approach to the overarching research question is generally illuminated by the situative principle of learning as 'participation' in practice, and specifically by Lave's (1996) notion of *telos*, and Sfard & Prusak's (2005) definition of learning as identity change and their identity-as-story construct. I also investigate how primary maths teacher identities evolve, and the processes of this evolvment in the light of Wenger's (1998) characterisations of identity as *nexus of multimembership*, as a *learning trajectory* and the component of 'imagination', which is one of Wenger's three modes of belonging.

Informed by both the sociocultural theoretical orientations and the empirical findings, I propose the use of the term *stelos*, which are learning stories or stories about learning changes in one's identity through participation in a Community of Practice. The term *stelos* borrows from Sfard and Prusak's (2005) proposition of equating identities with stories and Lave's (1996) notion of *telos*. Analysing the key data themes that emerged from teacher utterances, I show how teachers with a history of maths competence, that is "valued or positively valued maths identities" have their maths identities *reinvigorated*, whilst teachers with identities that previously shied away from maths have their "devalued or negatively valued identities" maths identities *remediated* (Lave, 1993b, p.77) through participation in NICLE. In the process new mathematical identities are *activated* through participation in community of practice, resulting in both instances in teachers with stronger maths identities.

The teachers' verbs and phrases from which emerges the synonyms *reinvigoration* and *remediation* and *activation* supports that 'transformation and change' (Lave, 1993a, p. 30) in identity happens through participation in Communities of Practice. Thus the synonyms explain the transformation and identity changes experienced by teachers participating in a primary maths teacher Communities of Practice professional development initiative. The synonyms also *provide a language* to describe 'learning mechanisms' in Communities of Practice, with learning mechanisms being "ways of becoming a participant, ways of participating, and ways in which participants and practices change" (Lave, 1996, p. 157). Thirdly the synonyms capture the learning of the eight teachers participating in an in-service programme and *connect* these with their mathematical histories and trajectories.

The second part of this chapter explores the first research question on how primary maths teachers' identities evolve in relation to participation in an in-service community of practice programme and the processes of such evolvment. To address this question I use Wenger's (1998) characterisations of identity as *nexus of multimembership*, and as a *learning trajectory* and the component of '*imagination*', which is one of Wenger's three modes of belonging. This exploration and analysis of data indicates that foundation phase teachers' embed their primary maths teacher identity within their foundation phase teaching across a range of subjects whilst Intermediate phase teachers who *only* teach maths at the primary level embrace maths subject specialised identities. Secondly in the Chapter I explain the processes through which primary maths teacher identities evolve in relation to participation as '*insiding*' and '*outcropping*'. These terms borrow from Wenger's (1998) discussion of identity as learning trajectory and extend two of the various types of trajectories found in communities of practice. *Outcropping* teacher identities trajectories do not confine or limit their participation only in NICLE and in maths classes but also extend their maths identities into a wide range of mathematics education practices, crossing boundaries and linking overlapping communities of practice (Wenger, 1998). *Insiding* involves teachers limiting their participation in NICLE and in maths classes. The teachers' maths identities can also shift between insiding and outcropping, with participation in the CoP leading to 'outcropping' of different forms and extent and at different stages of engagement within the professional development programme.

8.2 Describing the nature of primary maths teacher learning through learning stories-*telos*

To help unpack and understand the process of primary maths teacher learning and identity formation I use Sfard and Prusak's (2005, p. 19-20) definition of learning as "closing the gap between the actual/current⁴⁵ and designated identities" and their identity-as-narrative construct. Also to aid my analyses and discussion of the research finding is Lave's (1996, p. 156) notion of *telos* which concern "changes implied in notions of learning". Lave's notion of *telos* is a "liberating analytical tool" (Lave, 1996, p. 156) for discussing the learning processes within Communities of Practice - a point acknowledged in maths teacher education (Lerman, 2000; Matos, 2009). Lave (1996, p. 156) further elaborates that *telos* is "not the same as goal directed activity" but encourages instead "a focus on the trajectories of learners as they change". In other words the participants' trajectories as discussed in the learning stories and the community's *telos*' elements are deeply connected, reciprocal and mutually constituted. It is important to note that learning and identity transformation is an encompassing process that dually and mutually involves the participants and how they relate in the context of those communities as they pursue and engage in the valued enterprises of the community (Wenger, 1998). In this regard the notion of *telos* must not be misread as a top-down orienting of the participant's identity, and should instead be taken as a complex notion of development occurring in a dynamic direction (Matos, 2009).

As outlined earlier in Chapter 3, Sfard and Prusak (2005, p. 16) defined identities as "stories about individuals that are *reifying*, *endorsable* and *significant*". The teacher learning stories I discuss in this chapter meet Sfard and Prusak's criteria of narratives that are identities. Firstly the stories meet Sfard and Prusak's (2005, p. 16) notion of 'endorsability' as my use of teacher utterances and words allows me to "faithfully reflect the state of affairs..." Secondly Sfard and Prusak (2005, p. 17) argue that the "most significant stories are often those that imply one's memberships in, or exclusion from various communities". Thus in this study I describe the sampled teachers' learning histories some of which excluded or promoted them in participating and engaging in maths communities. Their NICLE participation stories shows

⁴⁵ More recently Sfard has chosen to replace the term 'actual' with 'current' to avoid the term sounding declarative (see Graven, 2012).

membership within a numeracy community of practice that also gives participants access to overlapping primary maths teacher communities.

The third criterion of reification requires further explanation on how it is used in this study. Both Heyd-Metzuyanim & Sfard (2012) and Wenger (1998) define reification as the discursive activity of conveying status of an object to something that is not properly an object. According to Wenger (1998, p. 58) the process of reification “provides a shortcut to communication” and also gives “form to our experiences”. The reifying qualities come with the use of verbs such as *be*, *have* or *can* and their derivatives (Sfard & Prusak, 2005; Heyd-Metzuyanim & Sfard, 2012). For example some of the derivatives of the verb *be* are *am*, *is*, *are*, *was*, *we*, *were*, *being*, *been*, *my*, *me*, *I*, *your*, *you* and *our*. The reifying descriptions can also feature such words as “*always*, *never*, *usually* and so forth that stress repetitiveness of actions” (Sfard & Prusak, 2005, p. 16). In tables 8.1 and 8.2 below the teacher’s articulated mathematical identities (in the second column) and the verbs and phrases used to describe their NICLE participation and learning experience (in the third column) are related to Sfard & Prusak’s (2005) operational criteria of identity as stories about individuals that are reifying, endorsable and significant. The table provides a range of example to show what I took as indicators of stelos.

Teachers	Articulated mathematical identity	Teachers' verbs and phrases describing their NICLE participation and learning experiences, from which emerges the synonym <i>Reinvigoration</i>
Valued maths identity (+)		
Ruth	<p>+ 'I think I have got a very good number sense you know inherently'</p> <p>'...personally I think I have a good number sense...'</p> <p>'when you look at the content that we were dealing with (in NICLE) I don't think that was new to me, no...I did do matric maths'</p> <p>'I used to be very good at maths, and my children are very good, so they must have genetically got it from somewhere'</p>	<p>'So it has <i>supported</i> what can sometimes become tedious. It has <i>freshened</i> it up... may be it has <i>awakened</i> that interest again and it has <i>supported</i> my, developing my own understanding, thinking about the process and steps of teaching'</p> <p>'What I have really enjoyed about it is that <i>it's taking me back to what I know is right...</i>'</p> <p>'I have been <i>supported</i>, I feel more confident about what has to be taught...'</p> <p>'...just the <i>stimulation</i> of the material that we were exposed to and I have really enjoyed learning about all that.</p> <p>'...I suppose it has <i>broadened</i> my involvement in it again. Yes I suppose it also <i>freshens</i> up my understanding and extensity as well'</p> <p>'...being involved in any topic <i>makes it relevant again and fresh</i> and it <i>awakens</i> your interest...'</p> <p>'...for me personally it was engaging and <i>enlightening</i> and interesting...to <i>build enthusiasm</i> for my own class and my own teaching and not to feel alone in it and to know that <i>we are on track...</i>'</p> <p>'...it <i>provided some light, it shed light</i> on how children learn ...'</p> <p>'I think I will remember <i>the inspiration</i> and the energy...when I say energy I mean <i>energy for the subject the enthusiasm...</i>'</p>
Melania	<p>+ 'I enjoy maths and hopefully my enthusiasm for maths spills over to the children...'</p> <p>'I can do maths I can help myself and I understand the concept that that I am teaching...I am very happy with the maths that I have to teach and I enjoy it...'</p>	<p>'...it just <i>sharpened my awareness</i> again ...definitely <i>it saved my teaching</i> because I have communicated more with the children about how they are doing things...'</p> <p>'...just every now and then in your teaching career you need to have some <i>bit of energy</i> and you need <i>to be refreshed</i> you need to be <i>revitalised</i> and I think that's what it has been for me it just sort of <i>refreshed</i> me given me new ideas, <i>boosted my enthusiasm</i> again....'</p>

	<p>‘I spend a lot of time with maths because I enjoy it, so I try to carry over that element of enjoyment...’</p> <p>‘I know my subject well enough, I can teach maths well...’</p>	<p>‘...definitely given me <i>new fresh ideas</i> that you immediately think I would implement those in my class’</p> <p>‘Very positive and I would say very <i>thought-provoking</i>. Very <i>stimulating</i>. It often <i>refreshes</i> your memory, <i>it gives you new ideas</i>’</p> <p>‘it is so easy <i>to get into a rut of doing things</i> in a certain way and your routine every day and when you have been to this, it just sort of <i>gives you new ideas...it helps break your routine</i> – makes lesson more exciting’</p> <p>‘And I said <i>one tends to get into a rut</i> and it just helps you to <i>bring new and exciting ideas</i> into your classroom’</p>
Robert	<p>+ ‘I am an authority in the intermediate phase mathematics’</p> <p>‘pure love of teaching and a pure love of mathematics’</p> <p>‘I have pulled myself from history. Being a history teacher towards becoming a more maths-orientated teacher’</p> <p>‘Currently...I feel more confident and comfortable in my field’</p>	<p>‘I think <i>refreshment</i> is always welcome because I think sometimes you become so confident that you start to just <i>stagnate</i> and you don’t entertain yourself with new ideas...’</p> <p>‘NICLE played a part and is still playing a part in <i>stimulating</i> me. When it <i>stimulates</i> you, you start to take it to heart...’</p> <p>‘...my understanding of mathematics was <i>stimulated</i> and it was supported because the little I had I felt it was <i>starting to grow</i>...’</p> <p>‘And also when I see they enjoy it, <i>its igniting in me, a fire</i>’</p> <p>‘I even feel strongly that NICLE <i>injected some energy</i> into a purposeful discussion’</p> <p>‘I think personal enjoyment is always <i>activated</i>...It was <i>refreshing</i>, also <i>energising</i> on a personal note.’</p> <p>‘No it just <i>reinforces</i> or <i>supports</i> how you teach it’</p> <p>‘So NICLE I would say <i>supports</i>. It <i>illuminates</i> or <i>makes it come alive</i>...so I think NICLE did <i>support</i> me in my studies and in my teaching practice’</p>
Everton	<p>+ ‘I really enjoy my mathematics teaching.’</p> <p>‘I am an above average numeracy teacher...’</p>	<p>‘...I feel as though I am <i>on the right track</i> with the way that I teach maths...’</p> <p>‘... <i>reinforcing</i> what I have, what I already do put into practice. Its learning, it’s kind of like <i>support system</i> for a lot of things I do’</p> <p>‘...that <i>broadened</i> my understanding of mathematics and how to get it across to children’</p>

	<p>‘Well I prefer to teach mathematics than virtually anything else, except languages. But all those subjects I enjoy, but mathematics I particularly enjoy’</p>	<p>‘<i>A light shining in on my maths teaching...</i> giving me more <i>insight</i> on my maths teaching. It’s been a <i>point of growth</i> for me as a teacher’</p>
Edna	<p>+ ‘I love numbers... I have a love of numbers’</p> <p>‘...I think I do much better in that (maths) than in other areas because I have a passion for it and I always tend to give more time towards that...’</p> <p>‘My strong point in the classroom is also maths. I know I am not supposed to do it but I tend to spend a lot more time with maths than the others’</p>	<p>‘...the only way that I will be able to help the learners around me is by to be <i>better equipped</i> and to take every opportunity that coming my way, to be <i>able to grow in that field...</i>’</p> <p>‘I <i>enriched myself</i> in order to give a better [lesson]...to carry it over better to the learners’</p>
Calvin	<p>+ ‘I like teaching maths, in fact I wouldn’t like to teach another subject’</p> <p>‘I have a good understanding of the content for where I am teaching’</p> <p>‘Currently I’m only teaching maths, so basically I’m specialising in maths... I don’t want to teach other learning areas’</p> <p>‘At least I’m comfortable with content. I know...I know intersen. I know the content of mathematics. I can teach anything from grade 4 to 6...I enjoy teaching maths’</p>	<p>‘...<i>my sense of mathematics are being tested</i>, and I am not talking of content based maths only but classroom management’</p>

Table 8.1: Teachers’ articulated (valued) mathematical identities, their participation experiences and the emerging *reinvigoration* synonym

Teachers	Articulated mathematical identity	Teachers' verbs and phrases describing their NICLE participation and learning experiences, from which emerges the synonyms <i>remediation</i> and <i>activation</i>
Devalued maths identity (-) – Stunted		
Pamela	<p>- 'But what I wanted to say is that I need to change my mind so that I will be able to teach mathematics correctly'</p> <p>'Because I, before I have attended NICLE I had problems...the problem is when I am teaching it to the kids, I was not sure whether I was doing it in the right form, but after NICLE now I can say I know...'</p> <p>'it (NICLE) has taken some (mathematical) fears that I did have'</p> <p>'I am sure I was fearing the unknown. Because...when I entered the primary level they said 'yo, maths, it's difficult, and then I came to that, to that route thinking that maths is difficult'</p>	<p>'After I did those sessions I am confident with myself and also it <i>has changed my ways of doing things</i> in numeracy because before NICLE I will use my, I will force my learners to know my method and only my method'</p> <p>'We are having specialists [in NICLE] <i>they do address our fears</i>. Sometimes as mathematical teachers <i>we do have fears</i> of how we are going to do this in my class. But with NICLE they will invite somebody and <i>that somebody will address your fears...</i>'</p> <p>'I am glad that I am part of this program. <i>It has changed my thinking</i>, it has also <i>helped me to love mathematics</i>. It has <i>taken some fears that I did have</i>'.</p> <p>'But because now we are with NICLE <i>our challenges and fears are being addressed</i>'</p> <p>'Meeting experts in mathematics. You see <i>the fears that we sometimes have...</i>sharing with other teachers from other schools.'</p> <p>'Oh, of <i>changing our perception on how to do mathematics</i> with our learners'</p>
Mary	<p>- 'I never had a very good foundation for mathematics especially in High school so I kind of lost, in sense I have lost interest'</p> <p>'Initially I was scared (to teach maths) because of my lack of confidence and knowledge and experience'</p> <p>'...the maths for me would be more of a challenge because of the whole mind-set I grew up with. Being told you can't do maths and girls... don't have to worry about maths'</p> <p>Because I gave up maths in standard... end of</p>	<p>'I think my mother <i>triggered</i> some sort of it. It intrigued me that she has a mathematical mind and you know I always thought I would like to work out something like that'.</p> <p>'I often feel very stupid compared to those other teachers...but I feel like <i>I am still growing</i>'</p> <p>'Only really this year do <i>I really regard myself as a numeracy teacher</i>, if you asked me last year I would have said, <i>oh no I can't do Maths</i>, but <i>this year I can see potential to actually call myself a numeracy teacher</i>'.</p> <p>'...it is helping us develop professionally...<i>developing my self-confidence with mathematics</i> and I love the sharing when I do my group work with things that come up, um, you know with the other teachers, sharing experiences''</p> <p>'...its <i>enriching</i> the basic knowledge that I have already'</p>

	<p>standard 7...I mean I probably got about 30%. I mean I failed maths standard grade. So at matric I wouldn't have a clue.”</p>	<p>‘...it’s exciting and its <i>stimulating</i>, and a lot of things you can relate to as well. You know, like especially with those guest speakers’</p> <p>‘Well it’s a <i>very positive experience</i> for me...it’s been <i>motivating</i> and you’ve wanted to put it into practice in our own classroom’</p> <p>‘It makes you feel <i>motivated</i> and I suppose it <i>inspires</i> us. It certainly <i>inspired</i> me as a teacher. I feel ...I am excited. It’s <i>not tedious thing</i> of ‘aah, I’ve got to do some maths today’. I do enjoy it. I look forward to it’</p>
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Table 8.2: Teachers’ articulated (devalued) mathematical identities, their participation experiences and the emerging *remediation* and *activation* synonyms

8.3 Connecting teacher participation and learning experiences with maths teachers' devalued or valued identities

Reading from their mathematical stories, and informed by Lave (1993a), I categorise the sampled teachers as either having *had* a negatively valued (devalued) or positively valued (valued) maths identity. The negative or positive maths teacher identities arise from the teacher stories about their school maths learning, classroom maths teaching and or life maths experiences. The school context or its setting also influences primary maths teacher identities. Ruth, Melania, Robert, Calvin, Edna and Everton had positively valued maths identities, whilst Mary and Pamela maths learning, teaching and life maths experiences expressed negative valuation of being and doing maths. I categorise the teachers' maths identities based mainly on their response to the first questions in the 2011 and 2012 interactive interview schedules, which read "*How would you describe yourself as a numeracy teacher?*" and "*How would you describe yourself as a teacher?*" and connect these across interview utterances that indicate whether a teacher has a devalued or valued maths identity. To provide rich thick description and in-depth qualitative data on how differently teachers with valued and devalued maths identities learn I use direct quotes, in tables 8.1 and 8.2 (above), from all relevant teachers' interview utterances relating to their learning experiences within NICLE, and link these to their mathematical histories and trajectories.

The tables above distinguishes categories between devalued and valued maths teacher identities as these relate to how these two groups of teachers describe their NICLE participation and learning experiences. From the data the two distinct sets of learning metaphors which are used to represent a range of synonymous used by the teachers, namely – *reinvigoration*, and *remediation* and *activation*. Though the sampled teachers had similar NICLE participation experiences they articulated them differently and in relation to their mathematical histories. Thus I equate the six primary maths teachers with positively valued maths identities' utterances of their learning experiences and the nature of their participation in NICLE with the synonym *reinvigoration*. Drawing on the '*stelos*' of teachers with negatively valued mathematical identities I suggest that their participation in NICLE '*remediated*' and '*activated*' more positive and participatory mathematical identities. It must be noted that the synonyms used by the teachers to describe their NICLE participation experiences were not part of the NICLE discourse, neither did I employ or introduce these terms during the interviews. Tables 8.1 and 8.2 above summarises the teachers' articulated

mathematical identities, their participation and learning experiences from which emerge the synonyms that dialectically explain the nature of primary maths teacher learning within an in-service CoP.

Below I elaborate on the emergence of each of these metaphors for the stelos of two groups of teachers with histories of positively and negatively valued mathematical identities respectively.

8.4 The stelos of teachers with positively valued mathematical stories captured metaphorically as ‘reinvigoration’

Six of the sampled eight teachers with valued maths teachers’ histories and identities described their participation and learning experiences in NICLE with verbs and phrases that are equivalent to or synonyms of reinvigoration. Given the length of the interviews, it is beyond the scope of this study to analyse and explain in detail each and every teacher utterance in relation to the three criteria of Sfard & Prusak’s elements contained in the operationalized definition of identity. Thus I will give only a few examples here for illustration purposes. All the teacher utterances in the second column of table 8.1 above meet the endorsability and significant criteria as has been explained before. Here I will explain how Ruth, Melania and Robert’s first statements indicate reification and reifying effects.

For example Ruth had said “*I think I have* a very good number sense you know inherently”; with Melania had said “*I enjoy* maths and hopefully *my* enthusiasm for maths spills over to the children...” and Robert had said “*I am* an authority in the intermediate phase mathematics”. Ruth’s utterance that she has a “very good number sense”, Melania’s articulation that she has “enthusiasm for maths” and Robert’s description of himself as “an authority in the intermediate phase mathematics” illustrates the concept of reification. Since these utterances show “certain permanent qualities” (Heyd-Metzuyanim & Sfard, 2012, p. 131) of Ruth, Melania and Robert’s relationship with maths. Ruth, Melania and Robert’s statements include use of verbs such as *have*, *I*, *am* and *my* which have reifying qualities. These have been italicised in the statements exemplified above.

Besides the reifying, endorsable and significant statements provided in the second column of the table, in this part of the chapter, I analyse and describe the sources of the positive primary maths teacher identities as communicated by Ruth, Melania, Robert, Calvin, Edna and

Everton during the interactive interviews. Calvin, Edna, Ruth and Robert's valued maths teacher identities were said to be as a result of their positive school maths learning experiences and or their sense of their ability to do maths at matric level. For example, though he stopped doing maths in Standard 7 (Grade 9), Calvin explained that his interest in the subject was because of his "primary school teacher, Mr Boyce (who) was very good in maths". Edna also attributed her enthusiasm for maths both to her positive primary and secondary school maths learning experiences. Ruth's valued maths identity emerged during her secondary school maths experiences when she did 'matric maths' whose content she explained went "beyond the level" at which they engaged in the NICLE sessions. In the initial stages of his career Robert had pulled himself from "being a history teacher towards becoming a more-maths-orientated teacher" and he similarly attributed this to having done "maths at high school". Thus for Calvin and Edna their positive memories of learning mathematics influenced their mathematical identity, whilst for Ruth and Robert the mere fact of doing maths at matric level strengthened their mathematical identities.

Besides having positive maths learning experiences both Robert and Calvin's further maths education studies had strengthened their mathematical identities. Robert's mastery of the intermediate phase maths content and his development of a positively valued maths identity he explained developed when he enrolled for the ACE maths re-skilling programme and for a Bachelor of Honours in Education during his further studies at RUMEP where he "qualified and got a distinction in maths teaching". For Calvin further studies in a Bachelor of Education degree specialising in Intermediate Phase mathematics at RUMEP had also strengthened his primary maths identity and practices. He said with regard to the programme "we did something on constructivism and I think that changed my approach on teaching", leading him to embrace learner-centred approaches. Both Robert and Calvin had "reconnected with mathematics" (Hodgen & Askew, 2007, p. 482) as a result of their further studies in maths teacher education degree programmes that had courses designed to specifically cater for Intermediate phase primary math teachers. Locally Nel (2012, p. 146) similarly notes that maths teachers can transform and develop strengthened maths identities through "reskilling programmes" and further maths education studies such as the ACE, as was the case with Robert and Calvin.

Ruth's learning story closely relates to Robert and Calvin's development of strong maths identities. Besides doing maths at matric level, Ruth also attributed her early interest in

'numeracy' from her first teaching job at a German school in Durban which co-ordinated in-house teacher workshops and also emphasised the importance of teaching children "number bonds...mental maths" using a 'lots of [resource] material'. Ruth's learning story shows the importance of in-house teacher development which had helped her to "reconnect with maths" and proved to be a "turning point" in her primary maths teaching practices (Hodgen & Askew, 2007, p. 482; Drake et al, 2001, p. 8). Hodgen & Askew (2007), Askew et al (1997) and Drake et al (2001) agree that engaging in extended professional development mathematics programmes influences the development of strong primary maths teacher identities.

Edna, Melania and Everton expressed their primary maths classroom practices as an important element that affected their identities positively. Thus Edna's positive maths identity was also evident in her articulation of her maths classroom teaching experiences as she explained that she tended to "spend a lot more time with maths" which was also her "strong point in the classroom". Melania's strong maths identity similarly came from her maths classroom teaching experiences, which made her 'excited', 'very happy' and 'to enjoy' the maths that she taught. Everton's positive primary maths teacher identity, which emerged when she started teaching maths as a senior primary teacher at Martindale in 1993, led her to prefer to "teach mathematics than virtually anything else, except language" and she insisted "upon the basics, the bonds and the tables". Interview utterances by Edna, Melania and Everton indicated that their maths classroom practices affected their primary maths identity positively. Classroom experiences and practices are factors that influence teacher identity mentioned by Van Putten (2011), Day et al (2006) and Clandinin and Connelly (1996). It is important also to note that classroom experiences can negatively affect teacher identities (Day et al, 2006; Jita & Vandeyar, 2006), however there was no evidence of this for these three teachers with positive maths identities.

Within the study sample, Ruth's, Melania's and Everton's strong maths identities seem to have been fashioned by the schools in which they taught. Thus both Melania and Ruth attributed their positive maths teaching identities to their school principal, who was a "very good maths teacher" and was "passionate about maths" and provided them with "good guidelines", a "lot of guidance" and "resources". Melania also explained that the daily meetings with her grade 3 'direct partner' (fellow teacher Ruth), made her share and draw on her colleague's knowledge in teaching maths, thus strengthening her maths teacher identity.

Similarly Everton's school teaching colleagues were said to have influenced her primary maths teacher identity positively. Thus she explained that in teaching maths she drew support from the former school principal Jane, a Science graduate whose mathematics was "pretty good" and currently worked for an organisation that taught maths in the townships, and from her current principal, Swallows, whom she described as "an excellent maths teacher". Both Day et al (2006, p. 606) and Samuel (2008) agree that the school settings, culture and organisation influences teacher identity, with the former elaborating that "the co-operation between colleagues in general and between those who teach the same subject influences teacher identities in a positive manner". The comments of Ruth, Melania and Everton show that their positive maths identities were also influenced by their school settings or context.

8.4.1 Reinvigoration

Having described above how Ruth's, Melania's, Robert's, Calvin's, Edna's and Mary's positive maths identities were influenced by their school maths learning, classroom maths teaching, life maths experiences and or the school context/setting, in the next section I describe how the term 'reinvigoration' emerged from the verbs and phrases used by the six teachers to describe their participation in NICLE. The verbs and phrases in the third column in table 8.1 are synonyms of reinvigoration and arise from the teachers' NICLE learning stories. I coded the teachers' responses to their experiences in NICLE⁴⁶ into three categories all relating to 'reinvigoration'. Table 8.3 below, illustrates these categories. The first group of terms is under the *freshened, refreshed* and *stimulated* category. The second group of teacher utterances falls under the verbs and phrases equivalent to the terms *reinforcing* and *enriching*. *Phrases relating to growth* forms the third category of words uttered by the teachers that referred to the verb 'reinvigoration'. Verbs and phrases used by Robert, Ruth, Melania and Everton relate to all three categories, whilst Edna's utterances refer to the second and third categories, with Calvin's only one phrase appearing in one category – the third one. It is also important to note that all the teachers' utterances appeared in the last category of '*Phrases relating to growth*'. Recall that the term 'reinvigoration' and the groups of terms used by the teachers to describe their NICLE participation experiences were not part of the NICLE discourse, neither did I employ these terms during the interviews. Table 8.3 shows the three categories and the distribution of teachers' verbs or phrases relating to 'reinvigoration'.

⁴⁶ The teachers' NICLE participation experiences were explained in response to question 17 and 14 in the 2011 and 2012 interactive interviews, respectively. I also report on teacher utterances that explain their NICLE participation across the interview questions were appropriate.

Category (and range) of verbs/phrases uttered	(f ⁴⁷)	Verbs and phrases uttered by each participant relating to ‘reinvigoration’ – (n ⁴⁸)					
		Robert	Ruth	Melania	Edna	Calvin	Everton
<p>1. Freshened, refreshed and stimulated</p> <p>Freshened, freshens, refreshed, refreshment, ‘new/fresh ideas’</p> <p>Stimulated, awakened, revitalised, energising, activated, energy, boasted/build my enthusiasm, inspiration, ‘break(s) routine’, ‘light shining on my teaching’</p> <p>Thought-provoking</p>	<p>32</p> <p>(11)</p> <p>(20)</p> <p>(1)</p>	<p>‘refreshment’ (2)</p> <p>‘stimulating’ (3)</p> <p>‘activated’</p> <p>‘energising’</p> <p>‘injected some energy’</p> <p>‘it’s igniting in me a fire’</p>	<p>‘freshened’</p> <p>‘fresh’</p> <p>‘freshens’</p> <p>‘awakened’</p> <p>‘awakens’</p> <p>‘stimulation’</p> <p>‘build my enthusiasm’</p> <p>‘enthusiasm’</p> <p>‘inspiration and energy’</p> <p>‘energy for the subject’</p>	<p>‘refreshed’ (2)</p> <p>‘refreshes’</p> <p>‘gives you new fresh (exciting) ideas’ (3)</p> <p>‘stimulating’</p> <p>‘revitalised’</p> <p>‘bit of energy’</p> <p>‘boasted my enthusiasm’</p> <p>‘help break routine’</p> <p>‘thought-provoking’</p>			<p>‘a light shining on my maths teaching’</p>
<p>2. Reinforcing and enriching</p> <p>Reinforces, supported, ‘better equipped’, ‘support system’ ‘taking back to what is right’ ‘on the (right) track’, ‘makes it relevant again’</p> <p>Enriched, enlightening, illuminates, ‘shed light on’, ‘light shining on my teaching’</p>	<p>23</p> <p>(14)</p> <p>(9)</p>	<p>‘reinforces’</p> <p>‘supports’ (3)</p> <p>‘illuminates’</p> <p>‘makes it come alive’</p>	<p>‘supported’ (3)</p> <p>‘taken me back to what I know is right’</p> <p>‘to know that we are on track’</p> <p>‘...makes it relevant again...’</p>		<p>‘better equipped’</p>		<p>‘Reinforcing’</p> <p>‘it’s kind of like a support system’</p> <p>‘I feel as I am on the right track’</p>

⁴⁷ ‘f’ represents the frequency of the utterances relating to each category of ‘reinvigoration’

⁴⁸ ‘n’ indicates the number of times mentioned if they said it more than once.

<p>‘give more insight’, ‘makes it come alive’, sharpened my awareness’, ‘saved my teaching’</p>			<p>‘enlightening’ ‘... provided some light’ ‘...it shed light on how children learn...’</p>	<p>‘sharpened my awareness’ ‘saved my teaching’</p>	<p>‘enriched’</p>		<p>‘giving me more insight on my maths teaching’</p>
<p>3. Phrases relating to growth</p> <p>Starting to/point of growth, not to ‘stagnate’</p> <p>Helps one not ‘to get stuck in rut’</p> <p>‘Broadened maths understanding/involvement’, ‘mathematics sense being tested’</p>	<p>9 (4) (2) (3)</p>	<p>‘not to stagnate’ ‘starting to grow’</p>	<p>‘broadened my involvement in it again’</p>	<p>helps not ‘to get into a rut of doing things’ (2)</p>	<p>‘to grow in that field’</p>	<p>‘my sense of mathematics are being tested’</p>	<p>‘point of growth’ ‘broadened my understanding of maths’</p>

Table 8.3: The distribution of teachers’ verbs or phrases (utterances) that relate to the term ‘reinvigoration’

8.4.1.1 Reinvigoration category 1: Freshened, refreshed and stimulated

Five of the six teachers with positive maths histories of participation described their learning experiences within NICLE using the verbs *freshened*, *refreshed*, *awakened*, *revitalised*, and *stimulated* and other phrases that are similar to these verbs. In table 8.3 above I grouped all these terms and phrases under the '*freshened*, *refreshed* and *stimulated* category' which relates to the synonym 'reinvigoration'. Ruth who said she had a "very good number sense" explained the nature of her participation in NICLE and how it supported her teaching of maths, saying NICLE had "*freshened* it up.....has *awakened* that interest again". Besides supporting her teaching practices, participation in NICLE also "*freshens* up (her) understanding" of primary mathematics, giving her '*energy*', '*inspiration*' and '*enthusiasm*' for the subject. Similarly during the 2012 interactive interview Ruth described how NICLE experiences '*fresh(ens)*' and '*awakens*' her understanding of maths and interest in teaching the subject. Furthermore according to Ruth participation in NICLE had helped "*build enthusiasm*" for her "own class", her 'teaching' practices and helped her "not to feel alone in it and to know that we are on track and that this is the relevant material". She had also explained that the material they were exposed to in NICLE '*stimulated*' her, making her "really enjoy learning about all of that". Thus participation in NICLE *stimulated* Ruth, leading her to *freshen*, *awaken*, and *build enthusiasm* for understanding and teaching primary maths.

Melania, in describing herself as a primary maths teacher, explained that she knew and taught "maths well" and spent a lot of time with maths because she "enjoyed it" and hoped that her enthusiasm spilled "over to the children". Melania had described her NICLE experiences in a way similar to that of Ruth. She described her NICLE experiences as "very positive and I would say very *thought-provoking*. Very *stimulating*. It often *refreshes* your memory, *it gives you new ideas*". In relation to the two last phrases, Melania had also explained that engaging in NICLE had definitely given her '*new fresh ideas*' which she would immediately "implement" in her class. Melania also uniquely described her participation in NICLE as '*thought-provoking*' and helping 'to *break routine*' which enabled lessons to be "more exciting". These phrases relate to the verbs '*stimulating*' and '*refreshing*', respectively. In the 2011 interview she eloquently described the nature of her learning using verbs and phrases synonymous with reinvigoration. Thus to her participation in NICLE involved,

...learning in the form of, just every now and then in your teaching career you need to have some *bit of energy* and you need to be *refreshed*, you need to be *revitalised* and I think that's what it has been for me it just sort of *refreshed* me and given me new ideas, *boosted my enthusiasm again* (Melania, Interactive interview, October 2011).

Melania's comment that participation in NICLE had '*boosted [her] enthusiasm*', '*revitalised*' and gave her '*some bit of energy*' also adds to the terms and phrases in the first category and closely relates to the term '*stimulating*'. Thus for Melania participation in NICLE '*refreshed, revitalised, stimulated*' and '*boosted her enthusiasm*', resulting in '*new fresh ideas*' to teach maths in her class.

Robert's positive mathematical history and identity is evident in his learning story as he remarked that he had a "pure love of teaching and a pure love of mathematics", and claimed to "be an authority in the intermediate phase mathematics" who felt "confident and comfortable" in the primary maths education field. Robert, like Ruth and Melania, said his participation in NICLE offered '*refreshment*' and '*stimulated*' him and his "understanding of mathematics". Like Ruth and Melania, Robert called his learning experiences '*refreshing*' though he went on to describe his participation in NICLE as '*energising*' and as '*injecting some energy*' thus using a verb that had been uttered by both Ruth and Melania in describing their NICLE participation. Robert uniquely described his learning experiences in NICLE as '*activating*' his "personal enjoyment" which lead him to give the best to his learners and "make maths interesting for them", and when he saw that they enjoyed maths, it would '*ignite ...a fire*' in him. The terms *energising* and *activating* and the phrase '*ignite a fire*' used by Robert to explain his participation in NICLE adds to the range of verbs in the first category of terms (*freshened, refreshed* and *stimulated*) that relate to 'reinvigoration'.

Everton, who described herself as an "above average numeracy teacher" who preferred and "really enjoy(ed) her mathematics teaching", metaphorically described her primary maths in-service community's learning experiences as a 'light shining on her maths teaching'. Everton's metaphor indicates that NICLE rekindled and renewed her primary maths teaching practices, and the metaphor relates to the verbs '*stimulated*' and '*refreshed*' that are in the first group of terms related to reinvigoration. Though Everton and Ruth also later used statements that contained the metaphor/verb *-light-* to describe their NICLE participation,

these belong to the second category of verbs and phrases as they carry the connotation of reinforcing and enriching.

Ruth, Melania and Robert described the nature of their learning through their participation in NICLE with the verbs *freshened*, *awakened*, *refreshed*, *revitalised* and *stimulated*. Ruth, Melania, Robert and Everton also described their NICLE learning experiences with phrases similar to the verbs ‘*stimulated*’ and ‘*refreshing*’. Notably the verbs *freshened*, *refreshed* and *stimulated* were used by Robert, Ruth and Melania and also relate to the phrases used by Ruth, Everton, Melania and Robert to describe their learning experiences within NICLE. All the verbs and phrases uttered by these four teachers are in the first category of terms that relate to the verb ‘*reinvigoration*’, which provides a comprehensive term and synonym arising from the teachers’ description of their participation experiences, and helps in explaining the nature of teacher learning within NICLE.

8.4.1.2 Reinvigoration category 2: Reinforcing and enriching

Ruth, Everton, Melania, Robert and Edna additionally used the verbs *reinforcing* and *enriching*, and the phrases related to these terms, to describe their participation experiences in NICLE. These verbs and phrases are in the second category of words relating to reinvigoration. The verbs, and the phrases with the same meaning as ‘*reinforcing*’ and ‘*enriching*’ used by Ruth, Everton, Melania, Edna and Robert add a new ‘entrenching’ dimension to the verbs *freshened*, *refreshed* and *stimulated* used earlier to describe the nature of their learning within NICLE. The terms also show how NICLE improved and supported the primary maths teachers’ practices. I will first discuss how the term ‘*reinforcing*’, and phrases relating to this term, featured in the teachers’ explanations of their NICLE participation experiences.

Both Everton and Robert described the kind of learning within NICLE as ‘*reinforcing*’ what they put into practice or how they teach. Ruth, Everton and Robert also used the verb - *support*- , or phrases containing this verb, to explain how their NICLE experiences enhanced their teaching practice, with Robert (who was studying for a Masters in Mathematics education) also explaining that participating in NICLE supported his further studies, whilst for Ruth, NICLE supported her “personal understanding of maths”. Similarly Edna explained how participation in NICLE enabled her to be “better equipped” to help learners. Both Ruth and Everton used the same phrase to describe their NICLE experiences and the teaching

material given therein as enabling them to be ‘*on track*’ or ‘*on the right track*’ and said it reinforced their methods of teaching maths. Ruth also used other phrases that indicated that NICLE reinforced and supported her maths teaching approaches. For example she explained her participation in NICLE as “taking [her] back to what she know[s] is right” and “...mak[ing] it relevant again”.

Edna, who had a “good understanding” and “love of numbers”, used a verb that closely relates with reinforcing to describe her participation in NICLE. She explained that NICLE had ‘*enriched*’ her in order “to carry it over better to the learners”. Both Robert and Ruth explained how participation in NICLE had enhanced their primary maths teaching practices using verbs and phrases that related to the term ‘enriched’ and contained the verb *light*. Thus Ruth explained her nature of learning within NICLE as providing “some light, it shed light on how children learn...their learning styles...observing their learning styles”. Furthermore for Ruth participation in NICLE for her was “engaging and *enlightening* and interesting” and what she had gained was having a “peer group” from which they could think “about it” and be “together in some sense”. Robert also explained that participation in NICLE ‘*illuminates*’ or makes primary mathematical theories such as Kilpatrick et al’s (2001) five strands of mathematical proficiency ‘*come alive*’. Also similar to the verb ‘enrich’ were the phrases used by Everton and Melania to describe how NICLE had clearly informed their maths teaching practices. Thus Everton explained that participating in NICLE gave her ‘*more insight* on [her] maths teaching’. Similarly Melania also explained that participation in NICLE both ‘*sharpened [her] awareness*’ and ‘*saved [her] teaching*’ because she now communicated “more with the children about how they are doing things and why they are doing things and the need to explain the reason behind what they are doing”. The verbs and phrases used by Edna, Robert, Melania, Everton and Ruth communicate how NICLE enhanced the primary maths teachers’ pedagogical practices, their group participation experiences as well as illuminating key primary maths theoretical concepts. These relate with the verb ‘enriching’, which is one of the key terms in the second category of utterances that relate to reinvigoration. Overall the verbs and the phrases with the same meaning as ‘*reinforcing*’ and ‘*enriching*’ uttered by Ruth, Everton, Edna, Melania and Robert, are in the second category of words relating to reinvigoration and mainly referred to how NICLE supported primary maths teaching practices.

8.4.1.3 Reinvigoration category 3: Phrases relating to growth

All six teachers who had expressed positive maths histories prior to participating in NICLE used phrases that relate to *growth* to describe their learning experiences. The verbs and phrases relating to *growth* are in the third category of words synonymous with reinvigoration, which is the key term proposed in this study to explain the NICLE participation experiences (and the nature of learning) of teachers with positive primary maths identities. Robert, Everton and Edna's phrases explicitly contained the verb 'grow/th'. This term explains how their mathematical understanding, their maths teaching practices and how they intended their career trajectories to grow in the field of primary maths education through participation in NICLE. Thus for Robert, participation in NICLE also offered him the opportunity for his practices not to 'stagnate'. The phrase 'not to stagnate' implies the verb *grow*. Similarly Melania twice expressed during the 2012 interactive interview how her participation in NICLE had helped her not 'to get stuck in a rut' and allowed her to "see other ways and other approaches". The antonym of the phrase 'stuck in a rut' similarly implies *growth* of new practices and ways of being in the classroom. Calvin, one of the two Intermediate Phase teachers, described himself as a primary maths teacher who "like(d) teaching maths, in fact I wouldn't like to teach another subject... other learning areas". Calvin explained the nature of his participation in NICLE by saying '*my sense of mathematics are [sic] being tested*, and I am not talking of content-based maths only but classroom management'. Through participation in NICLE Calvin was being challenged *to grow* and to push himself out of his comfort zone. Similarly Everton had also explained how participating in NICLE had deepened both her understanding and teaching of maths as NICLE had '*broadened [her] understanding* of mathematics and how to get it across to children'. Ruth also used the verb 'broadened' to indicate how participating in NICLE had improved her primary maths teaching approaches so that they accommodated exciting ways of teaching maths. For example Ruth said

I remember Mellony saying we must try games...my sister...she plays games herself and does problems herself and I wasn't doing that, so I think getting involved in puzzles, I got a whole lot of puzzles for myself to play...and so I suppose it has *broadened* my involvement in it again (Ruth, Interactive interview, November 2012).

Ruth is referring to sessions focused on solving mathematical challenges, puzzles and riddles that are a regular feature of the primary maths CoP. Robert, Everton and Edna described their

learning experiences within the professional teacher learning community, using the verb ‘*grow-th*’. Likewise Calvin’s statement that his ‘sense of *mathematics [was] being tested*’, Melania and Robert’s expressions that participation in NICLE enabled them not ‘to get stuck in a rut’ and ‘not to stagnate’ and Everton and Ruth’s explanation that participating in NICLE had ‘*broadened*’ their understanding and teaching of mathematics are all closely linked to the notion of *growth* and variations of the term ‘*grow*’.

The central argument here is that the umbrella term – *reinvigoration* - can be substituted with or is a synonym of the verbs and phrases in the three categories (and their range) uttered by the six teachers with valued maths histories to explain their participation and learning experiences within NICLE. Thus the term *reinvigoration* is the umbrella metaphor for both the phrases and the verbs – *freshened*, *refreshed* and *stimulated* - uttered by Ruth, Melania, Robert and Everton to explain their learning experiences within NICLE. These verbs and phrases are in the first category of words relating to *reinvigoration*. The terms ‘*reinforcing*’ and ‘*enriching*’ and phrases equivalent to these terms used by Ruth, Everton, Melania, Robert and Edna, though adding a new dimension to the teachers’ learning experiences, closely relates with the verbs ‘*freshened/refreshed* and *stimulated*’ used in the first category by Ruth, Melania and Robert to describe their learning experiences within the primary maths teacher learning community. All these verbs can be considered sub aspects of the term *reinvigoration*. All six teachers with a history of valued maths identities participating in NICLE described their learning experiences using verbs, phrases and expressions which closely relate to *growth*, which is similar to the verb ‘*reinvigoration*’. All in all the verbs *freshened*, *refreshed*, *stimulated*, *reinforcing*, *enriching* and *growth* are synonyms of, and are in the same semantic field as, the umbrella term *reinvigoration*, which is the candidate word I choose to describe the nature of participation in NICLE of teachers whom I regarded as having positively ‘valued’ primary maths identities. *Reinvigoration* holistically captures all these teachers’ verbs and phrases that describe their participation and learning experiences in NICLE.

8.5 The stelos of teachers with negative and stunted mathematical histories and their ‘remediation’ and ‘activation’ in NICLE

In the study sample I had two teachers whose stelos before their participation in NICLE indicated weak or negative mathematical histories - namely Mary and Pamela. Of interest in some of their journal entries these teachers wrote about their weak mathematical histories, yet none of the teachers with a history of positive maths identities had written in their journals stories that indicated their positive past experiences with maths. Mary and Pamela’s negatively devalued mathematical history utterances meet the operationalized definitional criteria of identity postulated by Sfard and Prusak (2005) as they are reifying, endorsable and significant, as has been explained earlier. Interestingly their statements in the second column in table 8.2 are *significant* as they show how Mary’s and Pamela’s histories excluded them from participating in maths communities. Pamela’s utterance that she “needed to change her mind so that she will be able to teach mathematics correctly” and Mary’s explanation that she “never had a very good foundation for mathematics” denote “certain [historically] permanent qualities” that indicate their negative relationship with mathematics (Heyd-Metzuyanim & Sfard, 2012, p. 131). All of Pamela’s and Mary’s statements in the second column also illustrate the qualities and effects of reification as they use direct and derivatives of reifying words such as *I*, *my*, *I am*, *was*, *have*, *me* and *never*. To show this I have italicised below reifying words in some of Pamela’s and Mary’s interview utterances.

But what *I* wanted to say is that *I* need to change *my* mind so that *I* will be able to teach mathematics correctly (Pamela, Interactive interview, November 2011).

...it (NICLE) has taken some (mathematical) fears that *I* did *have*... (Pamela, Interactive interview, November 2011).

Initially *I* was scared (to teach maths) because of *my* lack of confidence and knowledge and experience (Mary, Interactive interview, November 2011).

...the maths for *me* would be more of a challenge because of the whole mind-set *I* grew up with. Being told you can’t do maths and girls... don’t have to worry about maths (Mary, Interactive interview, December 2012).

Mary's and Pamela's negative mathematical histories had arisen through their unpleasant personal school maths learning and during their learning experiences in maths classes. Furthermore Mary's learning story reveals that gender stereotyping (that women cannot do maths) had negatively influenced her maths identity. Mary's life history was marked with unpleasant maths classroom experiences as a student. In the first interview Mary said of her maths history

I never had a very good foundation for mathematics especially in High school...when I went to High school... we had something like four Mathematical teachers and that is when I lost the whole essence of maths and thought that I will never be able to do this (Mary, Interactive interview, November 2011).

Similarly in the 2012 interview Mary reiterated this and repeatedly talked about these negative maths classroom experiences

I gave up maths in standard...end of standard 7 and I had four teachers that term. And there was a whole lot of politics happening and I was nowhere. I mean I probably got about 30%. I mean I failed standard grade. So at matric level I wouldn't have a clue (Mary, Interactive interview, December 2012).

Pamela's past maths trajectory indicated that she feared maths as she acknowledged that when she started primary school some learners had indicated to her that "yo, maths it's difficult, and then [she had] come to that, to that route of thinking that maths is difficult". Furthermore at secondary level she did not do "proper maths" but "functional maths". Both Mary's and Pamela's maths learning stories resonate with the primary maths literature which explains that some teachers had disappointing experiences learning mathematics, leading to a negative relationship with mathematics (Hodgen & Askew, 2007; Drake et al, 2001; Ball, 1996; Askew et al, 1997; Jita & Vandeyar, 2006). Thus Mary's and Pamela's bad experiences with mathematics in their own schooling resulted in negative (past) maths identities.

Besides their own bad personal experiences of mathematics as learners, before their participation in NICLE, both Pamela and Mary indicated that their own maths teaching classroom experiences had negatively affected their identities. Mary explained that before participation in NICLE she was scared to teach because of her "lack of confidence, knowledge and experience". Mary's *stelos* also shows how she felt uncomfortable teaching maths in her early career experiences. For example she said,

...when I first started teaching I didn't feel confident enough. I almost sort of would break out in sweat when I thought how am I going to get this across, how I am going to teach this (Mary, Interactive interview, November 2011).

In one of her reflective journal entries Mary labelled herself as someone who is “mathematically challenged” and when faced with explaining a mathematical problem she explained that her fear was extreme to the extent that she could at times “break out into cold sweat”. Mary reflected in her journal on a NICLE session presented on fractions in which she was called to explain to the NICLE group how they had solved the ‘apple tart’ problem. This encounter and Mary’s May 2012 journal entry below shows the tension encountered by Mary in transforming her negative maths identity towards a positive maths identity.

We were blessed with Lisa today. What a dynamic spirit! Focused on problem solving using fractions. I would have broken out into cold sweat if asked to explain that concept but she just has a way of helping us who are ‘mathematically challenged’ to understand. Just wish I could be more hands on with the concepts I am learning about cause I find it difficult to retain what I have learnt when I am not practising it (Mary, Journal entry, 8 May 2012).

Similarly before participation in NICLE Pamela explained that she had “problems with 2D and 3D shapes” especially with how to describe and teach them. In both interviews Pamela had mentioned that before her participation in NICLE she used to “force her learners to know her method and only her method”. Thus prior to engaging in NICLE, her “challenge...was to help [her] learners to enjoy the mathematics period”. Pamela’s journal entry (below), also show that before participating in NICLE she had fears in teaching mathematics which led her to use only whole class teaching methods and ‘dictate’ maths solution strategies to learners.

Before NICLE I was not confident on teaching mathematics also I feared the unknown, but now because I’ve met with other teachers from other schools my fears are gone...Before this programme that I’m in I wanted my learners to know only the methods that I’m used to and never gave them a chance to think independently. In this programme I was also taught to group my learners so that when I am introducing new concept[s] I’ll be able to work with a small group of learners...An emphasis was put to me as to ask my learners ‘why’ in whatever mathematics programme they are engage[d] in. Because I got confidence that I longed for, for so many years, my learners enjoy mathematics very much now (Pamela, Journal entry, 14 December 2011).

These utterances support Day et al (2006) and Clandinin & Connelly's (1996) argument that teaching experiences and practices influence teacher identity, with the former elaborating that identity can be affected negatively by classroom experiences. Pamela and Mary's mathematical histories and learning stories also reveal that their maths classroom experiences, which were marked with mathematical fears and a lack of confidence, negatively influenced their identities prior to participating in NICLE.

Mary's learning story from the second round of interviews shows that gender stereotyping had negatively influenced her maths identity. Thus Mary explained that her inability to do maths stemmed from the commonly held perception that if you were a girl "you don't need to do maths as long as you can cook" or "being told [that] you can't do maths and girls, you know, don't have to worry about maths". It had taken a while for Mary to "get out of that mind-set, that [I] can't do maths". While many argue that life maths experiences influence teachers' mathematical being (e.g. Marsh, 2002a, Askew et al, 1997), Mendick (2005) specifically argues that the masculinity of mathematics makes it more difficult for girls and women to choose and succeed at the subject than for boys. Thus Mary's negative maths history links with this widespread stereotyping that girls encounter locally and internationally.

Lave (1993b, p. 77) gives terminology applicable to Pamela's and Mary's maths fears utterances. According to her the statement that "we don't know real maths" is associated with "devalued or negatively valued identities". Using Lave's terminology both Mary and Pamela's past identity trajectories denoted 'negatively valued maths identities'. Both Mary and Pamela's stories reveal that their school maths learning, maths class teaching or their life experiences *stunted* the emergence of more positive maths identities. Primary maths education literature also indicates that school mathematics learning experiences (Hodgen & Askew, 2007; Drake et al, 2001; Askew et al, 1997; Ball, 1996; Van Putten, 2011; Jita & Vandeyar, 2006), maths classroom practices (Day et al, 2006; Clandinin & Connelly, 1996) and life mathematical encounters (Marsh, 2002a; Askew et al, 1997; Mendick, 2005) can negatively influence teacher identity. Similarly Lave (1993b) observes that schools contribute to the creation of negative identities. By *stunt* I mean life, school or teaching experiences or expectations that create trajectories that shy away from maths. The word *stunt* also comes from a sociocultural theoretical framework with the antonym of this term within the situative

framework being ‘*sustained*’, with Lave (1993b) alluding to the fact that identities and knowledge are formed and sustained in communities of practice.

8.5.1 Remediation and activation

Having described how Mary and Pamela’s negative maths identities were influenced by their school maths learning, classroom maths teaching and life maths experiences, I now describe how the terms remediation and activation emerged from the verbs and phrases used by these two teachers to describe their participation and learning experiences in NICLE. Table 8.2 shows the distribution of teachers’ verbs or phrases (utterances) relating to ‘remediation’ and ‘activation’. The two teacher utterances that relate to their transformation also meet the identity definition criteria postulated by Sfard and Prusak (2005).

Though Pamela claimed that she had a fear of mathematics, she said participation in NICLE had *changed* this. Three times, across the interactive interviews, she explained how NICLE had transformed her maths teaching approaches and also enabled her to love maths. Pamela’s NICLE participation story – *stelos*, included such comments as:

After I did those sessions I am confident with myself and also it *has changed my ways of doing things* in numeracy because before NICLE I will use my, I will force my learners to know my method and only my method (Pamela, Interactive interview, November 2011).

I am glad that I am part of this program. It has *changed my thinking*, it has also helped me to love mathematics. It has taken some fears that I did have (Pamela, Interactive interview, November 2011).

Pamela had also said that engaging in NICLE had “*changed* her perception on how to do mathematics” with learners. NICLE thus enabled in Pamela the *remediation of* traditional (or outdated) teaching approaches and maths fears. Participation in NICLE according to Pamela had “*changed* her...ways of doing things...her thinking and perception”, this shift and transformation to a new mathematical identity - that involved learners when teaching, was ‘confident’ and “loved mathematics” and was *activated* through engaging in the primary maths teacher learning community.

In relation to allaying her mathematical fears, Pamela explained that participation in NICLE and engaging with ‘specialists’ and fellow teachers sessions helped in addressing her

mathematical challenges and fears that pertained to teaching maths in her class. Thus Pamela said of her type of learning in NICLE,

We are having specialists *they do address our fears*. Sometimes as mathematical teachers *we do have fears* of how we are going to do this in my class. But with NICLE they will invite somebody and *that somebody will address your fears...* (Pamela, Interactive interview, November 2011).

But because now we are with NICLE *our challenges and fears are being addressed* (Pamela, Interactive interview, November 2011).

Meeting experts in mathematics. You see *the fears that we sometimes have...* sharing with other teachers from other schools (Pamela, Interactive interview, November 2012).

For Pamela the *activation* of a positive maths identity was enabled through engaging in NICLE which was a community in which she met with “other teachers from other schools” and most importantly ‘specialists’ and ‘experts in mathematics’ who addressed her classroom “challenges” and mathematical “fears”.

Mary had a similar *stelos*, though unique in the sense of explicitly referring herself as a ‘numeracy’ teacher as she said,

Only really this year do I really regard myself as a numeracy teacher, if you asked me last year I would have said, oh no I can’t do Maths, but this year I can see potential to actually call myself a numeracy teacher (Mary, Interactive interview, November 2011).

From this utterance a new mathematical identity trajectory can be seen as *activated* through Mary’s participation in NICLE. The formulated mathematical identity coheres with the primary intentions and the future projected identity of NICLE which aimed at creating stronger numeracy teacher identities. Furthermore Mary attributed her reformulated numeracy teacher identity both to her mother and NICLE. She explained her mother’s role as:

I am saying it wasn’t even a conscious thing you know that I want to become a numeracy teacher because I think my mother *triggered* some sort of it. It intrigued me that she has a

mathematical mind and you know I always thought I would like to work out something like that (Mary, Interactive interview, November 2011).

Mary used several synonyms to indicate how NICLE was refashioning her previously devalued maths identity which made her “feel very stupid compared to those other teachers”. Mary explained that participating in the NICLE community, in which some sessions were facilitated by guest speakers, was a “very positive experience” “*enriching, stimulating, inspiring, and motivating*” that helped her “*develop professionally*”. Mary’s NICLE experiences enabled her to develop “self-confidence with Mathematics”, improved her maths “basic knowledge”, made her “enjoy” maths and “put it into practice in her own classroom”, thus resulting in the *activation* of a more positive maths identity. It is important to note that the synonyms used by Mary to describe her NICLE experiences are similar and relate to all the three categories of phrases used by teachers with positive maths histories to describe their participation in NICLE. This may serve to show that both groups of teachers had similar participation experiences though they related them differently because of their maths histories.

Through her narration and recalling of her mother’s ‘mathematical mind’ and participation in NICLE, Mary managed to *remediate* her mathematical persona. Pamela’s mathematical ‘challenges and fears’ were also *remediated* through participation in the NICLE community. The concept of remediation though emanating from my empirical data is akin to the terms ‘reconstruction’ (Lave, 1993b, p. 73) and ‘reconstitution’ (Cain, 1991, p. 218) used by both Lave and Cain. Reconstitution or reconstruction occurs as participants exorcise negative identities and gradually interpret and construct a community identity through life stories (Cain, 1991, Lave, 1993b). The term *remediation* also closely relates with Drake et al (2001, p. 8) and Hodgen & Askew’s (2007, p. 482) suggestions that primary teachers with negative memories of learning and teaching mathematics experience a ‘turning-point’ in their learning of mathematics or ‘reconnect with maths’ when they participate in professional development programmes. I use the term *remediation* in a similar sense. Both Mary and Pamela exorcised their past negatively valued mathematical identities through participation in NICLE and in the process *remediating* such identities and *activating* more positive maths identities.

Though the term activation emerged through the interactive interview analysis, Wilson and Berne (1999, p. 194) also mention this term in discussing professional development

programmes and suggest that “teacher learning ought not to be bound and *delivered* but rather *activated*” [italics in original]. In the same sense the primary maths activities that the teachers participated and engaged in within NICLE *activated* teacher learning. The similarity to note from the *stelos* of Pamela and Mary is that their histories of weak mathematical identities become *remediated* and new mathematical identities are *activated* through participation in maths teacher communities of practice. Such mathematical identities have been *stunted* by personal life, maths school learning and classroom teaching experiences resulting in trajectories that fear maths. Further research with a larger number would be needed to see the extent to which this metaphor would be appropriate with other primary maths teachers with negative histories participating in similar programmes.

8.6 Learning as participation in primary maths practices

Besides the teachers explaining their learning using verbs and phrases that are synonyms of reinvigoration, and remediation and activation, evidence from the interactive interviews also indicates that some teachers described the nature of their learning in NICLE as active ‘participation’ in primary maths practices. Chapter 6 illustrated the diverse and varied key primary maths concepts and practices that the NICLE teachers participated in, thus providing background to teacher *stelos* of the primary maths practices that the teachers engaged in. In Chapter 9 I explain the primary maths activities in NICLE which teachers said they took into their maths classroom as these enabled their identities and practices to evolve (this relates to the 2nd research question). Therefore I will briefly discuss here how some of the sampled teachers described their NICLE experiences as active participation-in primary maths practices.

Robert described the nature of his learning in NICLE as ‘active participation’ and later in the 2012 interview portrayed NICLE as a “community of practitioners sharing ideas” and elaborating it as a “socio-cultural learning perspective”. He also said that participating in NICLE had revealed to him that ‘learning is social in nature’. However Robert’s explanation of his participation experiences in NICLE shows the influence of situative learning perspectives which he had read about during his Master’s in Maths Education studies.

Everton had also explained her engagement in NICLE as “learning by doing...I enjoy learning by contributing and hearing what other people say...just learning how other people deal with it...it’s practical”. Similarly Ruth described the nature of her learning in NICLE as “participation of the whole group” or “the peer group” in which they would “think about it

and being together in some sense” which helped her “not to feel alone in it”. Ruth elaborated that by participation in maths practices she meant

...defining something, thinking about...yes the definition...and finding out about mainly prior knowledge, developing the understanding of the topic...and then playing with it, experimenting with it (Ruth, Interactive interview, November 2012).

Edna similarly explained that in NICLE teachers were “actively involved and engaged...”, which she later elaborated as “engaged with a different lot of people and get their views and their input and certain issues and things”. Mary also described her NICLE experiences as entailing sharing experiences with other teachers through active participation,

...it isn't just learning from the lecturers, but also the group work, that for me is beneficial than sitting in the classroom and reading a text book and learning for myself (Mary, Interactive interview, December 2011).

I like the sharing you know. Sitting in a group with ladies from others, and gentlemen from other schools. You know you do a lot of sharing experiences and often a teacher will say ‘well this is what I do and this is how I’ and we’ll say that’s a good idea (Mary, Interactive interview, December 2012).

At NICLE you do a lot of practical, concrete. And for me, because I think in pictures, it suits me better you know. I can't just learn hearing, I've got to be doing. And because there's a lot of practical activity that NICLE provides. You give us the resources. We work with it first before we bring it back to our classroom. So that's how it helped me. It hasn't been...I haven't been a passive learner. I have been an active learner, by participating (Mary, Interactive interview, December 2012).

Calvin like Mary also remarked that participating in NICLE involved meeting new people and sharing classroom experiences and practices. Thus he said that in NICLE “you learn new stuff, you meet new people, you share experiences with other people and, and you hear what their class practices are”. Robert, Ruth, Everton, Edna, Mary and Calvin's explanation of learning in NICLE as active group participation, that involves sharing experiences, relates with the common situative perspective of learning as ‘participation’ (Rogoff, 1994, p. 209; Rogoff, 1995, p. 148; Lave 1993a, p. 9; Lave, 1996, p. 150; Wenger, 1998, p.4; Sfard, 1998, p. 5). In particular Everton's explanation of her NICLE participation experiences as ‘learning by doing’ illustrates Lave's (1993a, p. 15) points that “doing and knowing are inventive in another sense”. Researchers in maths teacher education have also drawn on the situative

perspective of defining learning as participation in communities of practice to explain maths teacher learning (Lerman, 1998; Lerman, 2001; Adler, 1998; Adler, 2000; Matos, 2009; Graven, 2012). Common in the sociocultural theory and maths teacher education literature that have foregrounded the notion of the communities of practice is their definition of learning as ‘participation’. This closely relates with how Robert, Ruth, Everton, Edna, Mary and Calvin’s explained the nature of their learning in NICLE.

Pamela, Mary and Everton also commented that participating in the NICLE CoP involved engaging with ‘knowledgeable masters’ in the field of primary maths education. For example Pamela explained that participating in NICLE involved “meeting with experts...specialists in mathematics”. Similarly Mary mentioned that the invited NICLE ‘guest speakers’ had activated mathematical learning. Everton also explained her NICLE experiences as “learning from other people, its learning from the other teachers, and its learning from other people like Tom”. Tom was one of the invited NICLE guests, who is a maths teacher educator and head of a partner organisation of the SANC who had presented two sessions on mental maths. Within the participationists theory masters or old-timers are crucial in providing access to a community’s practices (Lave 1993b; Lave, 1996; Lave & Wenger, 1991) and also in modelling the mathematical expertise/mastery and the intended mathematical identities (Lerman, 2001).

In maths teacher education it has been noted that teachers learn mostly when professional development programmes are taught by mathematically knowledgeable teacher educators (Hill & Ball, 2004; Matos, 2009). Besides utterances from Pamela, Mary and Everton the fact that half of the NICLE sessions during the period of this study are facilitated and presented by invited guests, most of whom were primary maths teacher education ‘experts’⁴⁹ also illustrates how participating in NICLE involved engaging with knowledgeable old-timers and masters in primary maths.

Participating in the in-service CoP had also helped the sampled teachers with their primary maths teaching practices. Thus Edna explained that participating in NICLE helped her “to carry it over better to the learners” and also to “relate to the learners and how to explain things to them”. Similarly Mary explained that engaging in NICLE activities was exciting

⁴⁹ Master or expert can be difficult to define but NICLE chose guest speakers on the basis of experienced maths teacher educators who are identified by the maths education community locally and internationally for their expertise.

and stimulating as most of the sessions could be “related” to the classroom as they were “practical” and “resourceful”, which made it “easier to implement it into your classroom”. Everton also noted that participating in NICLE ‘reinforced’ the knowledge that she had and what she “already put into practice”. In the 2012 interactive interview Everton also mentioned that engaging in NICLE helped her on “how to get it across to children”. Pamela, whose negative maths identity had been ‘exorcised’ through NICLE participation, also explained that participation in the professional development programme had made “it easy for her to do it [teach] in her classroom” which had allowed her learners to “enjoy the mathematics period”. In both interviews Calvin emphasised how NICLE connected to his classroom practices and experiences and said:

Most definitely you try to instil what you learned there (in NICLE), you try to practice in class (Calvin, Interactive interview, November 2011).

You can link it to classroom experience. You can link it to your content knowledge of mathematics. I think that is where you...for me that is where you are trying to move. Content. The knowledge of teachers around each area, and then how to impart that knowledge to the learners (Calvin, Interactive interview, November 2012).

Likewise Ruth explained how engaging in NICLE had influenced her teaching:

...build enthusiasm for my own class and my own teaching...and to know that we are on track and that this is the relevant material. This is the thinking that’s happening and that...we are linked to an international movement of thinking about how to teach maths (Ruth, Interactive interview, November 2012).

Both Ruth and Melania discussed during the interviews how NICLE had improved their maths teaching practices, especially concerning how children learn, and increasing learners’ engagement in class. The first phrases in the third column in table 8.1 by both Ruth and Melania also clearly illustrate this. For the social practice theory learning-in-practice means that “what is to be learned is integrally implicated in the forms in which it is appropriated - in situations whose specific characteristics are part of practice as it unfolds” (Lave, 1997, p. 18 & 19). Lave and Wenger’s studies of Liberian tailors, midwives, quartermasters, nondrinking alcoholics, dieting cooks, illustrate what learning-in-practice entails as these CoPs provide opportunities for how to actually do practices (Lave & Wenger, 1991; Lave, 1993b; Lave, 1997). In maths teacher education successful teacher learning is being reported when teachers engage and participate in and around the practices of what constitute teaching maths - that is

when they “learn in and from practice” (Matos, 2009, p. 167; Ball & Cohen, 1999, p. 10; Jaworski, 2009, p. 143). Lampert (2010, p. 21) captures this as “learning in, from and for practice”. All the sampled participants explained that most of the NICLE activities and sessions that they engaged in could be related to primary maths teaching practices or to “what primary maths teachers do” in their classes (Lampert, 2010, p. 29). In the following chapter I further engage with activities within NICLE that enabled the evolution of teachers’ primary maths practices when I address the 2nd research question.

The teacher’s utterances thus indicate learning as participation in primary maths practices and illuminates how the teachers’ learning stories illustrate the social practice theory. Learning as participation in primary maths practices illuminates the findings of this study, which relates to how primary maths teachers learn, and enables the study to reveal the way in which teachers in this study with a history of maths competence have their maths identities *reinvigorated*. On the other hand, teachers with identities that previously shied away from maths have their devalued maths identities *remediated* and *activated* through participation in NICLE’s primary maths practices. Such participation results in both instances in teachers with stronger maths identities. Teacher learning within the NICLE teacher CoP can thus be explained as the evolution of mathematical identities being *reinvigorated* or *remediated* and *activated* leading to strengthened maths identities through active participation in primary maths practices. The dialectical transformation of primary maths teacher identities happened within the practice-informed primary maths in-service community, with both the teacher learning stories and the analysed NICLE activities discussed in Chapter 6 strengthening and illuminating this finding.

8.7 Confidence

Another theme that also emerged from the interactive interview data was that participating in NICLE strengthened teachers’ confidence. Five of the sampled participants (Mary, Pamela, Ruth, Melania and Robert) outlined that engaging in NICLE had enabled them to be confident in themselves, in teaching maths in their classes and to colleagues, understanding the subject, and in instilling learners’ mathematical confidence. These 5 teachers explicitly used the term confidence, while the other four teachers used phrases that implied increased confidence but to a lesser extent.

Mary, who repeatedly said that she was initially scared to teach mathematics when she started her career because of her “lack of confidence and knowledge and experience”, later explained that participating in NICLE had helped her develop ‘confidence with mathematics’. She also said that, “my confidence with regards [*sic*] to my knowledge, what I have learned this year, I am sort of content with now”. Similarly Ruth had explained that participating in NICLE had made her “feel confident about what has to be taught, yah if someone tells me I must teach this I can say I am not gonna do it like that”. Mary, Ruth and Pamela also explained that engaging in NICLE had enabled them to be confident in teaching mathematics. For example Mary said; “...I probably wouldn’t have been confident in sort of wanting to teach mathematics if I hadn’t been to NICLE”. Ruth on the other hand also remarked that participating in NICLE enabled her “to go back to her own (teaching) style and I think the course, the NICLE course has given me confidence in trying out those things”. Both from the first interactive interview and in her journal entry Pamela said that engaging in NICLE made her “confident with herself” and “confident on teaching mathematics”, thus changing her ways of teaching primary maths to include more participatory learner approaches. Concerning the latter, Ruth similarly explained that her NICLE experiences enabled her “to gain more confidence to listen to her own gut feeling”, as well as giving her the “confidence to rely on my own doses”. Thus for Ruth and Pamela their NICLE experiences enabled them to be confident in themselves as professional educators.

For Melania the emergence of confidence through her NICLE participation was related to learners. For example wishing that when her learners leave her class there would have “been an improvement in their confidence” thus “they would be confident and daring when faced with a (mathematical) problem”. Robert, who was pursuing further studies in mathematics education, explained that participating in NICLE enabled him to “feel more confident and comfortable in his field” of primary maths education. Finally for Pamela the confidence she had gained through engaging in NICLE made her confident to share knowledge with other primary maths teachers at her school. Thus she said

I can change those assessment standards to suit a Grade R teacher help them on how to teach mathematics. I can help a Grade 2 and Grade 1 teacher on how to teach Mathematics because I did get a confidence that I have needed (Pamela, Interactive interview, November 2011).

It is useful to note that the phenomenon of confidence emerged in Graven’s (2002a; 2004) investigation of teacher learning within an in-service community of practice, and there is

much similarity in her study to Ruth, Pamela, Mary, Robert and Melania's utterances above. Whilst confidence and learning as participation in primary maths practices emerged in the data the key theme and contribution of this study lies in its explaining the nature of the primary maths teachers' learning and participation experiences through NICLE, using the synonyms *reinvigoration* and *remediation* and *activation* and relating these to the teachers' mathematical histories. It must be noted that the sampled teachers' NICLE participation-transformation experiences were similar though they articulated them differently. This transformation through participation in NICLE lead teachers towards strengthened, more positively valued primary maths teacher identities, resulting in learning and, in their view, improved primary maths classroom practices and understanding of maths.

In Summary

In outlining the nature of Communities of Practices, Lave (1993b, p. 77) has argued that "identities are formed and sustained" in Communities of Practice. It is participation in Communities of Practices that "make possible certain kinds of transformations of understanding, identity and knowledgeable skills" (Lave, 1993b, p. 81). In responding to the overarching research question that relates to the nature of teacher learning within the primary maths in-service community of practice this chapter illuminated the way in which teacher utterances and key metaphors emerging from groups of synonyms supports the idea of capturing the nature of learning within CoPs as 'participation' in primary maths teacher practices that results in 'transformation and change' in identity (Lave, 1993a, p. 30; Wenger, 1998).

Evidence from the teacher interviews - learning stories (*stelos*) - shows that participation in the primary maths Communities of Practice professional development programme led to change and transformation of the teacher's identities towards more positively valued primary maths teacher identities. The teachers' verbs and phrases from which emerge the 3 umbrella terms *reinvigoration* and *remediation* and *activation* supports that 'transformation' is enabled through participation in Communities of Practice. The metaphorical terms capture the transformation and identity changes experienced by teachers in NICLE as they closely relate to the word transformation, thus transformation remains the key candidate to describe the knowledge and identity changes that arise from participating in Communities of Practice. While the sampled teachers had similar participation and transformation experiences, they

related them differently because of their mathematical histories. The emergent terms *thus provide a language* to describe ‘mechanisms of learning’ (Lave, 1996) in Communities of Practice. The terms also express and capture the nature of learning or teacher participation and transformation experiences in maths teacher communities based on the maths teachers’ prior identities and connecting them with potential/future and valued maths identities trajectories.

Several studies that have used the notion of Community of Practice in maths teacher professional development have reported maths teachers’ transformation or changes in their mathematical identities, understanding and knowledge (Adler, 1998; Matos, 2009; Lerman, 1998; Graven, 2004, 2005, 2012; Nel, 2012; Hodgen & Askew, 2007). Empirical evidence, from the teachers’ utterances and *stelos*, shows that participation in the primary maths Communities of Practice professional development programme, led to change and transformation of the teachers’ identities towards more positively valued primary maths teacher identities. It also illuminates a shift of the teachers’ mathematical knowledge, teaching approaches and understanding. Primary maths education literature commonly argues that participating in extended practice-informed professional development maths education programmes creates positive maths teacher identities (Drake et al, 2001; Nel, 2012; Askew et al, 1997; Hodgen & Askew, 2007; Graven, 2003). The literature reviewed and the study’s teacher reports suggest that the formation of a maths professional development programme can lead to transformation and change in primary maths teachers’ identities, their mathematical understanding, and improves their classroom teaching practices when certain forms of participation are enabled in the CoP. The diagram below illustrates the nature of transformation and learning that occurred for the sampled teachers through participating in NICLE using the semantics discussed herein.

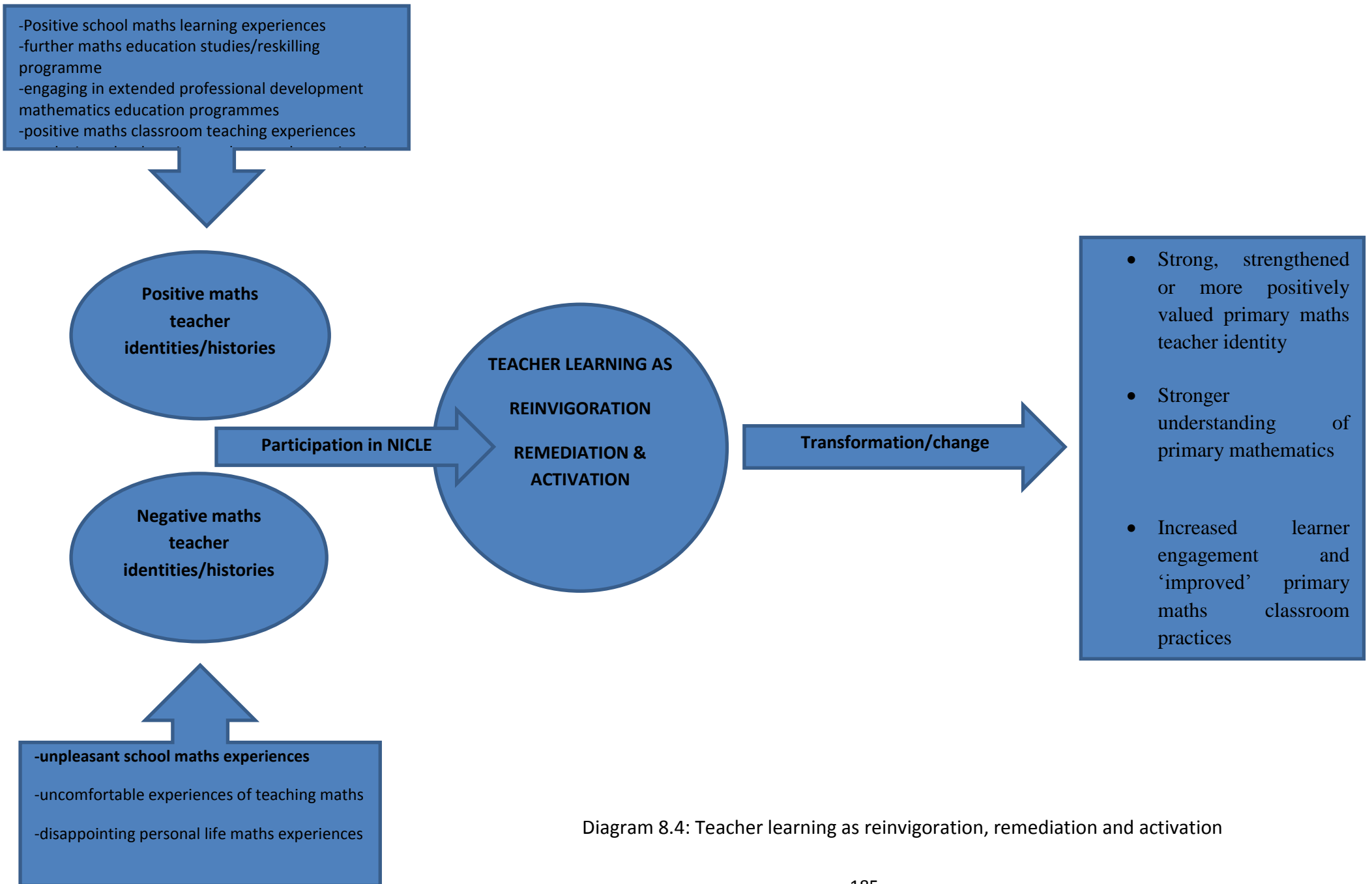


Diagram 8.4: Teacher learning as reinvigoration, remediation and activation

8.8 The processes through which primary maths identities evolve

The second part of this chapter addresses the second research question which relates to how primary maths teacher professional identities evolve in relation to participation in an in-service community of practice and also the processes through which primary maths identities evolve. Theoretical components from the Communities of Practice theory, namely Wenger's (1998) characterisations of identity as *nexus of multimembership*, as a *learning trajectory* and the component of '*imagination*', which is one of Wenger's three modes of belonging, (the other two being *alignment* and *engagement*) alongside primary maths teacher education literature will help address this research question.

With regard to the teachers' articulation of their classroom practices the study reveals that foundation phase teachers embed their primary maths teacher identity within their foundation phase teaching across subjects, whilst Intermediate phase teachers who *only* teach maths at the primary level embrace maths subject specialised identities. Drawing from Wenger's (1998) characterisation of identity as a learning trajectory, and extending this notion, the study explains the processes through which primary maths teacher identities evolve in relation to participation in an in-service Community of practice as '*insiding*' and '*outcropping*'. Outcropping teacher identities trajectories do not confine or limit their participation only in NICLE and in maths classes but also extend their maths identities into a wide range of mathematical dispositions and mathematics education practices, crossing boundaries and linking overlapping communities of practice (Wenger, 1998). *Insider* trajectories involve teachers who limit their participation only in NICLE and in maths classes. The teachers' primary maths identities can shift between insiding and outcropping, with extended participation leading to '*outcropping*' of various forms and degrees within the different phases of participation in professional development CoP.

8.9 Primary maths teacher identity as *nexus of membership*

Wenger's characterisation of identity as "*nexus of multimembership*" will be used in this study to note the differences and similarities in the primary maths teacher identities and how their identities evolve and also to note the differences in the processes of identity change between Foundation Phase (who teach across the learning areas) and Intermediate Phase teachers who only teach maths. This enables the study to investigate the 1st research question which focuses on 'how PMT identities evolve in relation to participation in NICLE and the

processes through which these identities evolve'. As explained earlier in Chapter 3 the notion of identity as multimembership shows that "our membership in any community of practice is only a part of our identity" (Wenger, 1998, p. 158). According to Wenger (1998, p. 159) identity under this aspect is "more than *just a single trajectory*; instead it should be viewed as a nexus of multimembership... it is not a unity but neither is it simply fragmented... (it is), at the same time, one and multiple" [emphasis mine].

I employ Wenger's (1998) characterisation of identity as *nexus of multimembership* to analyse data gathered through the participants' responses to the first two interview questions in the 2011 and 2012 interview schedules. The 2011 interactive interview questions 1 and 2 read:

How would you describe yourself as a numeracy teacher? and Describe your numeracy teaching practice to me.

Whilst the 2012 interview questions 1 and 2 read:

How would you describe yourself as a teacher? and Do you see yourself as a specialised teacher at all and if so in what?

To enrich my data I also present the teachers' utterances about their teaching and maths 'identities' across a range of other interview questions where relevant. My motivation for using this theoretical component stems from the fact that amongst the sampled research participants are foundation phase generalist teachers whose identity they emphasised was phase-based rather than a subject-oriented teacher identity. Thus the study uses Wenger's (1998) characterisation of identity as multimembership to investigate primary maths teacher identities from both within a phase and subject specialisation perspective.

8.9.1 Foundation phase teachers' primary maths identities

Across the two-year period of the study and during the interactive interviews all the sampled foundation phase teachers, including the multigrade teacher, with the exception of Edna, asserted that they were not only maths teachers – primary maths teaching was one part of their undertaking, even while they attended a subject-focused (numeracy/primary maths) professional development programme. These teachers highlighted that the nature of foundation phase teaching required teaching all the key subjects at the elementary level.

Thus their foundation phase teaching professional profile was phase-oriented rather than subject-focused, thus Ruth had said in the first interview

We are mixed teachers ...we are numeracy teachers for an hour and then we are other teachers as well because *we teach all the subjects*. *We don't do subject teaching* here so you teach numeracy in the morning, then there is literacy, there is life skills, there is art, there is phys ed [physical education], whatever there is... we are not really specialist numeracy teachers, so it is one of the areas that we teach everyday... (Ruth, Interactive interview, October 2011).

In the second interview Ruth had also reinforced her phase-embedded identity, saying that “in teaching primary school the opportunity to be specialised teacher...at this level is limited”. Similarly Melania, who taught at the same school as Ruth, had said

I wouldn't like to see myself as only a maths teacher...In foundation phase you got to *teach everything*, you gonna teach reading and spelling and writing you know the three Rs, reading, writing, arithmetic and everything else in-between (Melania, Interactive interview, October 2011).

...in foundation phase you have to *be able to do everything*. You have to be able to teach maths...language...phys ed (physical education)...art...everything. That is the nature of a Foundation phase teacher. So I enjoy maths very much and I enjoy teaching it, but I wouldn't say that I'm specialised in a way. I think it's not the nature of the job to be specialised (Melania, Interactive interview, November 2012).

This resonates with Pamela's utterance which succinctly captured her foundation phase multimembership teacher identity when she said

In the foundation phase the teachers are structured in such a way that in my training at college level I was supposed to *teach many subjects*...I was told you have to be able to teach languages, you have to teach mathematics, you have to teach religious education (Pamela, Interactive interview, 2011).

I am a specialised foundation teacher because *I can teach the four programmes, the four subjects* that we are having. I don't have any problems in doing that (Pamela, Interactive interview, 2012).

Mary, one of the pre-primary teachers in the sample, also articulated in both interviews how her foundation phase teaching identity foregrounded integrating the learning programmes, thus she said,

...everything is integrated in my programmes so as to actually describe myself as a numeracy teacher I find that difficult to express because I am not a numeracy teacher and even when I am teaching numeracy it is not, it is integrated in my daily programme. I am a holistic teacher, *incorporating all the three of our learning programmes* (Mary, Interactive interview, November 2011).

In the 2012 interview Mary also elaborated on the nature of her pre-primary teaching job and how it emphasised the concept of integration. Thus in her classes teaching was “very integrated”, emphasising “learning through play” with the maths coming out through “creative activities...in languages...in music”.

Like the foundation phase teachers, Everton, a ‘Grade 4 and 5’ multigrade intermediate teacher, expressed her teaching identity across subjects. Everton explained that the nature of her classroom practice involved teaching “everything across the board and *teaching all the subjects*. Art, English, Afrikaans, Xhosa...at very elementary level”. In the second interview she also said “when I’m in the classroom I don’t see myself specifically as specialised, I’m a *teacher of all subjects*”. Thus this embedded maths within phase identity remained consistent from the first year to the next even though confidence in primary maths increased it continued to be a phase-identity based connected to her teaching practice.

Similarly Edna, a pre-primary teacher, who voluntarily offered ‘extra maths classes with the Grade 3s’ at her school highlighted the importance of integration at the pre-primary level, in her teaching however she emphasised maths within this. Thus she said

I think I do much better in that than in the other areas (laughs) because I have a passion for it and I always tended to give more time towards that (Mary, Interactive interview, November 2011).

In the 2012 interview Edna also reiterated her foregrounding of maths in her pre-primary classes when she said “my strong point in the classroom is also maths. I know I am not supposed to do it but I tend to spend a lot of time with maths than the others”. Thus, though Edna taught in the foundation phase, her teaching identity emphasised mathematics above general multimembership across-subjects that characterised all the foundation phase

educators sampled in this study. Edna's foregrounding of her primary maths identity (as discussed in chapter 7) may have been influenced by her positive school maths learning experiences, her earlier career job and also from the experiences and practices of running extra Grade 3 maths classes (which offered her the space and opportunity to fashion a maths-subjects teacher identity and trajectory). I further explain other possible reasons why Edna's foundation phase teacher identity was inclined towards maths when I interrogate her trajectory and explain the processes of primary maths teacher identity evolution in the latter part of this chapter.

Whilst Edna's learning story was unique, all the foundation phase teachers participating in NICLE had an embedded primary maths teacher identity, though they had participated in NICLE their identity was not a single (subject-specific) trajectory but a nexus of multimembership. It was one and multiple (Wenger, 1998). Such a multimembership teacher identity could be attributed firstly to the phase taught as revealed by sampled teachers, that teachers in the foundation phase are supposed to "teach many/all subjects...everything". Secondly such a phase specialisation embedded identity arises probably because of the nature of foundation phase pre-service teacher training colleges as revealed by Pamela when she said "at college you are trained to teach many subjects". On Foundation phase teacher training the South African teacher policy states that "Foundation phase teachers must be capable of teaching all three subjects (Literacy, Numeracy and Life Skills) in Grades 1 to 3" (DHET, 2011b, p. 23; DOE, 2000). Primary maths literature also agrees that most foundation phase primary school teachers have a generalist teacher identity in a range of subjects/areas (Brown & McNamara, 2011; Grootenboer & Zevenbergen, 2008; Tatto & Senk, 2011). Thus according to Bernstein (1971, p. 229) elementary primary school teachers "are not socialised into strong educational identities". The study also shows that the sampled foundation phase primary teachers had a nexus of multimembership identities embedded in range of subjects, including maths. The nature of foundation phase primary teaching, policy and pre-service training reinforced such a generalist teacher identity. This was also the case with Everton, one of the multigrade intermediate teacher, though this does not apply with Edna, whose story indicates that her identity was shifting towards foregrounding maths. NICLE aimed at strengthening numeracy teacher identity based on the assumption that this aspect was underdeveloped and underemphasised, as is indicated by primary maths learners' poor performance in international, regional, sub-regional and national tests (DOE, 2008; Fleisch, 2008; Schollar, 2008; Carnoy et al, 2011; Taylor et al, 2013; Mullis et al, 2012; DBE, 2012).

8.9.2 Intermediate phase teachers' primary maths identities

Unlike the foundation phase teachers who were participating in NICLE, both Calvin and Robert's interview utterances reveal that their identity was maths subject focused mainly because of the Intermediate phase level which they taught and the subject(s) that they taught. Whilst Calvin only taught 'Grade 5 and 6' maths, Robert mainly taught maths from Grade 4 to 7 and would at times teach Technology and English in the Intermediate phase grades. Besides their maths teaching responsibilities at their respective schools, both teachers had also attained Bachelor of Education degrees with an intermediate phase maths focus which emphasised their single subject specialisation as maths. Because of his maths teaching responsibilities Calvin regarded himself as someone who had specialised in maths and would prefer not to teach any other school subject. Thus in the first interview he had said, "You know I like teaching maths. In fact I, I wouldn't like to teach another subject". He reiterated this maths teacher identity assertion in the 2012 interview when he said

Currently I'm only teaching maths so basically I'm specialising in maths. Although I don't have a problem teaching other learning areas. But if I get a choice I will say 'no rather give me mathematics'. I don't want to teach other learning areas (Calvin, Interactive interview, November 2012).

Robert was also quite assertive of his mathematical identity and portrayed himself as a "more maths-orientated teacher" who was "an authority in the intermediate phase mathematics" and "in charge of mathematics" as he was the "only person...teaching Grade 4 to 7" mathematics at Delta Primary school. Because of his further studies in numeracy Robert also saw the opportunity to "become a specialist in mathematics". Besides being the only intermediate phase maths teacher for the past 19 years at Delta Primary and his current Masters in mathematics education studies, Robert's maths identity had also been strengthened by his earlier maths education studies at RUMEP as he noted

I enrolled at RUMEP where I qualified and got a distinction in maths teaching. In that way I qualified myself with the concept of mathematics teaching as a reflective practitioner (Robert, Interactive interview, November 2012).

Similarly Calvin's primary maths teacher identity orientation, where he described himself as a "Grade 5, 6 maths teacher" was strengthened by his view of himself as having a "good understanding of the mathematics". Thus he said he did not "struggle with the content of mathematics intermediate phase" and was "comfortable" and "capable" in teaching it. The

fact that Calvin had 19 years maths teaching experience and specialised teacher training in the intermediate phase maths reinforced his primary *maths* identity. Regarding his RUMEP further maths teacher education training Calvin explained that it focused on intermediate and senior phase maths content and the notion of constructivism in the course changed his “approach on teaching where you don’t enforce yourself in teaching maths”.

Thus both Robert and Calvin had a maths subject focused primary maths identity because of their mathematical learning histories and their current teaching experiences which involved teaching-only maths at their respective schools. The South African teacher education policy allows for Intermediate phase teachers who teach from Grades 4 to 6/7 to have a subject domain specialisation, with Mathematics being one of the subjects (DOE, 2000; DHET, 2011a). Subject specialisation or “subject matter competence” has been noted as “the lynch pin of” an educational identity (Jansen, 2001, p. 242; Bernstein, 1971, p. 212). Intermediate-phase subject-specialists teachers are likely to have what Bernstein (2000, p. 54) calls “dedicated identities”. Thus, as intermediate phase teachers only teaching maths at the primary level, Robert and Calvin embraced strong mathematics specialisation identities and this differs from most of the sampled foundation phase teachers whose identities had an integrated focus across the key elementary subjects, including maths.

It is useful to note the differences and similarities between foundation and intermediate phase primary maths teacher identities as this helps the study to note relationships concerning how their identities evolve and the processes of identity change between Foundation Phase Intermediate Phase teachers. The next part of the chapter uses Wenger’s (1998) characterisation of identity as a learning trajectory and his notion of imagination to investigate the processes through which primary maths teacher identities evolve in relation to participation in an in-service community of practice.

8.10 Insiding and Outcropping primary maths teacher identities

Drawing from Wenger’s (1998) characterisation of identity as a learning trajectory the study explains the processes through which primary maths teacher identities evolve in relation to participation in an in-service Community of practice as ‘*insiding*’ and ‘*outcropping*’. These two terms are derived from the five types of learning trajectories listed by Wenger (1998) (fully discussed in Chapter 3). I thus use Wenger’s (1998) notion of trajectory to interrogate the teachers’ processes of succession of participation both within NICLE and across maths communities of practice. Because research question 2 looks at processes through which

primary maths teacher identities evolve in relation to participating in NICLE, this study *mainly* focuses on those primary maths identity changes that directly resulted from participating in the primary maths in-service community. The study's focus on NICLE numeracy trajectories concurs with Wenger's (1998, p. 156) explanation that "a community of practice is a field of possible trajectories". The study also uses the concept of imagination, which is one of Wenger's (1998) modes of belonging to strengthen the proposed terms that explain the processes of primary maths teacher identity evolution within NICLE. The concept of imagination was used in the interactive interview questions⁵⁰ to elicit information from the sampled teachers participating in NICLE concerning how they foresee themselves within the space, context and opportunities afforded in this numeracy teacher professional development programme. Besides data from interactive interviews the study also uses, where relevant, information from teacher journal entries to provide an in-depth qualitative description of primary maths teacher identity change in relation to participation in NICLE.

The term '*outcropping*' relates to what Wenger (1998, p. 154) identifies as '*Boundary trajectories*' which are amongst the various types of trajectories found in communities of practice. *Boundary trajectories* find value in "spanning boundaries and linking communities of practice" (Wenger, 1998, p. 154). Boundary trajectories are similar to 'brokering' which entails "connections provided by people who can introduce elements of one practice to another" (Wenger, 1998, p. 105). Instead of using the term 'brokering' or 'boundary trajectories' I prefer to use the term '*outcropping*' as it combines the term '*cropping*' which implies growth and '*outcrop*' which carries the notion of external extension. The term *outcropping* also closely relates with the synonyms *reinvigoration* and *remediation* and *activation* introduced in the first part of this chapter. *Outcropping* teacher identities and trajectories thus are not confined or limited to participation only in NICLE and in maths classes but also extend into a wide range of mathematical and mathematics education practices, crossing boundaries and linking with overlapping communities of practice (Wenger 1998).

I also use the term '*insiding*' for teachers whose identities (in terms of their *stelos*) are limited to participation in NICLE and in maths classrooms. The term borrows from and extends Wenger (1998) *insider trajectories*, under which full participating members continuously

⁵⁰ Questions 6 and 7 in the 2011 and 2012 interviews respectively asked the teacher on how they imagined themselves at the end of the NICLE programme and in terms of primary maths education.

change their practices and renegotiate their identities in relation to new demands, new inventions and new generations. The processes of *insiding* and *outcropping* are complex and at times involve shifting between these two processes, with participation in the CoP leading to different forms and extent of *'outcropping'*.

8.10.1 Outcropping maths identities

Outcropping maths identities emerged with six of the sampled eight teachers at various stages of their participation in NICLE. Generally teachers with valued maths histories or intermediate phase teachers tended to have outcropping identities in the early stages of their participation in NICLE. On the other hand teachers with weak maths histories or foundation phase teachers maths identities outcrop at a later period during their engagement in the in-service CoP. Teachers with histories of positive maths identities, whether foundation or intermediate phase teachers, tended to indicate their trajectories overlapping into a wide range of mathematical dispositions and mathematics education practices in the early stages of their participation in NICLE. Outcropping mathematical identities and trajectories spanned boundaries and linked overlapping communities of practice (Wenger, 1998). Teachers with such learning trajectories extended their maths participation and practice (thus identities) in various ways hence my use of the term *'outcrop'* to imply the growth and expansion of such identities into other related maths communities or practices.

In the following passages I illustrate Edna, Calvin, Robert, Mary, Everton and Melania's unique and distinct outcropping maths identity trajectories which were according to them triggered through their participation in the primary maths teacher learning community of practice. Outcropping also resonates with the various leader roles promoted in NICLE described in Chapter 6⁵¹ and the national department of education's leadership and research career trajectory teacher qualification pathways (DHET, 2011b). I employ the concept of *imagination* (Wenger, 1998) to strengthen the sampled teachers' envisioning of possible mathematical futures and identities as this relates to the processes of primary maths identity change in relation to participation in NICLE

8.10.1.1 Edna

Edna, one of the two grade R teachers participating in NICLE, had widened her interests in maths practices by becoming a member of the Association of Mathematics Education of South Africa (AMESA), within six months of participating in the maths learning community.

⁵¹ The SANC diagram in Appendix 6 also shows the emerging NICLE teacher leader roles.

According to Edna it was through participation in NICLE that her mathematical trajectory had extended into AMESA, as she said that NICLE had “introduced me to AMESA”. In the 2012 interview Edna also explained that “NICLE actually introduced me to a lot of things because I never used to attend workshops”. Edna had both attended an AMESA regional conference held at Fort Hare University on 15 October 2011 and had at her own expense and initiative attended a Numeracy teacher workshop by Aarnout in August 2011 in Port Elizabeth. Edna had also said during the interview that she “personally bought from Brombacher [Aarnout] a set of books” which she used during her ‘extra Grade 3 maths classes’.

A year after participating in NICLE, Edna had requested and was granted by her principal the opportunity to offer ‘extra Maths time with the Grade 3s’. Edna’s offering of extra Grade 3 maths classes was directly influenced by participating in NICLE where she had “got a lot of ideas”. She said that teaching only the Grade R would make her “sit with everything inside” and it would get “bottled up because [she] could not do it with the Grade Rs”. The ‘extra time in Maths’ sessions were offered twice a week for a 30-minute period and at times would take place at Edna’s house (Edna, Journal entry, March & August, 2012). During the interview Edna said that during these extra maths sessions she would “engage and actively involve” the learners so as to get “them to enjoy” maths. In relation to this, in her August journal entry Edna had written about how she tried to engage the Grade 3 maths learners “a lot in talking and discussing issues” (Edna, Journal entry, August 2012).

During the period of her participation in NICLE, Edna was also studying for a Diploma in Grade R teaching, which she completed during her second year of participating in NICLE. Towards the end of 2012 she had applied for a part-time Bachelor of Education Degree with RUMEP and was accepted for the programme. She had written about her application being accepted in her diary entry excerpt below.

While in G-town [Grahamstown] to sort out my outstanding bursary issue, I decided to pop-in at RUMEP. It must have been my lucky day or the ‘Angels’ have not forgot about me! I have been accepted into the B Ed programme (Edna, Journal entry, 13 December 2012).

Edna had also accompanied 3 of her school learners to the evening family maths event hosted by the Chair project and run by Steve in October 2012 in Grahamstown. One of her significant outcropping opportunities, that resonates with the projected NICLE numeracy teacher identities of promoting leader educator roles, was evident in June 2013 when Edna,

with my assistance, presented a ‘How I teach it’ session at the AMESA national conference in Cape Town.

Using Wenger’s (1998, p. 154) explanation of a trajectory as not being a “fixed course, destination or path” but “a continuous motion”, Edna’s trajectory suggests “one that has a momentum of its own”. Joining AMESA, offering extra maths time, pursuing further studies, attending additional maths workshops and events (in other towns and cities) and presenting at AMESA are all part of the “field of influences” (Wenger, 1998, p. 154). Such an outcropping primary maths trajectory closely related with how Edna imagined herself in the future after participating in NICLE. Thus Edna hoped “to be like” one of the NICLE facilitators and also to “specialise in maths education one day”. Edna’s primary maths learning trajectory extended into various overlapping maths communities and in the processes embracing primary maths leader educator and life-long learning roles, thus illustrating the process of her outcropping primary maths teacher identity.

8.10.1.2 Robert

Robert, one of the two intermediate phase maths teachers in the sample, had been awarded a scholarship by the Numeracy Chair in 2012 and completed his Masters in Maths Education on a part-time basis (he graduated on the 10th of April 2014). His research focuses on using analogue clocks in teaching time. Robert explained that his primary maths identity was in the “progressive stage of developing...to become a specialist in mathematics education”. Thus Robert imagined himself going into primary maths education academic research, as he said

I would like to go into academia and may be research-based or in the class situation. I’d like to go in that field. There’s so much more that a person can do through the NICLE programme to enhance and change, if changes are needed (Robert, Interactive interview, November 2012).

Robert’s “new images...that become constitutive of the self” (Wenger, 1998, p. 177) closely relates with his interest in furthering his professional and academic qualifications that emerged from and through participation in NICLE. In furthering his and the learners’ interests in maths, Robert’s school had joined the Conquest maths competitions held in Kwa-Zulu Natal, with one of his student doing “tremendously well” in the competition. Robert looked forward to participate in the AMESA during the following year, as he optimistically said “....maybe next year we will enter AMESA”. Robert’s outcropping learning trajectory

expanded into overlapping maths education communities with his identity forming trajectories “both within and across (maths) communities of practice” (Wenger, 1998, p. 154).

As mentioned earlier, engaging in NICLE influenced Robert’s growing maths teacher identity but this must also be understood in the light of his earlier studies at RUMEP, at which he specialised in maths and his current teaching job in which he mostly taught maths at the intermediate phase level. However participating in the primary maths CoP had enabled him to extend his mathematical interests, thus furthering his maths studies, entering learners’ in maths competitions, and he had the optimism of being an AMESA member. Robert’s outcropping maths teacher identity embedded the notion of life-long learner which cohered with the promoted designated identity for teachers in NICLE. Participation in NICLE had, according to Robert, “opened doors for him”, allowing him in the process to form maths identity trajectories “across communities”. Robert’s *stelos* illuminates Wenger’s argument that “a community of practice is a field of possible trajectories” (Wenger, 1998, p.156). In Robert’s case the possible pathways are different yet all related to his maths teacher identity and learning trajectory.

8.10.1.3 Calvin

One year after participation in NICLE, Calvin was invited by the district education officials to “be part of the presenters for CAPS”⁵², intermediate phase maths subject in March 2012. However he later turned down this offer because of what he alleged to be the “bad approach” of one of the district education officials. Calvin had also expressed in the first interview what he imagined to be in the future, when he explained that his “dream” was to be a teacher trainer and “not to be in the classroom”. Relating to this imaginative self was Calvin’s explanation in both interviews and in one of his journal entries of his desire to form a maths cluster with other teachers in his area. Thus he had said

...why can’t we have our professional body of Maths teachers? Having a Maths cluster where I can deal with other grade 6 teachers. Maybe I can learn from them and they can learn from me (Calvin, Interactive interview, November 2011).

There is need for a cluster. We don’t have a cluster...So in future if I am still in...in...in teaching cluster. Form a cluster in our area. It’s maybe Ja cluster. That is for me the most

⁵² Recall in Chapter 2 I explained that in 2012 the Department of Education introduced a new restructured CAPS curriculum.

important thing, so that we beef up all the educator's [*sic*] content, and strategies. Because you learn a lot from other teachers (Calvin, Interactive interview, November 2012).

I believe it is high time to form a mathematics cluster in the Alexandria region so that we can exchange ideas and assist one another (Calvin, Journal entry, 2 March 2012).

Whilst Calvin's teacher training trajectory can be attributed to participation in NICLE, it must also be viewed within the context of Calvin's early career maths trajectory, as he had trained teachers in the learning area of technology when OBE was launched in 1998, and had also conducted cluster maths demonstration lessons for the Intermediate Phase for other teachers in 2010. On the other hand Calvin's Bachelor of Education qualification, which had an intermediate phase maths specialisation component, and the nature of his teaching job, where he only taught maths, indirectly influenced his expanding maths teacher identity. Furthermore Calvin's position as the school deputy principal, and being a member of the school maths learning committee, resonated with his emerging identity as a leader both in education management and in primary maths education.

Calvin's, outcropping maths identity trajectory was also evident in his desire to join AMESA which he explained was 'a thinking thing' and had been negotiating with his principal for the last two years to let them join AMESA. Beside the quest to join a professional maths teacher association Calvin's engagement with maths extended into informal mathematical conversations or discourse with friends and colleagues, as he said:

I talk to (N), I talk to (M), M is a wonderful problem solver. M, she is also teaching at Delta primary but we talk mathematics. She is attending NICLE. She is a teacher at Delta primary. (N) is my neighbour. M always goes to her, to talk about mathematics. What is the lady at Delta high? - (V), we talk about mathematics...So my, my basis, my friends, its, I am working with anyone who is doing maths (Calvin, Interactive interview, November 2011).

Calvin's distinct maths identity was 'spanning' from NICLE into other maths education communities, thus giving him the opportunity to develop a maths identity that moved towards a maths teacher trainer identity trajectory. Calvin's *outcropping* maths identity trajectory, which according to Wenger (1998, p. 154) finds "value in spanning boundaries and linking communities of practice" (maths communities of practices in this case) was in alignment with

the intended and ‘designated identities’ (Sfard and Prusak, 2005) promoted in NICLE of establishing specialised maths leader educators who would continue to support and work with other teachers.

8.10.1.4 Melania

Melania’s NICLE participation trajectory also illustrates the notion of defining the processes of her primary maths teacher evolving identity as outcropping. Eight months after participating in NICLE Melania was invited to present a demonstration lesson during a NICLE session with six learners. In this demonstration lesson she focused on how she taught the concept of place value using flard cards in a flard card box. The invitation to present in NICLE was motivated through a lesson observation of Melania’s maths lessons by the SANCP’s teacher co-ordinator. Melania’s flard card demonstration lesson is an example of a NICLE teacher taking up the promoted NICLE leader educator roles. I will explain in the following chapter how some of the sampled teachers in this study revealed that this ‘demo lesson’ had influenced their primary maths teaching practices. Besides presenting a demo lesson, Melania’s career trajectory imagination was confined within her maths classroom practices as she explained in both interviews that she hoped that her learners would be “confident and daring” when faced with a mathematical problem. When asked if she had any aspirations of extending her primary maths identity beyond engaging in NICLE and her maths classroom practices, Melania said “I don’t really have time for much more than that right now”.

Melania’s NICLE demonstration lesson illuminates my reason of naming the process of teacher identity change through participation in a CoP as outcropping when it involves teacher identity trajectories that find value in spanning within and across communities of practice (Wenger, 1998). Though Melania’s trajectory interconnected and bridged the NICLE CoP and her primary maths classroom practice, leading her to present a demonstration lesson to other NICLE teachers, she still saw the need to continue with her primary maths teaching responsibilities. Melania’s story illustrates the process of outcropping and this shows the complexity of this notion and process of growing and expanding one’s identity within a CoP.

8.10.1.5 Mary

Like her Grade R counterpart - Edna - Mary felt the need at her school to offer mathematics “sessions with the Grade 3 classrooms” so that she could be in a position to “put into practice...what [she] had learned” in NICLE. It is unfortunate that her request to offer extra

maths sessions at her previous school, Martindale, had “fallen on deaf ears”, however in the second interview Mary explained that she would put a similar request at her new school. Mary’s intention to extend her participation in NICLE into Grade three maths classrooms shows how her identity overlapped into mathematics practices beyond the pre-primary level where she currently taught and was trained. In June 2013, and in her third year of participating in NICLE, and with the assistance of members of the SANC project, Mary also presented a ‘how I teach it’ session at the AMESA national conference in Cape Town. Such a growing and expanding primary maths identity was mainly provoked through participating in NICLE and also through Mary’s further studies for a Diploma in Grade R teaching. Following the completion of this in 2014, Mary registered for a Bachelor of Education degree through RUMEP. Mary’s desire to offer extra maths session for Grade 3 maths classes, and her national AMESA conference presentation, shows her “ability to link practices by facilitating transactions between” NICLE and other overlapping maths communities (Wenger, 1998, p. 109). Mary also explained her wish to be a ‘lifelong learner’ or a “constant learner” who didn’t “want to stagnate” but to stay “up to date with what’s happening and the different approaches”. She said she would prefer to “sort of specialise in maths” and reach a stage where she could do “an Honours or a Masters”. Mary’s outcropping primary maths identity closely related with her imagined maths specialisation trajectory, thus her NICLE trajectory connects “to an extended identity” (Wenger, 1998, p. 185). Her linking and connecting of NICLE practices with her AMESA presentation and her intention to teach maths grade 3, and being a lifelong learner with a maths specialisation, shows how her pre-primary maths school identity was shifting. Mary’s practices and identity outcropped beyond NICLE participation and teaching the Grade R classes and extending into related and overlapping primary maths teacher education communities.

8.10.1.6 Everton

After participating in NICLE for two years, Everton’s primary maths teacher identity was showing an interest in sharing with other primary maths school teachers what she had learnt in NICLE. Asked how she would imagine herself in the future in terms of primary maths teaching, Everton explained that she

Wish(ed) there was a way of er...sharing it (teaching primary maths). I must think hard about this...with other teachers in the area. That has been on my mind and um...I haven’t quite got round it. But I still want to. We have got another school here. But I find it hard to share

without being invited you know what I mean... I think NICLE should put a bit of thought into ways of helping people like me get to other schools...And I think that some way, or some mechanisms should be put in place to facilitate that kind of sharing (Everton, Interactive interview, November 2012).

Everton's primary maths identity showed the desire to transfer and translate the NICLE practices with other primary school teachers in her locality (a remote farming area). Everton's growing passion for maths leader roles was also shown when she submitted a 'how I teach it' paper for the 2013 AMESA national conference. It was unfortunate that her paper was not accepted. Such an outcropping mathematics teacher training trajectory which was revealed by Everton through her future intentions, resonates with the key objectives of NICLE of developing numeracy leader educator roles. Everton's future career trajectory and imagination also illuminates my reasons of naming the community and identity change processes of participants who "find value in spanning boundaries and linking communities" (Wenger, 1998, p. 154), as 'outcropping'.

The NICLE learning stories of Calvin, Edna, Mary, Everton, Robert and Melania illuminate the notion of 'outcropping' as one of the two processes through which primary maths teacher identities evolve in relation to participation in a primary maths teacher in-service CoP. The process of outcropping entails "translating, coordinating and aligning between perspectives" (Wenger, 1998, p. 109). Drawing from Wenger's characterisation of identity as a learning trajectory and the teacher utterances the study defines 'outcropping' as teacher identity trajectories that do not confine their participation only in NICLE and in their maths classes but also extend their maths identities into a wide range of mathematics education practices, crossing boundaries and linking overlapping communities of practice (Wenger, 1998). Wenger's (1998) concept of imagination also strengthens the proposed term on the processes of the evolution of primary maths teacher identity within NICLE which relates with the imagined and promoted numeracy teacher orientations. Teachers with positive maths histories and intermediate phase teachers tended to develop outcropping identities, whose realisation could be in different forms or types and at different stages of engagement within the professional development initiative. Reading from the discussed NICLE teacher trajectories the sampled participant identities spanned into further studies, primary maths teacher training, teaching extra after school maths classes and attending and/or presenting at maths conferences or within the numeracy in-service community of practice. A SANC

diagrammatic presentation of the teacher leader roles being taken by the NICLE teachers is available in Appendix 6. It is beyond the scope of this study to categorise all the types or forms of outcropping as the sample is small. Further research in a similarly designed CoP with more teachers could illuminate a wide range of forms of outcropping. Most of the outcropping teacher identities relate and resonate with numeracy leadership roles promoted in NICLE and the leadership and research career trajectories suggested by the Department of Education (DHET, 2011b). In some cases the outcropping identities led primary teachers to become “primary mathematics teachers” (Brown & McNamara, 2011, p. 11; Hodgen & Askew, 2007, p. 469; Graven, 2003, p. 26) who are proficient and have a passion and competence to teach maths in their classroom work.

The last part of this chapter explains the term ‘insiding’, which is used to describe the processes of primary maths identities whose practices are limited to participation in NICLE and in maths classes.

8.10.2 Insiding learning trajectories

Insiding was evident in the learning stories of Ruth and Pamela. The term borrows from and extends Wenger (1998) *insider trajectories*, which are amongst the five types of trajectories found in communities of practice. Insider trajectory identities occur when full participating members continuously change their practices and renegotiate their identities in relation to new demands, new inventions and new generations. The term insider or insiding is the opposite of ‘outsiders’, which is a term used in Communities of Practice to imply people who cannot easily enter or participate in the enterprises and activities of a particular community (Wenger, 1998). According to Wenger, full participation results in one being an insider whilst full non-participation implies an outsider position. I use the term insiding in a similar sense to define full-participation membership identities who engage both in NICLE and in classroom practices. Thus primary maths insider trajectory identities mostly limit their participation in NICLE and in maths classrooms. Insiding relates with qualification pathways of teachers “who choose to maintain a teaching and learning trajectory” (DHET, 2011b, p. 16). I also use the concept of imagination to strengthen the notion of insiding and in the process reveal the way teachers “envision their possible futures” through participating in the NICLE community of practice (Wenger, 1998, p. 178).

8.10.2.1 Ruth

In the first interview Ruth's portrayal of her imagined primary mathematics teacher identity showed some tension, as she emotionally said,

I could just go independent and find you know doing something, enterpreneuring..., where I want to be I don't know? I would rather wait and see...You know last year I completed a UNISA course in Art, I have just completed it and now I am in NICLE (laughs) how does that fit. I don't know yet, I don't know, so that's what happened where I want to be, just to cut it short and now I am tracking along a path that I do not know where it is going to go but every second Tuesday I come and enjoy and I go and I think I will try this (Ruth, Interactive interview, October 2011).

Ruth, a high school trained teacher with a History and Geography specialisation in the subjects, was grappling with who she wants to be, especially given the fact that when she joined NICLE she had completed an Art course with the University of South Africa (UNISA) and had been teaching at Heritage preparatory school for the last two years after having left teaching Geography and Art at a high school. Whilst she was in tension in the latter part of the interview she had justified her continuous participation in NICLE because she felt that NICLE had "awakened her interest", supported her "personal understanding of maths" and developed her own understanding of the "processes and steps of teaching". NICLE gave her "ideas of applying concepts" and "ways of engaging learners". Similarly in the second year of engaging in NICLE Ruth explained that she "thoroughly enjoyed" participating in the professional development programme as it had enhanced her "enjoyment of teaching".

Ruth also remarked on how her participation in NICLE invoked her mathematics identity, thus generating and envisioning teaching the older grades as she said,

I have you know at this very school we are starting a grade 4 next year and I have already been asked whether I would be willing to take the grade 5 in 2014⁵³ so I see myself there...in two years' time...teaching slightly older children (Ruth, Interactive interview, November 2012).

Ruth's explanation of her imagined primary maths teacher trajectory illustrates my description of the processes of identity change in relation to participation in a community of practice as 'insiding'. Thus Ruth's participation in NICLE provided her with a "full participation insider...identity trajectory" (Wenger, 1998, p. 154 & 167) that enabled her to

⁵³ In 2014 Ruth taught the Grade 5s.

change her maths practices, yet this change related mostly to her participation in primary maths classes and in NICLE. Such an insiding primary maths identity trajectory relates with one of the Department of Education's teacher pathways under which "teachers choose to maintain a teaching and a learning career trajectory" (DHET, 2011b, p.16), thus continue to work in classrooms rather than moving out of the school context into other educational settings, for example to become lecturers, teacher educators or work at the district office.

8.10.2.2 Pamela

Like Ruth, Pamela also explained her learning trajectory in terms that were limited to her participation in NICLE and in her maths classes. Her NICLE learning story and how she imagined herself after participating in the in-service CoP helps to understand the process of 'insiding'. Under this notion primary maths teacher identities evolve in relation to participation in NICLE leading to full participation in the primary teachers' in-service Community of practice and in maths classroom practices. Whilst Pamela's learning story, as described earlier, shows how NICLE transformed her from a maths-fearing teacher into a maths-loving teacher who democratically engaged learners, her primary maths teaching imagination also showed how she confined her practices in her maths classes. Thus in the first interview she saw herself as a "teacher that will produce. When my learners enter 'intersen'⁵⁴, that is Grade 4; they will be able to be independent especially in numeracy". Similarly in the second interview Pamela expressed how she intended to "expand herself" and become a "fundi of" primary maths and a "very good teacher of mathematics".

Pamela's explanation of her change in identity through participation in NICLE below illuminates the term insiding,

I am glad that I am part of this program. It has changed my thinking, it has helped me to love mathematics. It has taken some fears that I did have, it has because I love it now, it is easy to do it in my classroom (Pamela, Interactive interview, November 2011).

Thus Pamela limited her explanation of her learning in terms of her participation in NICLE and in her maths classes. Her insiding trajectory allowed a "full participation insider" identity within NICLE, which allowed her primary maths teaching practices to evolve and "create occasions for renegotiating her identity" to one that loved maths and engaged learners (Wenger, 1998, p. 167 & 154). As explained in relation to Ruth, the notion of insiding resonates with one of the Department of Education pathways in which educators "maintain a

⁵⁴ Intersen refers both to the intermediate phase Grade 4 to 6 and the senior phase Grade 7 to 9.

teaching and learning trajectory” (DHET, 2011b, p. 16). Thus the NICLE learning stories and trajectories of Ruth and Pamela were limited to their participation in NICLE and continued to influence their work in their maths classrooms. Whilst insiding involves full participation of insider trajectories within the community of practice it enables members’ practices to change in relation to “new demands, new inventions and new generations” which occur both in the community and within the broader context, thus leading participants to renegotiate their identities (Wenger, 1998, p. 154). In the cases of both Pamela and Ruth it leads to increased practices involving learner engaging maths classroom practices which is one of the key intentions of the NICLE programme.

Whilst the NICLE key aims and the projected identities and the Department of Education’s suggested qualification pathways and career trajectories relate with both the notion and the processes of ‘outcropping’ and ‘insiding’, it is important that the national government extends and supports these teacher identity trajectories within the context of the envisaged professional learning communities (DHET, 2011a). The concept of ‘outcropping’ and ‘insiding’ thus provides the space and opportunities to explore teacher trajectories and identities and improvise ways of supporting the teacher career pathways to fully benefit the different concerns of primary maths teacher education, be it to improve maths classroom practices or encourage leadership roles amongst practising teachers. Teacher leadership roles or trajectories could be supported at school and district level to lead or facilitate sessions in district professional learning communities (DHET, 2011a), and thus be critical sources of influencing other teachers understanding, identity and practices. Such sources of teacher learning could be one possible means of averting the local primary maths education crisis and improving the reportedly low levels of primary maths teachers’ knowledge (Fleisch, 2008; Carnoy et al, 2011; Taylor et al, 2013).

8.11 In Summary

In this chapter I have addressed the overarching and the first research questions and in the process provided rich and in-depth descriptions and analyses of the nature of teacher learning and the processes of primary maths teachers’ professional identities evolvment in relation to participation in an in-service community of practice. Drawing from Lave’s (1996) notion of telos and Sfard & Prusak’s (2005) identities as stories construct and analysing the key data themes that emerged mainly from teacher utterances the study discusses the teacher learning stories-*stelos*. The *stelos* reveals that teachers with a history of maths competence that is

“valued or positively valued maths identities” have their maths identities *reinvigorated*, whilst teachers with identities that previously shied away from maths have their “devalued or negatively valued identities” maths identities *remediated*. In both instances new mathematical identities are *activated* through participation in communities of practice, resulting in teachers with strong maths identities (Lave, 1993b, p.77). Informed by Wenger’s (1998) characterisations of identity as a *learning trajectory*, the study explains the processes through which primary maths teacher identities evolve in relation to participation in an in-service Community of practice as ‘*insiding*’ and ‘*outcropping*’. The processes of *insiding* and *outcropping* are complex and at times teacher identities can shift between these two processes, with participation in the CoP leading to ‘outcropping’ of different forms and extent and at different stages of engagement within the professional development programme.

In the following chapter I discuss activities, relations and forms of participation within the Community of Practice which *enable* or *constrain* primary maths teacher identities and practices.

Chapter 9: Primary maths teacher learning: affordances and constraints within NICLE

“To become a full member of a community of practice requires access to a wide range of ongoing activity, old timers, and other members of the community: and to information, resources, and opportunities for participation” (Lave & Wenger, 1991, p. 101).

9.1 Introduction

In Chapter 8 I investigated the overarching and the first research questions. In this chapter I address the second research question using the Communities of Practice theoretical elements discussed in Chapter 3 and key literature discussed in Chapter 4. Having explained the key activities that teachers engaged with in NICLE, I now discuss and analyse *how* these activities afforded or constrained evolving primary maths teacher identities and practices. To help analyse and interpret activities, relations and forms of participation within the Community of Practice which enable and constrain evolving primary maths teacher practices I use Wenger et al’s (2002) three fundamental structural elements of CoPs: *domain*, *community* and *practice*, and Wenger’s (1998) notion of engagement. These CoP theoretical concepts supplemented by teacher education literature help explore the primary maths teacher learning *affordances* and *constraints* within NICLE. In this study *Practice* relates to classroom teaching practice as well as NICLE practice (or learning practices afforded by NICLE). These are dealt with separately, resulting in four subsections for affordances.

This Chapter is therefore structured as follows:

In section 9.2 ‘Affordances’ I discuss findings in relation to affordances noted by teachers organised under the themes of:

9.2.1 Affordances in relation to *Domain*

9.2.2 Affordances in relation to *Community*

9.2.3 Affordances in relation to classroom teaching *Practice*, and

9.2.4 Affordances in relation to the nature of NICLE *Practice*.

I conclude this section with a summary of findings on affordances and provide two summary tables in this respect.

In section 9.3 ‘Constraints’ I discuss findings in relation to constraints noted by teachers organised under the three emergent themes:

9.3.1 Constraints relating to time

9.3.2 Constraints relating to travel distance, and

9.3.3 Constraints related to exclusion of others from NICLE.

In section 9.4 I conclude the chapter, summarising how the analysis in these sections answers the research questions.

I note however that I accessed Wenger et al’s (2002) three elements of CoPs at a later stage of my study when I struggled analysing and presenting data for this chapter. As explained in Chapter 3 there are similarities between the structural elements of a CoP (Wenger et al, 2002) and the social learning theory components (Wenger, 1998).

Discussing and analysing qualitative data from the empirical field using the aforementioned CoP’s theoretical elements reveals that participating in the NICLE *community of practice* sessions enabled positively evolving primary maths teacher identities and practices. Teachers particularly pointed out that their learning was enabled through engagement with primary maths experts that focused on the *primary maths domain’s* key concepts and issues informed by current research that link theory and *practices*. Learning was also afforded when teachers collaboratively and actively engaged in numeracy games, with teaching resources and demonstration activities that related to *primary maths teacher (classroom) practices*⁵⁵ and NICLE practices (i.e. the nature of the practices, relations and forms of participation within NICLE).

9. 2 Affordances

In this part of the study I discuss my research findings that focus on the *affordances*⁵⁶ (Greeno et al, 1998) relating to activities that teachers experienced during their participation in NICLE. Under the notion of affordances, this study investigates and discusses NICLE

⁵⁵ Lampert (2010) and Ball & Cohen’s (1999) definitions of teaching practice helps me explain the term. According to Lampert (2010, p. 29) “learning the practice of teaching is learning ‘what teachers do’” or it’s “about the practice of teaching and learning” (Ball & Cohen, 1999, p. 13). Borrowing from these definitions and for this study therefore primary maths teaching practices relate to what primary teachers do when teaching learners maths.

⁵⁶ Greeno et al (1998, p. 9) defines affordances as “resources, characteristics... and qualities of systems that can support interactions and... participation”. In other words affordances are “opportunities for engagement in practice” (Lave and Wenger, 1991, p. 93).

activities and resources that enabled teachers' take-up of what they learned in the professional development programme. The discussed NICLE activities according to the teachers generally improved their primary maths teaching practices and their understanding of specific numeracy concepts. Analysing these NICLE activities and resources enables the study to interrogate part of the second research question, relating to *how* activities within the Community of Practice enable evolving teacher numeracy identities and practices.

To help interrogate how teacher learning is enabled or constrained I draw on data from the 2011 and 2012 interactive interview questions 14, 16a, and 10 respectively which read:

Has NICLE supported your understanding of mathematics teaching at all so far? If so, explain.

What do you think are some of the advantages of participating in NICLE?

Which NICLE activities/sessions did you enjoy most? Why did you enjoy these activities? Which activities or materials did you use in your maths classes? Which activities or materials do you intend to use in your maths classes?

I enrich the data by presenting the teachers' utterances about their knowledge take-up within NICLE across a range of other interview questions. The interactive interview data are supplemented with information from teacher journal entries. I explore NICLE affordances using Wenger et al's (2002) three CoPs elements of *domain*, *community* and *practice*⁵⁷. Relating these elements to the empirical field of study: entails that NICLE is the *community*, whose *domain* is primary maths education and with its *practice* being primary maths teaching and learning *practices*. I also discuss the features of the NICLE activities that teachers identify as 'enablers' of take-up in practice alongside pertinent literature from teacher education. This will provide the opportunity for the study to investigate how and why the discussed "opportunities to learn" (Lave & Wenger, 1991, p. 92) - 'affordances' enabled take-up. Some of the arguments presented in this part of the chapter have been published (see Pausigere & Graven, 2013b).

⁵⁷ These elements are fully discussed in Chapter 3.

The NICLE activity and resource affordances noted by the teachers relate to the three key categories of Domain, Community and Practice as follows:

1. Domain: Access to **numeracy games, physical and printed resources** which enabled teachers to understand the primary maths *domain's* – numeracy concepts and improved their primary maths teaching and learning *practices*⁵⁸.
2. Community: Access to mathematics education specialists (local and international) and the concepts, ideas and approaches introduced by them as **guest speakers** in NICLE. These were explained as enabling the teachers to understand the primary maths (education) *domain*, key issues in the primary maths *community* (locally and beyond) and improved primary maths teaching *practices*.
3. Practice: Access to watching other teachers' classroom *practices* (e.g. **lesson demonstrations** in NICLE by teachers with learners and **videos of lessons**) and **opportunity to take up ideas in their own classroom practice**.
4. Practice: **Relations** within NICLE and the **nature of participation** enabled in NICLE practice.

These are all complexly intertwined. As Wenger et al (2002) point out, the components of *domain*, *practice* (meaning⁵⁹) and *community*, which the above relate to, are intertwined in the process of learning, experiencing, doing and belonging. Part of the teacher learning stories presented in Chapter 7 also illustrate the interconnectedness of these three fundamental elements of CoPs as a result of the teachers' participation in NICLE. In the next section I elaborate on each of these aspects separately and also point to the interconnectedness between them.

9.2.1 Affordances in relation to Domain

9.2.1.1 NICLE's numeracy games

All the teachers in the sample reported using NICLE's numeracy games in their maths classes. Several NICLE sessions, especially in the second year of the professional development programme, presented by Mellony together with the SANC project staff members and guest speakers, had emphasised the benefits of learning numeracy in a fun and

⁵⁸ The NICLE community's practices are about primary maths teaching and learning and this relates with my primary maths education informed definition of practice (Lampert, 2010; Ball & Cohen, 1999) and Wenger et al (2002) notion of *practice*.

⁵⁹ As explained in Chapter 3 the component of meaning is under the aspect of practice in Wenger et al's (2002) three fundamental elements of CoPs. Even Chapter 1 of Wenger's (1998, p. 49) book discusses 'Practice as meaning'.

exciting way through games. The 24 May 2011, the 24 April and the August 21st 2012 NICLE sessions had exposed teachers to fun and exciting ways of consolidating number bonds and number basic facts through alphabet maths games, dice and playing card games. In these sessions teachers were also given sets of resources (alphabet letters cards, dominoes, dice and playing cards) for use in their classes. Another session by a guest speaker on mental maths had also introduced the NICLE teachers to a ‘Rapping mental maths’ game, which is a rhythmical activity for learners to practice mental maths. Steve Sherman’s NICLE presentation on 9 October 2012, which focused explicitly on how to make maths more fun and engaging, was complemented by his mathemagic shows in NICLE-participating schools in March and October 2012, and by a family maths event on 8 October 2012. In all these presentations the guest speaker highlighted the importance of engaging learners with various numeracy concepts and developing fluency with basic number facts in a playful explorative manner.

Calvin, Robert, Melania and Edna had journaled about how they had used or intended to use the numeracy games learned in NICLE to *enhance the teaching of particular primary maths concepts*. Thus Calvin wrote that he intended to use the dice to “enhance the learners’ mental mathematics ability”. Robert had written how he had used the dice in his classes to enhance the learners “mental maths ability”. Calvin had explained how the numeracy games enabled the learners to “understand their bonds”. Both Robert and Edna (in her after-school Grade 3 maths classes) had written that the dice games enabled and ‘stimulated’ learners to do and practice the four basic operations. Similarly Melania had also written about how the card and dice numeracy games had promoted in her maths classes the learning of specific primary maths concepts (see below).

21 August

Maths games: Card and Dice

Tested various maths games that encourage counting, addition, maths language. This is a lovely informal way of learning. It is always important to have the fun elements in your class. So much learning takes place in these situations. These children really enjoy it! So many ideas! So little time. Don’t always know where to start. Need a longer day (Melania, Journal entry, 21 August 2012).

Melania’s journal excerpt also shows how using numeracy games *enhanced and promoted mathematical learning through informal and fun elements* which she saw as making learning enjoyable. Similarly Calvin, Mary, Robert and Pamela remarked on how the numeracy

games that they had engaged in in NICLE and used in their maths classes enabled the teachers, as well as the learners, to discover that maths was fun and was to be enjoyed. They also said this enabled learners to participate more in maths classes. Thus Pamela explained how participating in NICLE had introduced her to a new approach of using playing cards in teaching numeracy which provided the learners with opportunities to freely engage and participate during maths lessons. Thus she had said,

Because ...I don't know first that you can even use the playing cards in mathematics. But because of that everybody now is playing...is playing...they are using those numbers, 2 plus 9 in those playing games that are doing with playing cards. There are even those few that now they discuss with others (Pamela, Interactive interview, November 2012).

Similarly, Robert and Edna said they had enjoyed the NICLE numeracy games because of their playful and creative elements. When asked which NICLE numeracy activities or sessions he had enjoyed most, Robert responded

I think personal enjoyment is always activated, I would say, by playfulness... This year we had an activity where we had games. The playful nature of mathematics. It was refreshing, also energising on a personal note. You see to learn maths like not in a routine way where we have to. But there we mingled, active discussion, you laughed. In the laughter you gain understanding of how people are doing these games because some of the games are challenging. It causes you to think creatively and critically when you are answering people (Robert, Interactive interview, November 2012).

Calvin, Ruth and Edna had further explained how their numeracy classroom practices had changed to embrace the playful element. Robert had written in his journal that the numeracy games enabled the learners to be in a "competitive mood" and to 'participate' in maths classes. Edna indicated that participating in NICLE numeracy games enabled her to understand that "maths is actually fun and it is there for enjoyment". She went on to explain how engaging in such activities had transformed her numeracy classroom practices. She said,

So since I attended ...started to attend NICLE workshops I...when I have my maths session in the class I always try to do...make it fun for the learners, instead of, in the beginning I used to explain to them and hand out activities, I always use the time set out for maths now to do games and things concerning maths (Edna, Interactive interview, November 2012).

In the same manner Ruth also explained that the numeracy games had "brought home the fact that children also learn well if there is fun and oneself...we respond like children". Ruth had

also written in the first week of August how “everyone [in her class] enjoyed the skip counting computer game” which she had learnt from the NICLE information technology. Thus engaging in NICLE numeracy games was seen to improve both Ruth’s and her classes’ mathematical learning and enjoyment.

In both interviews Melania and Ruth described how they were using the alphabet numeracy game which *enhanced their mathematical teaching strategies*. Thus Ruth had pinpointed that the alphabet game was “very interesting” as it had

...supported what can sometimes become tedious... everybody in the class loves that, they just loved that game. So I think the NICLE programme has given me ideas, it has you know...developing my own understanding, thinking about the process and steps of teaching (Ruth, Interactive interview, October 2011).

Ruth also explained in the second interview how the mental maths games had provided “alternative ways of teaching mental maths”. Similarly Melania explained how the mental maths game and other NICLE numeracy games had improved how she taught and presented maths as it had given her “new ideas which helps break routine and make the lessons more exciting”.

All the sampled NICLE teachers explained that participating in the numeracy games activities enabled them to take-up the playful learning notion into their maths classes thus allowing their teaching practices to evolve. The numeracy games were said to enhance the teachers’ teaching strategies, the teaching of specific primary maths concepts and also promoted mathematical learning in a playful and fun way that provided learners with the opportunities to freely engage and participate during maths lessons. Teachers referred to a more fun and relaxed ethos in their classes. From a CoP perspective, participation in the NICLE numeracy games activities improved the sampled primary maths teachers’ *practices* and enhanced their understanding of key numeracy concepts in the *domain* of primary maths education. Wenger et al (2002) explain that the domain consists of core topics and key issues that members commonly experience. Thus mental maths and number bonds/facts are important aspects of the *domain* of numeracy education as noted locally in the Foundation for Learning Campaign (DOE, 2008), in primary maths documents (DBE, 2011b; DBE, 2011c; DBE, 2012) and in influential local (Schollar, 2008) and international primary maths research studies (Askew & Brown, 2003; Kilpatrick et al, 2001).

Related to the teachers' articulation, is the absence of maths teacher education literature that explains how play-based learning enables teacher practices to positively evolve in professional development programmes. The available literature (for example Ginsburg, 2006) which concurs with local primary maths documents and policies (DBE, 2011a; DHET, 2011b) explains how playful learning experiences enhance mathematical understanding in early education or Grade R classes. Information from the sampled teachers indicates that the NICLE mathematical games enabled teacher numeracy identities and practices to evolve as they provided opportunities for 'creative personal enjoyment' and learning which manifested in non-routine and fun ways of teaching maths. Exactly how this played out in classrooms would however have required classroom observation data.

9.2.1.2 NICLE's maths teaching (physical) resources

The sampled teachers also foregrounded using NICLE's physical resources in their maths classes. As explained in Chapter 6 the SANC project had given teachers carefully selected key resources following workshops in which teachers had worked with the resources. Furthermore in 2011 and 2012 each NICLE-participating teacher was allocated a stipend of money to spend on maths teaching resources. Some of the invited guests discussed in Chapter 6 had also given or exposed NICLE participating teachers to other key primary maths teaching resources. The sampled teachers mentioned that they had used the following physical resources in their maths classes: wooden cubes, 3-D shapes, the Diene's blocks, the fraction chart, empty number lines, boxes of matches, column paper-arrays, flash cards, flard cards, clocks and the place value spin board. Teacher explanations show that the physical resources activities mainly supported the teachers to understand and to teach specific primary maths concepts.

Within the participationists' perspective teaching and learning tools or artifacts are part of a community's shared resources. These are produced or adopted in the course of its existence and become part of its *practice* (Wenger, 1998). Wenger et al (2002, p. 38) also explain that communal resources such as 'concrete objects' improve *understanding of the community's knowledge, its practices and meanings*. Silver (2009), Borko (2004) and Adler (1998; 2000) have also argued that artefacts, tools and resources give teachers access to, embody and emulate maths teaching practices. According to Borko (2004) such tools are powerful in enabling teacher learning. Relating Wenger et al's (2002) CoP elements to the research findings indicates that the NICLE physical resources enabled the teachers' understanding of the primary maths *domain* and enhanced their primary maths teaching *practices*.

All the teachers except Edna⁶⁰ had explained that they had enjoyed the Diene's blocks, wooden cubes⁶¹ and the 3-D shapes NICLE activities and were *using these resources mainly to represent and teach* space, shape construction and measurement in their classes. Whilst Mary simply mentioned that she was using the blocks in her class, the other three FP teachers reported using the wooden blocks to construct three-dimensional shapes, to calculate area, and for measurement. Thus Melania had explained that the wooden blocks were good for teaching learners the concept of “area [and] for three-dimensional” figures. Both Pamela and Ruth had journaled on how they were using the blocks to construct 3-D shapes. Pamela also wrote in her journal about how she used the wooden blocks in her maths classes for measuring and to promote the learners' understanding of multiplication and division.

Like the FP teachers, Robert, Calvin and Everton explained that they were using the wooden blocks to construct three-dimensional figures and to calculate area, perimeter, and volume. For example Calvin and Robert said:

Because you remember those blocks that they gave us? I do area with those blocks. Those wooden blocks. I do area with it, I do perimeter, I do volume with it. The kids can physically count and see and then devise ways to count shorter and normally it will end up multiplying for area and volume (Calvin, Interactive interview, November 2011).

Yes there was a session where we had to work with cubes. Small cubes, and I could see from the grade 3 teachers how they could see the impact of it unfold in real class teaching practice. Where we had to construct 3D figures ...three dimensional figures and from there we see the manipulatives. That tools can be used in a variety of measurement topics like volumes. Even surface area and so on (Robert, interactive interview, November 2012).

Besides using the wooden cubes to teach the construction of 3-D shapes and to calculate space measurements, the IP teachers also extended their use of blocks *to teach and reinforce specific numeracy concepts and skills*. Everton journaled how she used the wooden cubes in her class to enhance the learners' understanding of positions and different views (orientations). Likewise Calvin used the 3-D shapes, in his maths classes to enhance the learners' understanding of the properties of 3-D objects such as the “edges, the vertices, the

⁶⁰ Most of these NICLE activities and resources were given to teachers when Edna had stopped participating in NICLE for almost 7 months, citing personal problems and challenges.

⁶¹ Each NICLE-participating school was given a box of 400 wooden cubes.

faces” (Calvin, Interactive interview, November 2012). Everton also diarised that she was using the Diene’s blocks to teach ‘whole numbers’ and ‘place value’. Zonia and Mellony’s joint session on 11 October 2011 had introduced NICLE-participating teachers to ways of developing the place value concept using Diene’s blocks and flard cards, with teachers being given photocopiable templates of the Diene’s blocks and sets of flard cards.

During the NICLE fraction sessions teachers had been given fraction charts, empty number lines and coordinate grid papers. Calvin, Robert, Everton, Melania, Ruth and Pamela explained that they had enjoyed the activities on fractions and were using these resources in teaching learners. Both Pamela’s and Calvin’s diary excerpts (below) explained that the fraction chart activities had exposed them to a variety of ways of representing and teaching fractions.

Also the shapes and the models we used was [*sic*] squares and rectangles, but we were taught to do something that is familiar with learners like cubes which will be represented by *sausage rolls* and so on (Pamela, Journal entry, 25 October 2011).

I must also make sure that they have *a variety of ways of representing fractions* e.g. fraction circles, fraction charts, strips etc. (Calvin, Journal entry, 9 May 2012).

Pamela also mentioned that she had learnt how to use numerous fraction figures and not only to teach the fractions $\frac{1}{2}$ and $\frac{1}{4}$. Calvin wrote in his journal how the NICLE fraction activities encouraged him to “do more mental mathematics relating to fractions” and to constantly teach learners fractions. Like Calvin, Everton and Robert journaled how they were using the laminated fraction chart in their maths classes to enhance the learners’ understanding of the fraction concept, with the former sticking the fraction boards on the learners’ desks.

Whilst Ruth mentioned using the empty number lines in her classes, Melania elaborated in her journal on the advantages of this and on how she intended to use this resource in her maths class. Robert, Everton and Melania also explained how they were using the grid paper to teach different mathematical concepts to learners. Everton mentioned that she used the grid paper to teach “construction” and also as another “alternative” to teaching and enhancing her learners’ understanding of multiplication and division sums, whilst for Melania the arrays would enable the learners to “visualise numbers...develop a sense of area and the

commutative property” concept (Melania, Journal entry, 5 June 2012). Similarly Robert had also written about how he had used the grid paper when teaching location, positions, x and y co-ordinates and transformation. The sampled NICLE teachers used various NICLE activities involving fraction charts, empty number lines and coordinate grid paper resources to teach specific mathematical concepts in their maths classes.

Three of the sampled teachers explained that they had enjoyed the mental maths flashcard activities to which they had been exposed during NICLE sessions. Tom had encouraged teachers to use flashcard activities to promote mental arithmetic and support learners’ computational fluency. In the first interview Melania had recounted how interesting the flash card mental maths activities were and how Tom had encouraged that mental maths be done early in the morning with learners working in groups. She said

More than improving my understanding they have been very very good ideas, mental maths and the way that he did that mental maths at the beginning of the morning with those flashcards and children working in groups I really really like those ideas... (Melania, Interactive interview, November 2011).

In the second interview both Melania and Everton explained that they were using the flash cards in teaching their maths classes with the latter journaling on 1 February 2012 how she used the flashcards to promote number sense for her Grade 4 learners.

Everton and Robert also mentioned using the Flard cards (also called number builders or place value cards) in their classes to teach the place value concept. The teachers were exposed to the flard cards during Aarnout’s second NICLE session, in which he had explained how the flard cards were key for breaking and building numbers into different figures. Teachers were given multiple sets of cards for classroom use in the following session. Everton had also journaled on 8 August how she was using the flard cards to reinforce number sense in one of her learners, who had been demoted from Grade 6. Similarly Robert had also written in his journal how the flard cards were important in ensuring that learners understand place values, in composing and decomposing numbers and for doing addition. Robert wrote

Flard Cards

I have realised that the learners continuously need exercise building and decomposing

numbers, especially grade 4 learners. The card with its lovely variety of colours were useful to do consolidation and revision of numbers.

The learners' ideas of place value need more attention than I normally anticipate. The flard cards were readily available and easy to use in whole class teaching and learning.

When the learners saw the parts of the whole number and how it is built to form a single number it became clear (more so for slow/low learners)

It's helpful to do addition work... (Robert, Journal entry, undated-2012).

Besides taking-up resources and activities from sessions presented by invited guests and presenters, six of the sampled teachers reported that they had enjoyed and appropriated into their maths classes the match stick patterns, place value spin board and the analogue clocks, which were resources given in NICLE sessions. The matchstick pattern activities, ideas and resources were introduced to teachers by Mellony during a NICLE maths challenge on 25 May 2012. Robert, Ruth and Calvin had explained using the matchstick activities to teach patterns in their respective classes. For example, Robert said

Yes the matchsticks to make patterns. Ja I incorporate it, I use it for my pattern work, geometric pattern work, so it supports my activities. It does (Robert, Interactive interview, November 2012).

The three teachers had written in the diaries how they were appropriating the matchstick activities in teaching learners to understand patterns. Robert further explained how he used the matchsticks to reinforce the generalised mathematical rules for patterns (e.g. $3n + 1$) and also in the teaching of two- and three-dimensional shapes. NICLE-participating teachers had also been given plastic analogue clocks, with Everton, Pamela and Robert saying that they were using the clocks to teach time. Robert also wrote in his journal the difficulties faced by learners in understanding analogue clocks. Everton also mentioned that she intended to use and order more clocks as some of her learners struggled with time. Thus in the second interview she explained that she "would like to use the clocks more" as she had noticed that "her children are not too hot on time". Edna explained that she intended to use the place value spin board in her classes to promote number sense, whilst Robert journaled how the number spinner was a "useful tool for mental maths", teaching the basic operation and creating a "cyclic awareness which learners would need in analogue clock".

The wooden blocks, Diene's blocks and 3-D physical resources helped teachers interpret different *meanings* to these concrete objects that enhanced the teachers' representation of aspects of their teaching. Thus these physical resources embedded in them mathematical *meanings* which teachers could interpret and use in their primary maths teaching *practices*. Wenger (1998) and Wenger et al (2002) explain that meanings are part of a community's practice, thus the physical resources improved the primary maths teachers' classroom *practices*. The fraction charts, empty number lines, grid papers, match stick patterns, place value spin boards and analogue clocks were also used by the teachers to teach learners different mathematical concepts such as fractions, positions, patterns, time and the place value concept. Thus engaging with NICLE's physical resources also enhanced the understanding of the primary maths *domain* - especially the concept of space and shape (geometry), patterns, numbers and measurement, which are key content areas in local primary maths education (DBE, 2011b; DBE, 2011c; DBE, 2012).

9.2.1.3 NICLE Printed resources

Similar to the physical resources, all the sampled teachers reported using printed and published material resources they were given (or exposed to) in NICLE sessions in their maths classes. These teachers explained that they had enjoyed learning and teaching from the homework books, edupeg books, the Grocott's 'Fun with maths – Ukufunda's newspaper supplements, number sense work books and Malati material. The SANC project had published and given to participating NICLE teachers mathematics homework learner books so as to encourage learners to do regular homework and promote independent maths learning. Calvin, Melania, Pamela and Mary reported that their learners were using the homework books, with Melania journaling how she "was excited about the homework books" and explaining in the interview how the children loved them as they were easily used at home and were free. Calvin had also revealed using the Grade 3 homework books though he "upped the intensity" for his grade 6 learners. Pamela also journaled how the homework books were enabling her learners to do their homework, with Mary suggesting that across schools homework initiatives could ensure that "learners get more practise with maths concepts" (Mary, Journal entry, 13 March 2012). It is useful to note that some of the printed resources given to teachers did not directly enable their learning but afforded opportunities that promoted learners' independent maths learning.

Everton, Ruth and Edna reported that they were using the edupeg workbooks *in teaching maths in their classes*, with Everton elaborating on how useful this resource was in

‘multigrade teaching’. The edupeg problem-solving books had been sponsored by Edupeg and thus provided freely to all NICLE-participating teachers. Edna explained in her journal that she used this resource for the Grade Rs and for her after-school maths sessions with the Grade 3s⁶². The three teachers also reported that the learners enjoyed doing the edupeg workbook activities, with Edna and Everton explaining that these resources promoted individual learner working. Edna had written positively in her journal:

The learners totally love the edu-pac [edupeg] exercises. I even use the book 1-4 for the grade R’s. No-rush, each one can get an activity and do it on their own time. I think what they enjoy the most is the colourful books and the fact that they can wipe it clean (enlarged my pages and put it in plastic sleeve) and redo the activity (Edna, Journal entry, October 2012).

As explained earlier in Chapter 6 the SANC had introduced the ‘fun with maths’ page called Ukufunda in the local Grocott’s newspaper, which aimed at getting parents and learners to engage with various numeracy concepts in a fun way. In several NICLE sessions teachers were given copies of the Grocott’s and they were also encouraged to visit the SANC website which had copies of the Ukufunda series supplements. Both Calvin and Robert had explained in the 2012 interviews that Grocott’s numeracy supplement activities *supported their own understanding of maths*. Thus Calvin had said, “the way that you are doing things it’s always maths-driven. Even like you [SANC project] put something in the Grocotts. Problem solving those things. It forces you to think”.

Both Edna and Everton commented on how the Number sense workbooks and the Malati material *provided them with multiple ways of representing mathematical concepts*. The workbooks and worksheets aimed at supporting the learners’ development of number sense and their conceptual understanding of fractions. Edna had also personally bought a set of Number Sense workbooks when she attended a Brombacher’s workshop in Port Elizabeth. Aarnout Brombacher had also introduced teachers to the concepts behind the Number Sense workbook series in his second NICLE session on 13 September 2011. Edna had reported using the workbook series both with the Grade Rs and in teaching the Grade 3 extra maths classes. She had also journaled that her extra maths class learners enjoyed the workbook activities. Everton also wrote in her journal how she used the number sense work book series to teach a learner (pseudonymed A) and to support his development of number sense. This learner had been demoted from grade 6 and was “really struggling with addition” and had

⁶² The edupeg books range from Grade R to Grade 6.

No idea of numbers WHATSOEVER – No sense of pattern $10-3 = 7$
 $20-3 = 17$

No bonds where do I start??

(Everton, Journal entry, 6 February 2012).

Everton also explained that she had “used those Malati worksheets that she [Lisa] has given us. Those were lovely. Ja, those are the main ones”. The Malati material was aimed at improving learners’ understanding of fractions using word problems. Everton, Ruth, Edna, Robert and Calvin reported that they had enjoyed learning from and teaching using the printed and published material resources they had been given or exposed to in NICLE sessions.

The NICLE CoP ‘artefacts’ in the form of teaching and learning textual resources had invoked the participants’ use of these materials in their maths classes. Thus all the sampled teachers reported using the resources in teaching their primary maths classes. The printed teaching resources were also reported to improve the teachers’ understanding of specific numeracy concepts, provided them with multiple, varied and alternative ways of representing mathematical concepts, which promoted the learners’ understanding of these numeracy concepts. Both Wenger (1998) and Wenger et al (2002) mention that books, documents and manuals are part of the communal resources that embody understanding of a community’s practices. The teachers’ utterances indicate that the textual resources improved the teachers’ understanding of the specific numeracy concepts within the primary maths *domain* and their maths teaching and representation *practices*.

From a CoP perspective, teaching and learning resources can be regarded as the tools, concepts, boundary objects or artifacts that connect participants to communities of practice (Wenger, 1998; Wenger et al, 2002). According to Lave and Wenger (1991) tools provide access to understanding and opportunities for participation in a community’s practice. This agrees with Wenger et al’s (2002) explanation that a community’s shared resources, such as ‘concrete objects’, ‘documents’ and ‘books’ enhance participants’ understanding and practices. Similarly Garet et al (2001), Silver (2009) and Borko (2004) have argued that maths teachers’ communities of practice’s artefacts and tools strengthen and deepen teachers’ understanding of important mathematical ideas and allow them to explore pedagogical possibilities when teaching. The teachers’ utterances and journal entries above indicate how NICLE’s physical/concrete manipulative-tools and printed resources supported the teachers’ understanding of particular mathematical concepts and teaching as they related to primary maths classroom practices which afforded opportunities for teacher learning. Using Wenger

et al's (2002) elements of a CoP to illustrate the research findings, shows that engaging with NICLE's physical and printed resources enabled teachers to understand the primary maths *domain's* key areas (e.g. geometry, patterns, measurement, number sense) and improved their pedagogical *practices* in numeracy classrooms.

In the next section I look into the second part of the 2nd research question, which relates to *how* these NICLE artefacts and tools enabled or afforded teacher learning. Robert's, Mary's, Edna's and Everton's interview utterances and journal entries help in addressing this question. Robert, Edna, Everton and Mary agreed that they took-up the NICLE resources and material because they were physical 'concrete manipulatives-tools' that supported their mathematical teaching and related to their practice. Thus for Robert the "materials... support what [he was] already teaching" (Robert, Interactive interview, November 2012). Mary explained that she could "relate" to the NICLE material and Edna also explained that the NICLE "resources" could be used in the classes and made it easier to explain things. Everton's 11 September 2012 journal entry indicated that some of the resources they had been given in NICLE were "great support material". Interpreting these teacher utterances and journal entries using Wenger et al's (2002) fundamental elements indicates that teachers took-up the NICLE-*community* resources into their primary maths classes as it resonated and related with their *domain* and *practices*, which is *primary maths - teaching practices*. The above illuminates that numeracy teacher learning is enabled in communities whose focus includes a mathematical as opposed to merely a pedagogical focus.

9.2.2 Affordance in relation to Community: NICLE specialist guest speakers

Another aspect noted by the sampled teachers was 'enjoying' different sessions presented by the invited guests. As indicated in Chapter 6, half of the NICLE sessions during the period of the research study were presented by invited numeracy education specialist guest speakers. Thus the sampled teachers mentioned that they had enjoyed and took-up into their maths classes activities from the various speakers' presentations. In Chapter 6 I explained how the invited guests' presentations were on key numeracy concepts, approaches or issues, and tended to connect theory and practice. In the section below, I unpack using four themes how engaging with primary mathematics 'masters' or 'specialists' enabled the sampled teachers to take up key numeracy concepts, approaches, issues and improved their general pedagogical approaches and the teaching of specific numeracy concepts. The four themes are:

9.2.2.1 Understanding numeracy concepts and approaches

9.2.2.2 Improved representation of specific numeracy concepts in teaching

9.2.2.3 Understanding key issues in primary maths education

9.2.2.4 Access to overlapping communities of practice

According to Wenger et al (2002, p. 244) CoPs naturally consist of “‘experts’ who can recognise and validate innovations” within a community. Likewise Lave (1993b, p.67) acknowledges that “masters...are often crucial in providing...legitimate access to its practices”. Lave (1996, p.153) also elaborated that masters “embodied exemplars of what apprentices were becoming”. Under the socio-cultural theory and CoP perspective experts, masters or old-timers are important as they embody and provide access to a *community* and its *practices*, which help teacher CoPs participants to model mathematical practices from knowledgeable specialists (Lerman, 2001). Interpreting the empirical evidence using the CoPs element (Wenger et al, 2002) shows that the NICLE-invited guests exposed the sampled teachers to the primary maths *domain*, to the primary maths education *community* and to the primary maths teaching *practices*.

9.2.2.1 Understanding numeracy concepts and approaches

Calvin, Melania, Pamela, Ruth, Edna, Everton and Mary indicated how participating in Aarnout’s (number sense), Lyn’s (language and RUCSAC approach), Lisa’s (fractions), Zonia’s (zero concept) and Bev’s (Singapore maths) presentations had enabled their understanding of key specific numeracy concepts and approaches. For example both Ruth and Calvin said that they had appropriated from Lisa’s sessions into their classes key concepts relating to the teaching of fractions, thus Ruth took-up from the fraction presentations into her class the notion of “posing problems that don’t always have a whole number solution”, (Ruth, Interactive interview, November 2012), whilst Calvin had learnt that “learners must do more mental mathematics relating to fractions” (Calvin, Journal entry, 9 May 2012).

Zonia, who was at the time the NICLE teacher co-ordinator, was doing her Master of Education research focused on investigating teachers, and learners’ understanding of the concept of zero. She is thus considered a specialist in this area. Zonia’s session on the concept of zero was said to expand teachers’ knowledge about this concept. Thus Mary said.

But definitely for me like I said earlier the penny drops and I am like okay, the concept of zero it just puts it into perspective. We are teaching it even in the CAPS, they only present zero in the fourth term which I find quite intriguing there is obviously a reason for why they are doing that. How important zero is and the place value. And I love finding about the history, what happened before zero, you know, it's just that extra information about a concept how it helps me see it as a bigger, it's not just zero anymore, there are other things to it (Mary, Interactive interview, November 2011).

Ruth, Edna and Calvin had also explained enjoying Zonia's session as it had given them more information on the zero concept which Edna expressed as having "taken for granted". The presentation on zero was also interesting for Ruth because it involved "analysing the value of zero and thinking about the history and the importance of it". Calvin also talked about how Zonia's session was "very interesting", which led him to transfer this concept in his maths classrooms as he reported "talking about the zero" concept with his learners. Everton also said that Zonia's session had helped her understand the zero concept as well as improving her teaching approaches, as she said

I mean I just remember Zonia's session on zero. Thinking about it in the way she sort of put it, it was very good, very good and it also helped me to understand, to look at things from a child-centred point of view (Everton, Interactive interview, November 2011).

Similarly Ruth explained in the first interview, that Zonia's session had drawn more attention to the concept of zero and it had also enabled her to engage learners in her classes. Thus Zonia's session on the concept of zero provided research information on a key numeracy concept which enabled teachers to take-up what they learned from her session into their maths classes. Although the teachers indicated taking up this concept, most of them did not fully explain how they used it in their maths classes.

Calvin and Edna said how Brombacher's focus on how to support the development of learners' 'number senses' had afforded them the opportunity to understand the number sense concept. Similarly Calvin, in the first interview, had also explained that the presenter who did the 'number sense' session was "very good" and he was trying to instil what he had learned in this session in his classroom practices.

Everton and Calvin also reported that they had enjoyed and took-up the ‘Singapore maths’ approach into their intermediate phase classes. Thus Everton remarked that she had started using Singapore maths in her classes

I was very taken with that Singapore Maths you know and I would like to work with my group I am sure. Next year I am planning on introducing that method *more* with most of the things that I do... (Everton, Interactive interview, 27 October 2011).

Calvin also admitted taking-up this notion into his maths classes as he said

Singapore maths. I tried it in the class. I am doing it with the kids. You won’t get instant success. It will take time but..., the brighter learners catch that concept quicker but for the average and below it will take time (Calvin, Interactive interview, November 2011).

These two teachers thus reported that they had taken-up some of the Singapore maths approaches into their primary maths classes.

Lyn’s NICLE session (discussed in Chapter 6) introduced the RUCSAC approach, which is a strategy used to solve word sum problems. Calvin, Melania, Pamela, Edna and Mary explained and wrote in their journals how they had enjoyed this RUCSAC approach and had taken-up the strategy and were using it in teaching problem-solving in their maths classes. Thus Calvin explained in the second interview that he had “introduced the kids to that (RUCSAC approach)”, with Pamela writing on how she had “implemented these (RUCSAC) steps to her learners”. Mary narrated how the strategy would help her overcome the challenges she faced in teaching her grade 3 after school classes word problems. Calvin had also journaled that he would continuously “use the RUCSAC approach in solving (word) problems”, likewise Melania intended to use the problem-solving technique in her future teaching, with Mary similarly expressing how valuable the approach was when she wrote “liked the RUCSAC method think it would definitely help some learners. Always useful to have different approaches”. Five of the sampled teachers explained how they had enjoyed the RUCSAC word problem-solving technique had taken-up the strategy and used it in teaching word sums, with some of the teachers expressing their intention to use the approach. The details of how the approach was used in class were not however given and so the nature of the take-up of ideas is largely unexplored in the interviews and journal entries. Classroom observations might have allowed insights into this.

Besides taking-up the RUCSAC approach into their classes, two of the sampled teachers mentioned that they had started to use in their classes' mathematics baseline tests. Lyn's session had also introduced the NICLE teachers to the importance of using and analysing learner performance through mathematics baseline tests. In this session each NICLE-participating school was given a hard copy of the Grade 3 to 7 maths baseline assessment tests. Whilst Mary and Everton both expressed interest in the baseline assessments tests, the latter went on to journal on how she had used the tests in preparation for the ANAs, thus she had written: "I will also use the baseline tests received at NICLE from NMMU lecturer [Lyn]. They were great in prep for ANAs as well, cover all areas" (Everton, Journal entry, 1 November 2012).

The invited primary maths specialists and guest presentations enabled teachers to understand concepts of fractions, zero and number sense concepts and to take-up some problem-solving aspects of the Singapore maths methods and the RUCSAC word problem-solving approaches. As outlined in Chapter 6, the guest presentations focused on key and important primary maths concepts (fractions, number sense, place value and number concept) which are core to the primary maths field – *domain* (Wenger et al, 2002). Local primary maths curriculum documents (DBE, 2011b; 2011c), reports (DOE, 2008; DBE, 2012) and influential primary maths research studies (Askew & Brown 2003; Schollar, 2008; Kilpatrick et al, 2001; Ma, 2010; Ball, 1993) identify such key numeracy concepts as critical for primary maths learning. The primary maths experts also emphasised primary maths approaches, such as Singapore maths and the RUCSAC word problem, which were informed by research. According to Wenger et al (2002, p. 38) such approaches relate to *practice*, as they concern "ways of doing things in a specific domain" - such as methods of solving word problems in primary maths. Furthermore the fact that these approaches are informed by research resonate with Wenger et al (2002, p. 38) explanation that a "community's *practice* explores...the latest advances in the field" [emphasis mine]. Thus the primary maths experts enabled primary maths teacher learning because they focused on 'key issues' and 'topics' in the primary maths *domain* - field and primary maths teaching *practices*. The teacher utterances and journal entries reveal that focus on the primary maths *domain* and *practices* enables teacher learning and specifically their understanding of key specific numeracy concepts and approaches. Hill (2004) and Hill & Ball (2004) have also explained that focusing on a particular identifiable mathematical topic or concept during professional development programmes increases primary maths teachers' opportunities to learn and teach that mathematical content.

9.2.2.2 Improved representation of specific numeracy concepts in teaching

Besides enabling teachers' understanding of primary maths concepts and approaches, engaging with numeracy education specialists also enabled teachers to improve their teaching through improved access to representations of specific numeracy concepts. Everton, Edna, Pamela, Ruth, Calvin and Mary expressed how the visual representations of fractions and Singapore maths problem solving diagrams afforded them opportunities to enhance their teaching of particular primary maths concepts.

Thus Pamela, Melania and Calvin's journal entries indicated how Lisa's NICLE sessions had helped them improve their teaching and representation of the fraction concept, with Calvin writing

I should also make sure that they [learners] have a variety of ways of representing fractions e.g. fraction circles, fraction charts, strips, etc. (Calvin, Journal entry, 9 May 2012).

Melania also journalled twice in May that the learners must "realise that things can be divided into any amount of parts. Divide chocolates into five parts, 10 parts, 8 parts etc." She also repeated the same idea when she wrote how in her class learners were "realising that you can share (e.g. a piece of chocolate) into more parts than just 2 or 4. You can share by 5 or 6 or 3". Similarly Pamela had also written that she had learnt from Lisa's session how to use different fractions such as $\frac{1}{5}$ and $\frac{1}{8}$ and not only $\frac{1}{2}$ and $\frac{1}{4}$ when teaching fractions. Both Everton and Calvin explained how Lisa's fraction presentation had enabled them to understand the importance of constantly teaching fractions throughout the school year. Thus Everton had journalled how important it was to incorporate the teaching of fractions once a week in her classes, with Calvin also writing that he will ensure "that learners are constantly busy with fractions. Even if I gave problems once or twice a week, learners must not stop working with fractions". Calvin had also explained in the interview how he had learnt from Lisa's presentation to "spread evenly" the teaching of fractions in his classes.

Everton also expressed how part-whole visual representations promoted in the Singapore maths session had improved her teaching of problem solving.

I always go back to the Singapore maths, that was really an 'aha' moment. That inner way of solving problems, to use that part of the whole. That was the main thing (Everton, Interactive interview, November 2012).

Thus six of the sampled teachers expressed how engaging with invited numeracy education specialists afforded them opportunities to enhance their teaching and representation of particular primary maths concepts. Relating the teachers' comments above to Wenger et al's (2002) structural elements of CoPs reveals that the guest primary maths experts enabled teacher learning as it focused on improving their primary math teaching *practices* (e.g. the Singapore maths approach) and how they could represent specific primary maths concepts (such as mental maths and fractions) in the numeracy *domain*. Thus by affording teachers the opportunities to improve their teaching and representation of particular maths concepts the invited guests enhanced the primary maths teachers' teaching *practices* of *numeracy*.

9.2.2.3 Understanding key issues in primary maths education

Some of the sampled teachers pointed to learning more about the issue of 'language', (presented by Lyn) which enabled them to understand how language was a key and critical issue in primary maths education. Lyn's presentation drew on maths language research and theory (Setati, 2005; Mercer, 1995) to explain how language can be used as a resource in multi-lingual mathematics classes. Similarly Wenger et al (2002, p. 32 & 31) argues that a domain "...consists of key issues or problems that members commonly experience" some of which "...researchers pursue at any given time". Thus the subject of language is a central issue in the primary maths education *domain* and has been the focus of research. Lyn's focus on this core and problematic issue in the field/domain of primary maths education provided opportunities for teacher learning.

Thus Calvin, Edna and Mary had explained and journaled on how Lyn's focus on language had made them realise how problematic yet important the issue of language was in their schools and classes and how the multilingual approach can be used in teaching maths classes. Thus in the second interview Calvin had explained enjoying Lyn's focus on language because it made him "realise once again...that language is a barrier... so we need to solve that issue of language". Calvin had highlighted the nature of her maths classes' language problem and how the session allowed him to see the difficulties from the learners' point of view when he reflected in his journal on Lyn's presentation and wrote

This is a day that I will never forget in my NICLE live (life). Lyn opened my eyes to a frequent answer I get. I will ask a learner a question and he/she will answer 'yes'. I got [get] angry when learners gave me that answer. I won't anymore because English is not their mother tongue...Language is a big problem in my case as learners are Xhosa speaking and I

am Afrikaans speaking. The medium of instruction is however English (Calvin, Journal entry, 4 September 2012).

Similarly Edna had articulated that language was an ‘issue’ at her school. Besides being a problem both Edna and Calvin had highlighted how important language was in teaching and learning thus Edna had said “...the reason I liked [Lyn’s] presentation, because it was something that was close to my heart”. Being something close to heart implies that Lyn’s language presentation was important for Edna. Likewise Calvin had explained that “language is of great importance in our school. Because we can’t run away from the fact that kids are only doing English in class”. Whilst Lyn’s presentation had helped understanding how important and problematic the issue of language was it also highlighted teaching approaches to overcome this challenge. Thus Calvin journaled that he would make “sure that he had more resources explaining things in English and Xhosa”. Similarly Lyn’s presentation had made Edna “look at things from a different perspective and to try and improve [her] approach or to try a different approach toward the kids” with Mary explaining “how fortunate it is to have different things in [her] classroom, like in Afrikaans and Xhosa”. Thus besides focusing on the domain of primary maths the issue of language also improved these primary maths teachers’ language teaching practices. Wenger (1998, p. 47) mentions that ‘language’ is an aspect of practice. The multilingual approach can also be related to Wenger et al’s (2002, p. 29) explanation that the practice’s “shared knowledge and resources enables the community to proceed efficiently in dealing with the domain”. Thus the solution offered by the invited guest to the language problem in maths education can enable the NICLE teachers to improve their primary maths teaching *practices* in multilingual maths classes.

Lyn’s focus on using language in mathematics classes had made Calvin, Edna and Mary realise how problematic yet important the issue of language was and how this could be tackled in teaching maths classes. Thus engaging with invited primary maths experts also enabled teachers to understand key issues in the primary maths education *domain* and improved their primary maths teaching *practices*.

9.2.2.4 Access to overlapping communities of practice

Another aspect mentioned by some of the sampled teachers was that engaging in NICLE maths overlapping communities of practices influenced their teacher numeracy identities and practices. Participating and engaging across communities enables members of a community to share knowledge and practices about the concerned community of practice (Wenger et al,

2002; Wenger, 1998). Wenger-Trayner and Trayner-Wenger (2011) also mention that “interactions with other communities” is one of the factors that results in successful communities of practice. During the two-year period of the study, some of the overlapping activities or communities (mentioned by the teachers herein) supported by the SANC included the AMESA national maths week programme, the AMESA conferences and the Maths Education 21 Century conference teacher-focused mathematics day. Teachers were also encouraged to attend Brombacher’s workshop held on 27 August 2011 in Port Elizabeth. Calvin, Robert, Melania, Pamela, Edna and Mary explained how NICLE maths overlapping communities of practices had enabled their learning. Participating in extended maths CoPs enable teacher learning as teachers take up primary maths *practices* from these communities into their classes.

Both Edna and Pamela had attended an AMESA regional conference held at Fort Hare in 2011, thus Edna had mentioned that NICLE had “introduced her to AMESA” which she reported had “changed the whole maths thingy into game, into a fun day”. Pamela also journalled about her attendance at this AMESA conference and how it had enabled her to see other teachers and presenters’ primary maths practices. Robert also reported that participating in NICLE had allowed him to

...attend conferences, workshops, where you talk specific mathematics. And you become part of this *maths community* and it...kindled the spirit to want to know more and understand more (Robert, Interactive interview, November 2012).

In the interview Robert spoke about attending the international Maths Education 21 Century conference’s teacher-focused day, which enabled him to appreciate “how language in mathematics is so crucial” when teaching maths. Edna also explained how NICLE had provided her with information that enabled her to attend a consultant’s workshop in Port Elizabeth, which focused on developing number sense and in which the presenter introduced the Number Sense workbooks, with Edna personally buying a set of these books for her ‘extra grade 3 maths classes’.

During the 2011 national maths week the SANC had co-ordinated a Maths teacher relay at Delta High School in which some of the NICLE teachers within that cluster had participated. Thus Calvin and Mary had reported enjoying and learning from this event. Mary said

When we took part in the maths bonanza in Delta it almost brought us closer together because we did quite well (in the maths relay) so it almost *built some good fellowship between us*. We have numeracy in common now, whereas before we didn't really because Everton was teaching 4s and 5s and I was teaching Grade R and now NICLE has brought us together...(Mary, Interactive interview, November 2011).

The above quotation by Mary also shows another form of participation that emerged as teachers engaged in overlapping maths communities of practice. Mary's utterance indicates increased relationships across teachers in their schools and illustrates that teacher learning is also enabled when teachers participate in overlapping maths CoPs with their school colleagues. Ruth and Melania, who taught at the same school and usually participated together in the NICLE sessions, had also talked in the first interviews of their "very good relationship", under which they "worked very-very closely together" and "helped and supported each other". Calvin, the deputy principal at Bongani Primary, who travelled with some of his teachers, also explained how NICLE had reinforced their school teacher collegiality and teaching practices when he said

Normally I go with Pamela and then they complain till Grahamstown. When we come back we talk NICLE till Delta. No complaints. So it is supporting teachers (Calvin, Interactive interview, November, 2012).

Six of the sampled teachers had explained how their participation in overlapping (related) communities of practices had enabled their learning. According to Wenger (1998) and Wenger-Trayner and Trayner-Wenger (2011) participating and interacting in extended communities is a characteristic feature of successful engagement within a CoP. Both Wenger et al (2002) and Wenger (1998, p. 118) concur that participating across communities or overlapping communities enables participants to learn and 'share *practice*'. The teachers' utterances also revealed that teacher participation in NICLE enabled increased engagement with their school colleagues in their schools. Thus participation in overlapping communities of practice tends to improve the teachers' primary maths *practices* and also allowed teachers to engage in related *communities*. I link these aspects to the CoP elements or social learning theory components of *practice* and *community*. In relation to the latter, Wenger et al (2002, p. 24) note that "communities of practice takes many forms".

Teacher learning is also enabled when teachers engage in maths overlapping communities of practices, share classroom experiences in friendly ways that mutually respect teachers and

regard them as professionals. Such *affordances* seemed to enable teachers to engage learners in maths classes and improved primary maths teachers' understanding of specific numeracy concepts.

Summary of affordances noted in relation to Community

In this section I have unpacked using four themes and Wenger et al (2002) CoPs elements how the teachers explained taking up ideas and how engagement with 'masters' or 'specialists' enabled their learning. Engaging with several primary maths education specialists provided opportunities for teachers to take up key numeracy concepts, approaches, and issues in primary maths education and improved their general pedagogical approaches and the teaching and representation of specific numeracy concepts. Relating these themes to Wenger et al's (2002) three basic structures of a CoP the study argues that engaging with invited primary maths experts provided teachers' access to a wider primary maths *community*, and through them access to the *domain* of numeracy teaching and to primary maths teaching and learning *practices*.

Whilst the sampled teachers explained taking-up 'specialists' ideas and incorporating them in their classes, the study needs to address the second part of the 2nd research question, which relates to *how* these primary maths education experts enabled or afforded teacher learning. The invited guests' presentations enabled teacher learning as they were on key identifiable numeracy concepts, approaches and issues (Hill, 2004; Ball & Hill, 2004) of the primary maths *domain* that was informed by theory and current research that connected with primary maths classroom teaching *practices*. Examples of invited guests sessions that connected theory and practice included Aarnout's presentation that connected the notion of developing learners' 'number senses' and the theory of the five strands of mathematical proficiency (Kilpatrick et al, 2001) as well as the Singapore maths presentation which was informed by research and linked problem-solving and the heuristic drawing model. Lisa's focus on conceptual understanding of fractions, was also informed by research done in the Western Cape by Hanlie Murray one of the Curriculum developers of the fraction component in the recently introduced primary maths curriculum, so was Zonia and Bev's presentation which drew from their Master of education research studies. There is also no doubt that number sense (Aarnout), mental maths (Tom), fractions (Lisa), the number concept such as the zero concept (Zonia) and problem solving (Bev & Lyn) are key fundamental universal numeracy content areas noted in primary maths education (Kilpatrick et al, 2001; Askew & Brown,

2003; Brown et al, 1989; Schollar, 2008; Fennema et al, 1996; Ball & Wilson, 1996). Such numeracy concepts are also foregrounded in the new South African curriculum (DOE, 2008; DBE, 2011b; DBE, 2011c; DBE, 2012). Furthermore the issue of language in South African primary mathematics classes is also a critical, problematic yet important issue (Taylor et al, 2013; Setati, 2005; Setati & Planas, 2012; DBE, 2010). Teachers thus take-up from professional development programmes numeracy concepts or issues that are “of great importance in [their] schools” (Calvin, Interactive interview, November 2012) what Edna metaphorically relates to as issues “close to heart” (Edna, Interactive interview, November 2012) or what both Edna and Calvin implicitly refer to as being “problematic issues” in their classes. These numeracy concepts or issues relate to *practice* that is to the teaching and learning of maths. They are also important as they are noted by influential international numeracy studies and represented by the local curriculum as key areas and aspects of the primary maths *domain*.

Besides the invited guests presenting key numeracy concepts and issues the sampled teacher generally took-up activities from these sessions as they were considered to be presented by knowledgeable primary maths experts. As explained earlier, under the social practice theory and the CoPs perspective, masters or old-timers are crucial in providing access to a *community* and its *practices* (Lave 1993b; Lave, 1996; Lave, 1997; Lave & Wenger, 1991; Wenger et al, 2002). In maths education masters are important in modelling teachers’ mathematical practices (Lerman, 2001). In maths teacher education it has been noted that teachers’ learning is enabled in professional development programmes taught by “mathematically knowledgeable” teacher educators (Hill & Ball, 2004, p. 345) or what Matos (2009, p. 169) calls “more senior colleagues”. The theoretical framework and maths teacher education literature’s postulation that ‘experts’ enable learning relates with the sampled teachers explanations that some of the NICLE sessions that were presented by invited guest primary maths teacher education experts afforded opportunities for taking-up particular and key mathematical knowledge, concepts and issues and appropriating these into their maths classes. Overall and in Wenger et al’s (2002) terms the invited guests exposed the sampled teachers to the primary maths *domain* and to its *community* and *practices*.

9.2.3 Affordances in relation to classroom teaching practice

Affordances related to teaching practice were noted across two key NICLE aspects. Firstly in relation to the community of specialists who brought in ideas which improved classroom

teaching practices. Secondly affordances were noted in relation to access to watching possibilities for classroom practice (NICLE teacher live classroom demonstrations and the inclusion of videos of classroom practice). These are discussed below. The first relates closely to the element of community discussed above.

9.2.3.1 Improving teaching approaches – changing classroom practice

In this section I discuss one of the emerging themes that relates to how the sampled teachers' explained that engaging with experts improved their pedagogical approaches. Melania, Pamela and Calvin explained how Brombacher's emphasis on how 'critical' it was for learners to "explain what they are doing in maths classes" (Fieldwork notes, 12 April 2011) had improved their maths teaching practices, with Melania clearly outlining how the session had "sharpened her awareness" about

...interacting more with children and having them explain to you how they are thinking how they are working out problems from that perspective...I have communicated more with the children about how they are doing things and why they are doing things (Melania, Interactive interview, October 2011).

In the second interview Melania reiterated the influence of the number sense session on her teaching approach when she said

Um I think that Brombacher made me realise too that ...the importance of getting the feedback from the children all the time...to um keep on trying to see how they are thinking. How they are working things out...to ascertain how they are thinking, why do they think that (Melania, interactive interview, November, 2012).

Pamela also journaled on 14 November 2011, how the NICLE programme and specifically Brombacher session had enabled her to critically engage learners and employ small group-focused teaching approaches in her classes.

Everton, Ruth and Edna also said that Zonia's session had improved their teaching practices towards multiple and child-centred approaches. Thus Edna had explained in the second interview that Zonia's session had helped improve her teaching strategies, as she said, "she (Zonia) gave us a lot of input and different ways of doing things". As I have explained in the section above, both Everton and Ruth commented that Zonia session had helped them understand the zero concept, as well as improving their teaching approaches. In relation to enhancing their teaching practices Everton commented that the zero concept session had

enabled her “to look at things from a child-centred point of view”, with Ruth similarly remarking that this session afforded her the opportunity to engage learners in her classes, as she said

....what I took along from it, was asking the children to define it, so that is learning for me, how to allow for discovering things instead (Ruth, Interactive interview, October 2011).

Everton, Ruth, Edna, Pamela, Melania and Calvin said that engaging in Brombacher’s and Zonia’s zero concept sessions had afforded them opportunities to improve their general teaching approaches towards learner-engaging practices. Wenger et al (2002, p. 38) explain that practice entails “a set of socially defined ways of doing things...” Similarly pedagogical approaches can be viewed as a key aspect of teaching *practices* which explains how knowledge is supposed to be transmitted in classes. Teacher evidence presented here indicates that engaging with experts enabled teachers to enhance their pedagogical *practices*.

9.2.3.2 Access to watching possibilities for classroom practice

During the period of the study there had been two lesson demonstrations with NICLE teachers where teachers watched a class being taught. Teachers were also shown different video clips related to the teaching and learning of numeracy. Six of the sampled teachers indicated that the lesson enactment activities and the video clips had *transformed their teaching or instructional practices* towards learner-engaging, creative, inclusive non-procedural and multilingual teaching strategies and *encouraged them to improvise teaching resources*. Under the socio-cultural theory “demonstrations – learning by ‘observation and imitation’” and “mimesis” embed learning within the community’s practices and settings (Lave & Wenger, 1991, p. 105; Lave, 1996, p. 151). According to Wenger (1998) communities of practices’ tools and artefacts are also key for reifying (giving form and meaning) experiences and practices. This concurs with his later explanation that a community’s resources embody *meaning* and the community’s *practices* (Wenger et al, 2002). Similarly under practice-based professional development initiatives videos and lesson enactments simulate and immerse teachers in mathematics teaching-related activities and experiences (from which they can interpret meanings) (Adler, 2000; Silver, 2009; Kazemi & Hubbard, 2008). Lesson demonstrations and videos are mostly noted for linking and connecting teachers to real practices and resources (Adler, 2000; Silver, 2009; Kazemi & Hubbard, 2008). The observation of demonstration lessons and the watching of videos

provide teachers access to teaching *practices* and to interpret *meanings* from these CoPs tools.

9.2.3.2.1 Observation of demonstration lessons

Both Glynnis (an invited FP local teacher and part-time lecturer) and Melania, one of the sampled teachers in this study, had done practical demonstration lessons in NICLE sessions with real learners. Melania's flard card practical lesson enactment activity with six of her Grade 3 learners emphasised the importance of place value with learners using flard card boxes to solve maths tasks and freely explaining how they had worked their solutions. Glynnis Suttie's practical demo lesson with ten Grade 3 learners focused on number concept development and relations using flard cards and also illustrated how critical learner engagement is in teaching maths. Calvin, Pamela and Mary had explained and diarised on how they had enjoyed these demo lessons as they were practical and encouraged learner-engaging teaching strategies. Thus Mary recounted during the second interview, Glynnis' demo lesson and how practical it was.

Pamela like Mary, also indicated enjoying the lesson enactments and implicitly their practicality. Thus in the journal she wrote

She (Glynnis-local teacher) did mental maths using flard cards. Her boys were so fascinating, because her lesson was flowing without any hiccups (Pamela, Journal entry, 7 August 2012).

During the interview Pamela had also said that Melania's demo lesson had been "very interesting because the learners were easy to manage and manipulate those (flard cards)". She also went on to explain how these demo sessions had helped her learn to develop mathematics resources such as Flardcard boxes to use in her classes.

During the first interview Calvin also acknowledged the influence of Melania's practical session on his practices. He said

...you learn a lot of things. You learn new stuff, you meet new people, you share experiences with other people and you hear what their class practices are. Like that lady at Heritage [Melania] you can see that those learners weren't coached it's what is happening in the classroom (Calvin, Interactive interview, November 2012).

Earlier in the interview Calvin had remarked how in conversation with colleagues he had said that their maths classroom practices must also be learner-engaging as they had witnessed during Melania's demo lesson. Reflecting on Glynnis Suttie's demonstration lesson Calvin

journalled that this presentation had influenced him to work with learners on the mat. Thus he wrote

I should try and plan in stages when I am busy with slow learners, the other learners should be busy with activities that [are] more advance[d] (Calvin, Journal entry, 24 July 2012).

Calvin, Pamela and Mary said that they enjoyed these demo lessons as they were practical - with real learners working on mathematical problems using the actual maths resources and encouraged learner-engaging teaching strategies.

9.2.3.2.2 Watching video clips

Besides live demonstration lessons, Mellony and some of the invited guests had also shown the NICLE teachers various video clips on (maths) teaching and learning. The teachers' comments indicate that these videos had influenced their teaching practice and powerfully illuminated key primary maths pedagogical issues. Both Mary and Everton had reported in their journals how they had enjoyed a Ken Robinson video⁶³ titled 'Do schools kill creativity?' which they also claimed illustrated the importance of inclusive and creative teaching approaches. Mary had written in her journal entry:

Really enjoyed the TED clips. Made a lot of sense 'children do have different abilities and talents' and I think we are always so quick to label children who are different (Mary, Journal entry, 28 February, 2012).

In the same way Everton had also highlighted how the TED series video emphasised creative teaching in her diary recording below.

Found the Ted video interesting – liked the concept of keeping creativity alive in the classroom. Resolved to have each learner tell a joke/riddle every day can involve numeric riddles (Everton, Journal entry, 6 March, 2012).

Ruth had also said in the interviews how she had “loved the little story about Ma and Pa”⁶⁴ which had led her to “question rote learning”, thus illustrating to her the importance of teaching for conceptual understanding. Mellony had also shown teachers a Deborah Ball grade 3 classroom video clip on teaching odd and even numbers. Calvin also commented on

⁶³ The Ken Robinson video was shown to NICLE teachers on 28 February 2012 as a way of invoking teachers to transform teaching and learning and explore their creativity.

⁶⁴ On 24 May 2011 Mellony showed the teachers a Hillbilly maths video clip that involved Uncle Pa and Ma erroneously dividing 25 by 5 to get 14. The video clip is available on the following link: www.youtube.com/watch?v=TwV7OO043FA

how a video clip shown by Lyn had powerfully illuminated (and embedded *meanings* relating to) the importance of language in teaching maths, thus he recounted:

They had an inset at Bishops. It's a school in Cape Town where it's mainly white. They do Xhosa as a third language, ja. And in that the...the teacher came in the class and said 'ok' A black teacher, Xhosa...wants to do an experiment in Xhosa. And she asked the question and the kids' response was 'ewe' which is yes. And when ...in my dealing at school you get that a lot... So language is of great importance in our school (Calvin, Interactive interview, November 2012).

Mary, Everton and Ruth had reported enjoying some of the video clips shown in the NICLE sessions. These had enabled teacher learning as they strongly illustrated inclusive, non-procedural, creative and multi-lingual primary maths teaching practice and strategies.

Six of the sampled teachers' utterances and journal entries indicate that both videos and the demonstration lessons transformed their maths classroom teaching *practices*. Teacher comments also show that sessions modelled by a fellow teacher, as was the case with Melania and Glynnis' presentations, have a great impact on teachers' learning of instructional *practices* and improvisation of resources, an argument supported by Ball and Even (2009), Kazemi and Hubbard (2008) and Borko (2004). Classroom video tapes which Kazemi and Hubbard (2008, p. 436) classify as "depictions" have been reported to be strategic artifacts of practice that convey realities, proofs and complexities of classroom events (Ball, 1996; Putman & Borko, 2000; Ball & Cohen, 1999; Hill, 2004), which powerfully illuminate maths ideas. Within the CoPs theory demonstrations are noted as being effective for context-bound understanding and enable learning experientially (Lave & Wenger, 1991; Lave, 1996). On the other hand videos, which are a community's tools and artefacts, are essential for giving form and *meaning* or reifying participants' experiences and practices (Wenger, 1998; Wenger et al, 2002). The teachers' comments, the CoP theory perspectives and postulations from the above-cited teacher education literature indicates that lesson demonstrations and videos present authentic classroom events, realities and experiences and powerfully illuminates mathematical ideas and issues which improve teachers' instructional *practices* and their *meaning*-making senses thus enabling teacher identities and practices to evolve positively.

9.2.4 Affordances in relation to the nature of NICLE practice: relations and the nature of participation promoted

In this section I discuss affordances related to the nature of practice promoted in NICLE. As will be evident in the discussion teacher utterances on the nature of NICLE practice equally relate to the nature of relations promoted in the community and between community members. The nature of NICLE practice also connects with the forms of participation encouraged in NICLE, which will be discussed in the following section.

9.2.4.1 Relations within NICLE that enable teacher learning

According to Wenger ‘relationships’ are a critical aspect of engagement within a CoP (Wenger, 1998, p. 174; Wenger et al, 2002, p. 34). In this part of the chapter I discuss and analyse relations within the NICLE CoP that the sampled teachers reported as enabling or constraining their learning. By investigating relations I focus on how the NICLE teachers interact and relate with the Chair and staff in the project, invited guests and amongst themselves. The data and information concerning relations that can afford teacher learning within NICLE were not gleaned from any specific interview questions but were gathered from relevant teacher utterances across the interviews and also from journal entries. Though some of the teachers did describe relations that constrain teacher learning these they reported were not noted in NICLE but in district-mandated workshops and other professional development initiatives. Generally the teachers explained that teacher learning is enabled by a ‘friendly’ CoP that ‘mutually respects’ teachers and regards them as professionals. In the section below I analyse data that point to this and relate it to the three elements of CoPs (Wenger et al, 2002) which relate to the four components of the social learning theory (Wenger, 1998). Empirical evidence also suggests that teacher learning is enabled in such teacher CoPs as this creates conditions that promote interactions and engagement within the community of practice.

9.2.4.1.1 Teachers as professionals and mutually respectful relations

Ruth, Pamela, Melania, Mary and Everton explained that teacher learning was enabled in the primary maths in-service CoP programme through mutually respectful relations that respected and regarded teachers as professionals. Seeing teachers as professionals and being respectful to them relates both to the aspects of *identity* and *community* respectively. I have theoretically explained following Wenger et al (2002) in Chapter 3 how participation in a

community develops an identity. I will firstly explore how NICLE's participation ethos resonates with the notion of a community.

Wenger et al (2002, p. 28) argue that "a strong *community* fosters interactions and relationships based on *mutual respect* and trust" [emphasis mine]. Wenger-Trayner and Trayner-Wenger (2011) in their recent work also mention that the level of trust within a community is one of the factors that make CoPs successful. Melania clearly portrayed the nature of relationships within NICLE that promoted evolving numeracy identities and practices, and in the process comparing these to the Departmental workshops, when she said

Often you go to these Departmental things and they almost talk down to you. Like you are a teacher and you don't know what you're doing, you know. NICLE has really gone, from the onset, they are trying to help, they are trying to uplift, they are trying to improve, they try to ...but they respect you...they respect...they respect you, you know. They respect where you are at and they're helping you (Melania, Interactive interview, November 2012).

Ruth and Pamela also made similar observations comparing the relationship fostered in NICLE and in the Department's teacher development programmes and went on to elaborate on how the NICLE promoted interactions, engagement and professional teacher identities within the CoP, thus Ruth said;

I think there is an attitude difference. I think at NICLE there is respect for us as professionals. I don't think our competence is questioned at NICLE, whereas at the Departmental one it's not questioned exactly, but there is an underlying assumption that we have to be uplifted which ...results in a very different response from teachers. If you are at the Department one, people feel like kind of forced response and sometimes you really killed it...ah its likely more patronising the attitude (Ruth, Interactive interview, November 2012).

This concurs with Pamela's utterance that

Most of the time the facilitators are interacting with us and also they are respecting our views. We do not just sit there and listen to them. Sometimes we will come out with solutions and sometimes we do the...the problems ourselves and they just give us chance on how to discuss most of the things (Pamela, Interactive interview, November 2012).

Besides promoting interactions and engagement, regarding teachers as professionals, according to Pamela, also underscored the importance of encouraging divergent views. On the nature of relations that promoted learning within NICLE Mary similarly remarked that

accommodating different views, such as different mathematical approaches and strategies, also fostered critical thinking amongst participants in the teacher CoP. Wenger et al (2002, p. 28) point out that robust communities “encourage a willingness to share ideas, expose one’s ignorance...”. Wenger-Trayner and Trayner-Wenger (2011) also mention that “recognition for contributions” in a community is one of the numerous factors that make CoPs thrive. Thus reflecting on an incident in which her drawing solution to a sharing tart problem (in a fraction-focused workshop) was accepted during a NICLE activity. Mary had this to say:

I mean that they sort of accept the different ways. It isn’t like old school ways. This is the way and its parrot fashion and you just repeat it, repeat it. It’s sort of developing your critical thinking... (Mary, Interactive interview, December, 2012).

In the same interview Mary went on to say that NICLE sessions were “always so accommodating”.

In her 8 May 2012 journal entry Mary also recounted this incident, explaining how it emphasised the mutual respect that existed between her and Lisa – one of the key partners of the Chair and invited NICLE guest speaker - when she wrote that “she would have broken out into a cold sweat if asked to explain that concept but she (Lisa) has a way of helping us who are mathematically challenged to understand”. Mary’s journal entry shows the supportive and non-judgemental approach of some of the NICLE presenters which helps illustrate the mutual respectful relationship that existed between the teachers and key partners and invited guests.

According to Ruth, Pamela, Mary, Melania and Everton, teacher learning was enabled in the primary maths in-service CoP programme through mutually respectful relationships that regarded teachers as professionals thus promoting interactions, engagement, and divergent views which foster critical thinking. Such relationships were promoted within NICLE and foregrounded in the Chair documents that explained that NICLE participants were “professional... life-long learners who actively participated in the community” (SANC, 2011, p 16; Graven, 2011b, p. 3; Graven & Schafer, 2011, p. 13). Furthermore NICLE emphasised a two-way partnership in which the teachers, Chair staff and key partners were all co-learners who worked together to bring different experiences and expertise to share in the community (Graven & Schafer, 2011; SANC, 2012; SANC 2011). Both local and international teacher education literature explains that professional development programmes that mutually respect

and recognise teachers as lifelong professional learners stimulate and support teacher learning (Graven, 2005b; Graven, 2012; Jita & Vandeyar, 2006; Wilson et al, 1996; Abdal-Haqq, 1996; Ball & Cohen, 1999; Grossman et al, 2001). Thus NICLE's regard for teachers as professional lifelong learners in co-partnership with programme co-ordinators and facilitators afforded participation opportunities that enabled the positive evolving of their numeracy identities and practices.

NICLE's regard for respectful co-partnership relationships that regarded teachers as professionals foster the development of a numeracy *community* and indicates the promoted primary maths teacher *identity*. Embedded in the envisaged NICLE relationships were the projected primary maths teacher identities - with identity (one of the key components of the social learning theory) developing through participation in a community of practice (Wenger, 1998; Wenger et al, 2002). The notion of a community thus links and connects with the component of identity (Wenger et al, 2002; Wenger, 1998). Similarly the professional relationships promoted in NICLE encouraged the development of a primary maths teacher learning *community*, which related with the promoted professional PMTI. Wenger (1998, p. 184) also explains that the work of engagement (i.e. participating in a community) entails such processes as "shaping identities in relation to one another". Explicit in the NICLE professional relationships and the encouraged forms of engagement was both the nurturing of a primary maths *community* and the envisaged primary maths teacher *identity*.

9.2.4.1.2 Friendly relations

Calvin, Everton, Melania and Mary also explained that teacher learning is enabled in and through friendly relations. Melania described her NICLE experiences and the nature of relationship that existed between teachers and the SANC staff as being "...a positive experience. The people you have been so friendly..." Calvin went on to elaborate on the nature of the bond and togetherness within NICLE

The *camaraderie* amongst [us]. You can see the people feel they *belong* in NICLE. They don't feel out of place. It's not a struggle to get people to respond...they just respond (Calvin, Interactive interview, November 2012).

Thus the camaraderie – and the sense of community belonging (Wenger, 1998) fostered within NICLE enabled the teachers and facilitators to engage and interact during sessions. The friendly relations promoted in NICLE were also reported by Everton to have been

evident during Lisa's NICLE fraction presentations. Thus Everton described a workshop facilitator's presentation as having been carried out in

...a wonderful manner, which I hope to try and emulate more in my classroom between the relationship...The way she presents things to the people listening, and her as a facilitator she's a very dynamic and user-friendly person in the way she presented (Everton, Interactive interview, November 2012).

Everton also wanted to emulate and model the presenter's friendly and helpful approaches in her classes. Mary reiterated the same presenter's dynamism in her journal entry when she wrote "we were blessed with Lisa today what a dynamic spirit". The four sampled NICLE teachers' utterances help illustrate that friendly relationship between the teachers and the Chair staff, key partners and invited guests enabled teacher learning.

Teacher professional development programmes that exude egalitarianism and friendly relationships support and encourage significant teacher learning (Wilson et al, 1996; Grossman et al, 2001; Lieberman, 1995). Wenger et al's (2002, p. 37) later work explain that a CoP creates an atmosphere of "openness... trusts" and a place where it is "safe to speak the truth and ask hard questions". From a social learning theory the friendly relationship that existed between NICLE teachers and SANC staff and invited and core partners of the Chair fostered a community of practice, under which learning entails a sense of belonging to a community (Wenger, 1998; Wenger et al, 2002). Such friendly relationships promoted the bonding and growth of the primary maths CoP and resulted in the sampled teachers freely engaging and interacting with facilitators during NICLE sessions, thus affording opportunities for the positive evolution of teacher numeracy identities and practices. Thus the friendly relationship expressed by the teachers illustrates both the social learning component and the CoP element of *community* (Wenger, 1998; Wenger et al, 2002).

Having discussed how teacher learning is enabled in friendly CoP that mutually respect teachers, regard them as professionals and which promote opportunities for interactions and engagement within the community of practice, I now discuss forms of participation within the teacher CoP that allow numeracy teacher identities and practices to evolve positively. I also relate some of the forms of relationship that enable teacher learning to Wenger et al's three fundamental elements of a CoP which are similar to Wenger's (1998) social learning theory components.

9.2.4.2 Forms of participation that enable teacher learning

I now focus on forms of participation that enabled teachers to take-up the described NICLE activities into their maths classes. The types of participation within the CoP were mentioned by the sampled teachers in the interactive interviews and also in some of the teachers' journal entries. The data presented here were gleaned across all the teacher interviews and their journal writings. The information analysed and discussed in this part of the study helps address part of the second research question, which relates to forms of participation with the Community of Practice that enable or constrain teacher learning. Some of the forms of participation mentioned by the sampled teachers had been mentioned above on the section on *Teacher learning affordances in NICLE*. In relation to this question the study reveals that teacher numeracy identities and practices evolve when sessions are presented by invited primary maths expert guest speakers and when teachers share classroom experiences, actively participate in the CoP and engage in maths overlapping communities of practices. Three key aspects of forms of participation noted by teachers are discussed below. These are

- 9.2.4.2.1 Engaging directly with 'experts'
- 9.2.4.2.2 Sharing classroom experiences and practices
- 9.2.4.2.3 Active participation

9.2.4.2.1 Engaging directly with 'experts'

As discussed earlier, all the sampled teachers reported enjoying different sessions presented by invited numeracy education specialist guest speakers. With half of the NICLE sessions during the period of the research study having been presented by guest speakers, participation in NICLE enabled the teachers to engage with experts in the field of primary maths. The social learning theory relates 'experts' to the element or component of *community*, as CoPs consist of 'masters' who are critical for ensuring learning and the identity transformation of participants (Wenger et al, 2002; Lave & Wenger, 1991).

Pamela explained that NICLE had provided her access to 'specialists' and 'experts in mathematics' who she alleged addressed her classroom mathematic challenges. Similarly Edna also said "what I like about NICLE uh, they invite a lot of guest speakers to introduce certain things to us". She had also reiterated the same statement in the second interview when she explained that "after every second week ...there was at least somebody from somewhere that gave us a session on one of the topics or whatever". Calvin had also pointed out how he had "learnt a lot of things" and "new stuff" in NICLE as he had "meet new people". Mary

had also commented that engaging in NICLE was “exciting and stimulating” as it involved interacting and learning maths classroom practices from ‘guest speakers’. As explained earlier the sampled teachers appropriated maths practices through engaging with primary maths experts in NICLE. In Communities of practice participants learn from ‘masters’ and ‘old-timers’ as they generate identities and “move towards full participation” (Lave & Wenger, 1991, p. 91). Wenger et al (2002) also explains that ‘experts’ are critical for identifying and confirming existing knowledge and new developments within a community. In maths teacher education it has been noted that teacher learning is enabled in professional development programmes taught by mathematically knowledgeable teacher educators (Hill & Ball, 2004; Matos, 2009). Thus learning and understanding for some teachers participating in NICLE was enabled through engaging with invited specialists/experts (masters) who provided access to the primary maths education’s *community*.

9.2.4.2.2 Sharing classroom experiences and practices

Another form of participation that enabled teacher learning mentioned by six of the sampled teachers was that engaging in NICLE enabled participants to share classroom experiences, practices and ideas on teaching resources. The sharing of maths teaching experiences was through group work discussions, informal talk or when a participating teacher presented during a NICLE session. Wenger et al (2002, p. 39) explain that sharing ideas, resources and joint activities enables “successful *practice* development”. I thus relate the aspect of sharing of classroom experiences and practices to the CoP notion of *practice* (Wenger et al, 2002; Wenger, 1998).

Mary emphasised in both her interviews that she had learnt through engaging with other NICLE teachers

I love the sharing when I do my group work the things that come up. You know with the other teachers, sharing experiences it is a huge advantage because we learn from one another (Mary, Interactive interview, November 2011).

Just that whole networking, you know. Getting to sort of meet other teachers and share things with other teachers. It’s been a big advantage (Mary, Interactive interview, December 2012).

Everton, Edna, Calvin, Robert, Pamela and Ruth had similarly mentioned the advantages of sharing classroom experience and practices with other teachers in NICLE. Everton said

...the big thing is seeing other people do it and discussing it with them and finding out what your common problems are and finding solutions to those common problems (Everton, Interactive interview, November, 2012).

I enjoy learning by contributing and hearing what other people say ... Just learning how other people deal with it (Everton, Interactive interview, November, 2012).

Robert had also said that engaging in NICLE enabled him to “get other people’s views of what is happening in the classroom...being able to share with them about their classroom practices”. Similarly for Pamela NICLE provided a forum for meeting other teachers and sharing classroom “challenges and problems”. Calvin also explained that through participating in NICLE they could “share experiences with other people and you hear what their class practices are, like that session by (Melania)”. The latter statement refers to Melania’s demonstration lesson on using flard cards.

Ruth and Pamela also said that NICLE provided a context for sharing both classroom experiences and ideas on teaching resources. Thus Ruth remarked

What I have gained was to have a peer group and thinking about it and being together in some sense, I think it’s...to build enthusiasm for my own class and my own teaching and not to feel alone in it and to know that we are on track and that this is the relevant material (Ruth, Interactive interview, November 2011).

Pamela also revealed in the first interview that it was her “dream” to be part of the NICLE programme as it allowed her to “share her experiences with other school” and also interchange ideas on “how to make and use certain resources”. Edna had also mentioned that NICLE provided a setting where she got the “chance to meet different educators from different schools and different environments” and in the process share ideas on classroom resources. The fact that the NICLE target group was grade 3 and 4 teachers also promoted the sharing of ideas across the foundation and intermediate phase educators (SANC, 2013), a point that was also raised by Robert when he explained that the “synergy between the grade 4 and 3 teachers’ enabled the sharing of dilemmas that they experienced in real class situations”. For the sampled teachers the NICLE peer group provides a forum in which participants’ network and in the process share classroom experiences, practices and ideas on teaching resources. According to Garet et al (2001) professional development programmes designed for teachers from the same grade level provide opportunities for teacher discussion and in the process allow teachers “to share their knowledge and learn from one another”

(Lieberman, 1995, p. 593). This also concurs with the suggestion of Smylie (1998), Hill (2004), Wilson and Berne (1999) and Putman and Borko (2000) that sharing classroom experiences is an effective source of learning to teach. Empirical evidence also shows that sharing classroom experiences, practices and ideas on teaching resources within NICLE, which targeted primary level maths teachers, provided opportunities to share classroom practices which enabled teacher numeracy practices to evolve and to develop a sense of belonging to a community that has shared goals of improving primary maths education.

Such a form of participation relates both with the '*practice*' element or component (learning as doing) of the social learning theory and three dimensions of practice (Wenger, 1998; Wenger et al, 2002). Thus the teacher utterances illuminate how "joint enterprise, mutual engagement and shared repertoire" are key dimensions of *practice*, which Wenger (1998, p. 72-73) explains are the "sources of coherence of a community". Similarly Wenger et al's (2002, p. 29) later work also explains how the element of practice entails sharing knowledge and resources which they explain "enables the community to proceed efficiently in dealing with its domain". Firstly the teachers' comments that NICLE provided opportunities that enabled them to share classroom practices and ideas on teaching resources respectively relates with the mutual engagement and shared repertoire elements of practice (Wenger, 1998). The fact that engaging in NICLE provided a sense of belonging to a community whose shared vision and main undertaking was improving primary maths education (SANC, 2011, 2012 & 2013) relates with the 'joint enterprise' dimension of a community (Wenger, 1998, p. 73). Thus both the three dimensions of practice (Wenger, 1998) and Wenger et al's (2002) element of practice illustrate how the aspect of sharing classroom experiences and practices relates to the development of primary maths classroom *practices*.

9.2.4.2.3 Active participation

I have explained in chapter 8 how some of the teachers explained their NICLE experiences as participation. Here I elaborate on the aspect of *active participation* which some of the teachers reported as enabling their learning. The feature of active participation relates to the *community* element or component (Wenger et al, 2002; Wenger, 1998). According to Robert, Everton, Mary and Edna NICLE involved active participation and practical demonstrations/experiences devoid of theoretical rhetoric. In instances where theory was emphasised it related to practical issues. Robert's interview utterance is illustrative of this:

People come with different ideas with sessions and it demonstrates it is not just a talk show it is active participation, that keeps it lively and the interaction is not, it is on a level ground where the lecturer is on the same path as you. The interaction is not where you have to just be absorbing theoretical knowledge of someone else (Robert, Interactive interview, November 2011).

Robert's utterance also shows the lateral and egalitarian relationship that existed between NICLE teachers and presenters. Later in the interview Robert elaborated that he "believed in active participation" in his classroom. He said he liked NICLE because it "shared the same approach". Similarly Edna expressed the form of participation that she had experienced in NICLE,

Everybody is actively involved and engaged. It's not like somebody was standing there in front and preaching to us and we just had to sit. There are a lot of activities to keep us going for the day... (Edna, Interactive interview, November, 2012).

Though Edna admitted that NICLE sessions were characterised by 'active participation' she went on to say that NICLE participants also engaged in "a lot of practical, concrete...hands-on experiences" which made it easier for her to "implement it" in her classroom. Similarly Everton explained that her NICLE learning experiences were marked by practical activities. Teachers' comments indicated that active participation and practical experiences enabled and influenced their learning.

This concurs with teacher education studies indicating that 'active learning' (Hill, 2004, p. 220; Garet et al, 2001, p. 925), 'active involvement' (Lieberman, 1995, p. 595) or 'active participation' (Graven, 2012, p.132) supports teacher learning. Teachers' comments also relate with the central component of the social practice theory under which learning is explained as 'social participation' which encompasses the "process of being active participants in the *practices* of social communities" (Wenger, 1998, p. 4) [italics in original]. The aspect of active participation which some teachers explained as enabling their learning relates to the element of *community*, for Wenger et al (2002, p. 41) argue that community "membership depends on participation". The social learning theory, the CoP concept and professional teacher development literature explanations resonate with the sampled teachers' comments that active participation and practical experiences in the NICLE *community* created opportunities for the positive evolution of primary maths practices.

9.2.5 How do NICLE affordances enable teacher learning?

Analysing and discussing the NICLE affordances above that enabled teacher learning reveals that teachers participating in professional teacher learning communities mostly take-up into their maths classrooms key numeracy concepts, resources, issues and approaches presented by invited primary maths experts. Teacher learning is also supported when teachers engage in activities that relate to classroom *practices*. Thus teacher numeracy identities and practices seemed to evolve when they engaged and participated in such professional development activities. Analysing the empirical findings using Wenger et al (2002) structural elements reveals that engaging in activities presented by primary maths experts exposed teachers to the primary maths *community*, its *domain* and *practices*. Wenger (1998, p.175) also explains that “engagement transforms communities, practices and persons”. Thus participating and engaging in the NICLE community which foregrounded key numeracy concepts in the primary maths domain transformed the teachers’ identities and practices.

Responding to the second part of the question that relates to *how* these activities enabled teacher learning, all the sampled teachers said that participating in NICLE had enabled them to engage learners more in their maths classes. Learner-engaging pedagogies were highly emphasised in NICLE and evident across most of the sessions observed in the period of the study. Furthermore local primary maths curriculum documents also promote such pedagogies. Thus participation in the primary maths learning community, according to the teachers, improved the primary maths teacher’s *practices*. The teachers also explained that engaging in NICLE had improved their understanding of particular numeracy concepts and content, (such as fractions, place value, mental maths, number sense, problem solving or the zero concept), approaches (such as the RUCSAC word problem solving and the Singapore maths approaches) and key issues in primary maths (such as multilingual maths classes and homework practices). These numeracy concepts, approaches and issues are critical ideas and content areas in the primary maths *domain* which are emphasised in the primary maths education *community*. It is important to note that the pedagogical strategies, numeracy concepts, approaches and issues that teachers indicated taking-up from the primary maths teacher CoP were highly prioritised in NICLE, as discussed in Chapter 6. The details of how these affordances were used in class were mainly not given by the teachers, thus classroom observations might have allowed insights into this.

For this study teacher learning was noted when teachers said that participating in NICLE improved their mathematical understanding, their teaching approaches or when they reported taking up NICLE activities, and using various addressed numeracy concepts and resources in their classes. Table 9.1 below provides a summary and an analysis of teacher learning affordances and what teachers indicated as taking-up through participating in these activities. The table also shows how these teacher learning enablers relate to the three fundamental elements of CoPs (Wenger et al, 2002).

Teacher learning affordances/enablers	The fundamental element(s) of a CoPs does it relates to	What teachers indicated taking-up from the NICLE activities (and resources)
Numeracy games	Domain & practice	<ul style="list-style-type: none"> • Promoted the teaching of various numeracy concepts in a playful explorative manner • Enhanced the teaching of particular primary maths concepts (e.g. place value, number bonds) • Improved mathematical teaching strategies
Activities in which teachers were provided physical maths teaching resources	Domain & practice (and meaning)	<ul style="list-style-type: none"> • Exposed teachers to a variety of ways of teaching and representing mathematical concepts (such as using blocks for concepts of measurement) • Enhanced the teachers understanding of specific numeracy concepts (e.g. place value, fractions, number patterns)
Activities in which teachers were provided printed and published material resources	Domain & practice	<ul style="list-style-type: none"> • Teachers used the printed resources in teaching their maths classes • Provided teachers with multiple and alternative ways of representing mathematical concepts • Supported teachers' understanding of specific numeracy concepts (problem solving in the Grocotts 'Ukufunda' supplements)
Activities presented by invited numeracy education specialist guest speakers	Community, domain & practice	<ul style="list-style-type: none"> • Enabled teachers' understanding of numeracy concepts (e.g. fractions) and approaches (Singapore maths & RUCSAC approach) • 'Improved' teaching and representation of specific numeracy concepts • Enabled understanding key issues in primary maths education (e.g. multilingualism) • 'Improved' general pedagogical approaches
Live demonstration lessons and video clips	Practice (teaching practice and meaning)	<ul style="list-style-type: none"> • 'Improved' instructional practices and how to use and make teaching resources

Table 9.1: NICLE activities and resources that enabled teacher learning and what teachers indicated taking up from these activities.

Having summarised the NICLE activities as well as resources that enabled evolving teacher numeracy identities and practices, and how these activities enabled teacher learning, I now summarise the *relations* and *forms of participation* within the CoP that teachers indicated enabled evolving teacher numeracy identities and practices using the CoPs theoretical elements (Wenger et al, 2002; Wenger, 1998).

The data discussed above show that teacher numeracy identities and teaching practices evolve and are enabled within the NICLE sessions when teachers shared classroom experiences and actively participated in the CoP and engaged in maths overlapping communities of practices. Teacher learning is also enabled when teachers participate in teacher communities with their school colleagues. Since the NICLE programme targeted teachers from the same schools, grade and subject, this offered potential advantages and opportunities for teacher learning in schools. Teacher learning is also enabled in CoPs that are friendly, mutually respect teachers and regard them as professionals. The teacher utterances and some of their journal entries reveal that such relations and forms of participation provide opportunities for interactions, engagement and sharing classroom practices in the CoP which enable teacher numeracy identities and practices to evolve positively.

Table 9.2 below summarises relations and forms of participation within NICLE practices that enabled primary maths teacher learning. It also relates some of these to the CoP elements and the social learning theory components and explains how such relations and forms of participation enable and promote teacher learning.

	Relations and forms of participation that enable primary maths teacher learning	Element(s) of CoP it relates to	How do such relations and forms of participation enable and promote teacher learning (based on both grounded and literature led analysis)?
Relations	Teachers as professionals and engagement in mutually respectful relations	Community, that is learning as belonging & (identity)	<ul style="list-style-type: none"> • Promotes interactions and engagement • Encourages divergent views and different mathematical approaches and strategies • Fosters critical thinking
	Friendly relations	Sense of community, that is learning as belonging	<ul style="list-style-type: none"> • Enabled teachers and facilitators to freely engage and interact – safe space
Forms of participation	Interactions with invited numeracy education experts	A community consists of experts	<ul style="list-style-type: none"> • Enables interacting with experts in the field of primary maths and learning maths practices from them
	Sharing classroom experiences and practices	Practice, learning as doing and the three dimensions of practice	<ul style="list-style-type: none"> • Provides opportunities to share classroom experiences, practices, ideas and resources
	Active participation	Active participation occurs in a community	<ul style="list-style-type: none"> • Enables teachers to engage in practical activities/experiences
	Participating in overlapping communities of practice	Practice & community	<ul style="list-style-type: none"> • Enables teachers to see other teachers and presenters' primary maths practices • Reinforces school teacher collegiality

Table 9.2: Relations and forms of participation and how they enable primary maths teacher learning

Having discussed the relations and forms of participation within NICLE that enabled teacher identities and practices to evolve, in the next section I discuss teacher learning constraints raised by the sampled teachers, and thus attend to the last part of the second research question.

9.3 Constraints (and attunements to constraints)

This section of the study presents and discusses constraints experienced by the sampled teachers during their participation in NICLE, thus helping illustrate part of the second research question. The data presented here was gleaned from both Question 16b in the 2011 and question 13 in the 2012 interactive interview schedules, which requested the sampled teachers to explain the disadvantages of participating in NICLE. To enrich my argument I also link the teachers' responses to these two questions to other interview utterances that connect to activities cited by the primary maths teachers' as inhibiting their learning and participation in NICLE. None of the sampled teachers' journal entries had information about teacher learning constraints and so the data discussed below emerged from interviews. Borrowing from Greeno et al (1998) I use the term *constraints* to imply regularities, systems or materials of social practice that inhibit interaction or participation. Constraints thus relate to the 'bounded character of engagement' which outlines the limitations of engagement, and concern the "obvious physical limits in time and space" (Wenger, 1998, p. 175). Wenger-Trayner and Trayner-Wenger (2011) in their latest work also mention that time is a challenge for most communities. Furthermore I present some teachers' suggestions to their participation constraints. I call these attunements borrowing from Greeno et al's (1998) CoPs interaction concepts. These theoretical elements alongside teacher education literature illuminate my discussion of teachers' constraints and attunements to participation. The sampled teachers explained that time to engage in professional work and travelling distance constrained their participation in NICLE. This issue also raises the tension of how to scale-up maths professional development initiatives when time and distance is an issue.

9.3.1 Constraints related to time

Four of the sampled teachers reported that they faced time⁶⁵ constraints in attending and participating in NICLE sessions. Ruth and Melania, who taught at the same school, felt

⁶⁵ It is useful to note the changing 'times' for NICLE over the years of this study. In 2011 NICLE sessions were from 3-5 pm every fortnight. In 2012 the sessions were changed from 2:30 to 5pm.

constrained to find ‘time’ to attend NICLE from their teaching work schedule. Ruth disclosed that her

...duties at school continue to be the same so we are not relieved off. I just happened to have Monday duties at school and Tuesday, so I often find that when I get to Wednesday I haven’t had one solid afternoon of preparation time (Ruth, Interactive interview, October 2011).

Melania was also in a similar predicament as she said in both the interviews, with her second interview utterance below illustrating this.

It’s just the time factor really. You know. I just find that...one has so many other things at school. So many others...um...it’s just the time. You know it’s only every second Tuesday, but every Tuesday comes around so quickly...Ja it’s just the time factor that’s the only disadvantage that I can say (Melania, Interactive interview, November, 2012).

Besides having to teach, Mary and Calvin said how their extra-school responsibilities and duties constrained their participation in NICLE. Mary, who taught at a ‘farm school’, had the responsibility of transporting learners to and from their homes. She said that NICLE should start 30 minutes later to allow for time to take the “children to the bus stops”. Calvin who was a deputy principal and had administrative duties also explained that

...time becomes an issue...Like yesterday I was in a meeting in PE [Port Elizabeth]. Last week you saw me, you phoned me. I’m in a meeting ...I was on my way to a meeting. It can clash sometimes with NICLE and I don’t want it to clash with NICLE per se, because I missed out on the computer session (Calvin, Interactive interview, November 2012).

In the previous interview Calvin also expressed that the NICLE sessions’ time was itself inadequate. To him “two hours is not enough”. Arising from the interviews these teachers noted that *contact time* can inhibit teacher engagement. Wenger (1998, p. 175) explains such limitations within CoPs as the ‘bounded character of engagement’ which entails the “physical limits in time and space” as humans can “dispose of only a finite number of hours per day”. Similarly Wenger-Trayner and Trayner-Wenger (2011) note that “time is a challenge for communities, whose members have to handle competing priorities”. Both international and local teacher education literature also points out that the greatest challenge to successful staff development programmes is the unavailability of time to engage in professional work (Farmer et al, 2003; Grossman et al, 2001; Abdal-Haqq, 1996; Graven, 2005b; Adler & Reed, 2002).

As an attunement to this constraint Ruth had implicitly suggested that they be ‘relieved off’ their school duties when they participate in NICLE and this is similar to the “freed up time” approach, which is one of the strategies suggested by Abdal-Haqq (1996, p. 4) for creating time for teacher development. In relation to this, in its third year the SANC was paying for teachers to relieve and cover classes of NICLE-participating teachers. Thus one attunement to the time constraints is to seek relief teachers who help learners with school work when teachers engage in professional development activities.

9.3.2 Constraints relating to travel distance

The other most commonly-appearing challenge described by four of the sampled teachers was that they were inconvenienced by having to travel long distances from their schools to participate in NICLE fortnightly sessions. The distance of course increases travel time to sessions. Robert, Calvin and Edna had to travel 170km to attend NICLE sessions and pointed out that they were constrained by the travelling distance. In both interviews Robert had explained that “travelling was always challenging”. Similarly Calvin also said that his main constraint in attending NICLE was the distance they had to travel to participate in the CoP. Edna’s constraint explained that having to rely on other teachers for transport to attend NICLE sessions also showed another aspect of the transport challenge. Everton, who taught at a farm school and had to travel a total of 160km to and from their school to attend NICLE sessions, also commented how challenging it was to attend NICLE. On this constraint Everton said

...it’s the travelling for us, its heavy going. It makes a very long day. We get up early, we drive buses, we drive children and we get back here at 7 ‘O’ clock some nights (Everton, Interactive interview, November 2011).

The travelling distance was expressed in terms of adding to the time factor. Since transport money was given the expense of travelling did not emerge. Maths teacher education literature explains this challenge as the ‘dilemma of site’ from which staff development can take place—whether it can be district, university or school-based (Graven, 2005b, p. 214; Garet et al, 2001; Adler & Reed, 2002), with school-based programmes being convenient and most preferable for numeracy professional development initiatives (Askew et al, 1997; Ma, 2010). Closely related to this was Calvin’s suggestion in the first interview that NICLE sessions could be carried out at cluster school sites. In America such groups of schools who work collaboratively with teachers sharing knowledge, experiences and strategies together are

called school family, school network or networked learning communities (see for example Katz & Earl, 2010; Lieberman, 1995) and these are similar to the locally proposed professional learning communities (DHET, 2011a). Thus cluster-based professional learning communities could be one of the possible solutions to the distance and time for travel constraints. Locally Jita and colleagues have similarly argued that teacher clusters provide opportunities for effective professional development that encourages teacher interactions, trust and identity change (Jita & Ndlalane, 2009; Jita & Mokhele, 2012). However on the other side, participating across clusters maximises on guest expertise and allows for sharing across clusters in one district. Generally the travelling challenges arise from the tension of the site and closely relate to time constraints, and all these concern the aspect of convenience. Wenger (1998, p. 175) explains such constraints within CoPs as the ‘bounded character of engagement’ which entails the “physical limits in time and space”, as humans can “dispose of only a finite number of hours per day” and there are also “physiological limits” to the tasks and activities that each of us can be involved in.

9.3.3 Constraints related to exclusion of others from NICLE

A constraint cited by four of the sampled teachers relates to how NICLE can be *scaled up* to cater for larger teacher audiences whilst not compromising the benefits of smaller intimate maths teacher learning communities. Calvin, a Deputy Principal, remarked that NICLE catered only for a particular number of teachers, thus some of their teachers who were not part of NICLE were “missing out”. Calvin’s school had 13 foundation phase teachers who could have joined NICLE, unfortunately, the primary maths teacher initiative could not “accommodate all of” these teachers. As a result only six Grade 3 and 4 teachers from Calvin’s school were participating in NICLE. Pamela, who taught at the same school as Calvin, had also said that NICLE’s activities and its resulting benefits were limited to a few schools and suggested that “each and every school in the district should be part of this programme [so that] we excel in mathematics”. In relation to this, in the previous interview Pamela had also hinted that “even the farm schools, they want to be part of this programme”. Melania had wished the same

The thing is it would be nice if ...if more people would participate. More people could benefit from it, you know. More teachers. I know the teachers would like to go, but there’s no way that...that the whole staff could go...But it would be nice to have more people being able to participate. It would be nice if more people could benefit, because I know they would love to go (Melania, Interactive interview, November 2012).

Mary also suggested that the primary maths in-service CoP must “accommodate all the teachers”. The teachers’ wish for increasing and enlarging the NICLE so that it accommodates more teachers is taken up as a tension needing further interrogation in the concluding chapter. Closely related to this limitation is also the issue of sustainability, which concern the ability of such in-service CoP to be self-sustaining after the withdrawal of funding.

The teacher suggestion thus needs further research concerning the potential of ensuring that smaller teacher communities of practices can be reformulated into larger professional learning communities while still retaining their teacher learning benefits. Most importantly is how the learning ‘enablers’ noted by teachers above would be affected by larger CoPs and on the other hand there are logistical requirements and the need for more financial resources for larger communities. The teachers’ suggestions therefore needs further research pertaining to how CoP-informed teacher professional development initiatives can be *scaled up* to cater for larger teacher audiences whilst not compromising the teacher learning benefits of smaller maths teacher learning communities.

9.4 Conclusions

This chapter has looked into the second research question that relates to the activities, relations and forms of participation within the Community of Practice which enable or constrain evolving teacher numeracy identities and practices. Wenger et al’s (2002) structural fundamental elements of a CoP which relate to the social learning theory components, Wenger’s (1998) notions of engagement and relevant teacher education literature was used to interpret and understand teacher learning affordances and constraints within the primary maths teacher in-service CoP.

The study indicates that teachers participating in professional teacher learning *communities* mostly take-up into their maths classrooms key numeracy concepts, issues and approaches that relate to the primary maths *domain* presented by primary maths experts which are informed by research and theory that link *practices*, with teachers collaboratively and actively engaging in a range of activities that relate to *primary maths* classroom *practices*.

Teacher learning was said to be enabled in friendly CoPs that mutually respect teachers and regard them as professionals. Numeracy teacher identities and practices also evolve positively when teachers share classroom experiences, actively participate in the CoP and engage in

maths overlapping communities of practices. Such activities, relations and forms of participation improve primary maths teachers' knowledge and teaching practices.

Whilst the teachers felt challenged by the travelling distance and limited time to engage in professional work, they also provided attunements to these constraints, pointing to the need for further research pertaining to how teacher communities of practices can be *scaled up* to cater for larger teacher audiences whilst not compromising their learning benefits.

The following chapter investigates the last question and presents some of the research findings, interpreted through Bernstein's pedagogic identity model and Wenger's (1998) notion of alignment. I explain four-market related teacher identities, positions and practices in relation to the new CAPS curriculum and the ANA standardised tests. I also discuss how institutional and classroom contexts influence primary maths teacher identities and practices.

Chapter 10: Primary maths teacher identities and practices' alignment to national and other contextual factors

10.1 Introduction

In this final chapter of the study I interrogate the third research question which relates to how teachers' evolving identities and practices relate to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP. This chapter zooms out from NICLE to discuss and analyse the broader curriculum landscape and the sampled teachers' working contexts. The study takes interest in how the sampled teachers participating in NICLE relate their practices to the recent changes in South African primary maths education which saw the introduction of a common national curriculum framework - CAPS, and the roll out of compulsory annual national assessments across primary grades. The research findings indicate that most of the primary maths teachers say that their practices are positively influenced by the CAPS though they take different positions in relation to the ANA tests. For my analysis of teacher interviews and journal data I draw mainly from Bernstein (2000) and Tyler's (1999) four pedagogic identity categories and Wenger's (1998) notion of engagement. In Chapter 2 I analysed, using Bernstein (2000) and Tyler's (1999) pedagogic identity model, how the current changes in South African primary maths education projects and promotes a market teacher pedagogic identity. Informed by the theoretical framework and the empirical data I identify four market-oriented teacher positions that primary maths teachers take in relation to the recent local education changes. Besides educational changes empirical data also indicates that teacher identities and practices are also influenced by their classroom and school working contexts.

10.2 Primary maths teacher identities and positions in relation to recently introduced CAPS curriculum and the ANAs

The second part of this study interrogates the last research question using the third component of Wenger's (1998) three modes of belonging (alignment) and Bernstein's (2000) pedagogic identity model that generated four pedagogic identity positions (namely Conservative, Neo-Conservative, Therapeutic and Market). Relevant (maths) teacher education literature discussed in Chapter 4 is also drawn on to supplement the discussion. This part of the study

focuses and presents data gleaned from interview questions relating to the new curriculum. Two of these appeared in both the 2011 and 2012 interview schedules. These questions read

What is your opinion on the Annual National Assessment tests? Have they influenced your teaching at all?

Another group of questions included only in the 2012 interview schedule read

What is your opinion on the new CAPS document? Could you explain what type of primary maths teaching and learning practices are being encouraged by CAPS? Does the CAPS position fit with your own beliefs about how primary maths should be taught and enjoyed by learners?

I supplement the interview data with information from teacher journal entries.

This study takes particular interest in how the sampled teachers participating in NICLE relate to the current South African curriculum changes which saw a new curriculum (CAPS) implemented across primary grades in 2012. Additionally the current context has been characterised by the introduction of new national monitoring measures, whereby all South African primary learners undergo Annual National Assessments (standardised tests) to monitor and track their literacy and numeracy (mathematics) levels across Grades 1 to 6 and Grade 9 (DBE, 2011a; DBE, 2012). The study discusses how the sampled teachers view the CAPS curriculum and the ANAs and how this influences their primary maths teaching practices.

In the next section I categorise the primary maths teacher positions and identities as either being; Pure Market (Edna and Everton), Market-therapeutic (Melania), Critical-market (Robert) or Shifting market (Ruth, Pamela & Mary). In the analysis I grappled with identifying a pedagogic category that related to Calvin, however his description of practices combines features of Critical market and Pure Market which is not a clearly marked position. The diagram below illustrates the four teacher positions with the market pedagogic identity being in the centre as it is the officially promoted primary maths teacher pedagogic identity in curriculum documents as argued in Chapter 2.



Figure 10.1: Primary maths teacher positions in relation to local educational changes

The names of these subset teacher positions draw from both Bernstein’s four pedagogic identities and the empirical data. They are also informed by Bernstein’s (2000) suggestions that in education reform contexts the pedagogic identities can be available in “pure or mixed forms” (Bernstein, 2000, p. xii), “that they can be collaborations between these positions in the arena of the reform” (Bernstein, 2000, p. 67) and the identities can also “shift to other resources in the field” (Bernstein, 2000, p. 74). The argument presented herein draws from and extends my earlier work with Graven (Pausigere & Graven, 2013c; Pausigere & Graven, 2013d) and draws from feedback provided during conference presentations (Pausigere & Graven, 2013a; Pausigere, 2014).

The four primary maths teacher categories show the influence of the nationally promoted Market pedagogic identity (as argued in Chapter 2). However teachers position themselves differently within the projected official pedagogic arena. For example, whilst all the sampled teachers were positively aligned to the CAPS curriculum, they positioned themselves differently in relation to the ANAs. Thus the teacher’s categories indicate their alignment⁶⁶ to the CAPS position and their different responses to the ANA tests. It is such relations that lead all the teacher positions to bear the characteristics of Market identities. Besides curriculum

⁶⁶ I use the term alignment as implied in Wenger’s (1998) work.

changes, the research findings also indicate that primary maths teacher identities and practices are also influenced by institutional and classroom contexts as will be illuminated as my analysis of data unfolds.

10.2.1 Pure Market: Edna and Everton

This category is the typical market position described by Bernstein (1999; 2000) which Woods and Jeffrey (2002) refer to as ‘instrumental’ with some of its features relating to Morgan et al’s (2002, p. 456) “Examiner: using externally determined criteria” maths teacher orientation. I borrow the term ‘pure’ from Bernstein (2000, p. xii) who suggested that in education reform contexts the pedagogic identities can be available in “pure or mixed forms”. Thus both Edna and Everton’s positions reveal the classical pure market pedagogic identity category as they share a common teaching and learning orientation in relation to CAPS and the ANAs. These two teachers expressed that the new curriculum changes and national standardised assessments aligned with their views and influenced their maths teaching practices positively.

Everton expressed that she liked the CAPS for its content based focus, and its specification of content that ensured uniform national curriculum coverage. Thus she said

I like it. I very much like it. I like that fact that they are specifying what areas need to covered in what part of the year...basically they’ve just made it clearer exactly what is required of us and that is wonderful. It’s nice to know that when you get a child coming from another school, if they followed the CAPS document they should have covered everything that I have covered. We’re on the same page (Everton, Interactive interview, November, 2012).

She later went on to explain that because the CAPS was content based it allowed teachers to “follow the same content”. However Everton had some reservations on the new curriculum policy document which she suggested was “very prescriptive”. Everton’s reasons for nevertheless aligning to the CAPS curriculum are similar to the objectives contained in the educational policy documents of ensuring that there are similar interpretations of the curriculum across the country (DBE, 2011c). This relates with characteristic features of the market position which according to Tyler (1999) emphasise the centralised production of a national curriculum, with selected content and what constitutes knowledge. With regard to her teaching practices Everton expressed that the CAPS documents gave her “plenty of room...to extend the children and do extra and do more imaginative stuff”. For Edna the new curriculum promoted learner engaging approaches which she explained resonated with her

maths teaching and learning practices. Thus she explained that CAPS allowed for each learner to be treated

...as an individual and to always keep in mind that everybody has got a mind of his own. And you encourage the learners and give them time and opportunity to explore and reason. That is how I feel about teaching...You must always give the learners the chance and opportunity to work out things for themselves... (Edna, Interactive interview, November 2012).

Both Everton and Edna's teaching practices aligned with the CAPS subject guidelines which leave room for primary maths teachers to "sequence and pace the maths content differently from the recommendations" in the documents (DBE, 2011c, p. 32) and also emphasises learner-centred approaches (DBE, 2011b; DBE, 2011c). Such social teaching and learning approaches are embedded in the Market identity position (Bernstein, 2000; Tyler 1999) and these are similar to the promoted CAPS pedagogical strategies which Edna and Everton positively related with.

Both Everton and Edna expressed the fact that the ANAs were "quite good" and a "positive thing". Everton's maths teaching practices had been adapted to suit the ANAs as revealed in both interviews and in her journal entries. Thus in her teaching Everton said she would "expose" her learners to the "ANA problems put in a different way". For Everton there were no differences noted between the content of the ANAs and the mathematical content that the learners are supposed to be taught. Thus for her it was good for the "children to be exposed to them (ANAs) because they actually learn that this is nothing different to what they have learnt it is just put in a different way". Everton also explained that she used the ANA test items in compiling her end of term formal assessment tests. Thus in her 1st of March and 4th September 2012 journal entries she reported using the previous ANAs and ANA exemplar papers in preparing her classes' end-of term formal assessments. Everton also expressed that she would test in

... smaller chunks and then revising more, rather than just saying 'right we've done that now, the kids should know it'. And going to the next thing. Come back and remind them, come and do these ANA stuff papers with all different phases of the maths that they have done, rather than just work through to the end and just assume that they are going to remember everything (Everton, Interactive interview, November, 2012).

Everton's teaching practices including her assessments were incorporating the ANAs. Edna expressed that the fact that the ANAs were formal national external assessments, which evaluated teaching effectiveness, learner performance and informed teaching practices had inspired her (a grade R teacher) to take extra after school maths classes with the Grade 3s. She felt motivated and inspired by the ANAs to move and teach the higher primary grades. She explained

...that's why I actually went to Grade 3, when you get those results from the ANA you know it is something that you didn't set up for the kids. When you get those results it will give you time to do reflection, how can I do better, how can I go about to increase or improve the current results and things (Edna, Interactive interview, November, 2011).

In the second interview Edna had reiterated the importance of the formative evaluation and the monitoring function of the ANAs which provided her with

...feedback on yourself as a teacher because the ANA is not a paper set up by the school, you see, so there can also check. You can also rate yourself as a teacher. How did you go and how are your learners performing? Are they ready for external papers and things like that? (Edna, Interactive interview, November 2011).

Edna's utterances indicate that she accepted the formative, monitoring and control functions of the ANAs thus allowing for her maths teaching practices to be influenced by them. Everton openly expressed dovetailing her teaching practices to align with the national standardised tests. The two teachers' ANA related practices suggests the Market pedagogic identity position whose focus is on producing learners who have an "an exchange value in the market" (Bernstein, 2000, p. 69). Thus this teacher category buys into the importance and legitimacy of learner performances in national standardised tests as an indicator for monitoring learners and teachers. Besides focusing on the improvement of learner performance in annual national assessments, Edna and Everton's classroom practices were also said to actively engage learner's to understand maths concepts, as is envisaged by the CAPS which corresponds with the market pedagogic identity orientation. Thus Edna and Everton teaching practices "fit within broader structures" and "aligned their actions with the demands of the ...educational standards" and its "systems of styles and discourses" (Wenger, 1998, p. 174 & 180).

10.2.2 Market-therapeutic: Melania

Whilst Melania aligned herself with the national curriculum policy of the recently introduced (CAPS) (discussed below) she totally rejected the “inhumane approach” characterising the ANA tests. The market-therapeutic category selects moral (Ball & Wilson, 1996, p.155) and humanism (Woods & Jeffrey, 2002, p.92) values from both the market and the therapeutic positions. In terms of the primary maths knowledge supposed to be taught this position relates with the market features embedded in the CAPS curriculum whilst the rejection of universal standardised tests resonates with the therapeutic category. In other words, Melania’s position shows a combination of the therapeutic and market pedagogic identity category, something which Bernstein (2000) suggested is possible within education reform contexts. Of all the eight teachers Melania seemed the only one who rejected the ANAs as having any value and whose primary maths teaching practices were thus according to her unaffected by them.

Like most of the teachers Melania explained that the CAPS curriculum was ‘user-friendly’ and went on to express that “it was absolutely fine...straightforward...good”. She said she was “happy with the changes” made in this policy document. On the primary maths knowledge privileged in the new curriculum, Melania explained that “it goes around your problem-solving...your number values... patterns and fractions”. She explained that in terms of primary maths knowledge and teaching practices the new curriculum highlighted the need for learners

...to come up with answers and be able to explain their actions, you know explain the reasons when they’re doing their counting, when they are doing their number-values, when they are looking for number values, when they are looking for patterns and things. Being able to explain their reasons on how they’re doing. And their problem solving also integrating it into everything else, not giving them rigid methods... (Melania, Interactive interview, November 2012).

She also said the CAPS pedagogical approach, that entailed providing opportunities for learners to “experiment and ... to work out things for themselves” and to be “more hands-on”, enabled successful learning. As explained earlier in Chapter 2, and relating with Melania’s utterances, the CAPS curriculum also focused on improving learners’ number sense, problem solving and operational fluency and this corresponds with the market position which according to Bernstein (1999, p. 252; 2000, p. 71) “focus upon ‘basic skills’”.

Furthermore Melania's preferred pedagogical approaches aligned with the new curriculum which encouraged teachers to actively engage learners within the recommended mathematical concepts and discourse (DBE, 2011b; DBE, 2011). This relates with the market pedagogic position (Tyler, 1999; Bernstein, 1999). Melania's teaching practices concur with the humanism values described by Woods and Jeffrey (2002, p. 92) under which primary teachers "base their notion of 'good teaching' on child-centred principles with an emphasis on activity, discovery and curriculum integration..."

Though Melania preferred the CAPS to the earlier curriculum, she had reservations of the curriculum's emphasis on horizontal calculation over the vertical calculation method. She disliked the horizontal calculation approach for it "was not a natural way of adding up" and did not relate with high school mathematics calculation strategies.

In both interviews Melania expressed her indifferences to the ANAs with her primary maths teaching practices hardly influenced by the standardised tests. Melania outlined that her teaching approach had not been influenced by the ANAs as it was important to her that the "children have a well-rounded understanding and be well grounded" in key subject concepts. She side-lined the tests as "totally absurd" and explained that the learners were still "young", and put under enormous "pressure" through standardised testing. She also explained that the learners' "concentration span was so short" and the learners had "problems with reading" with the exam format being different to normal classroom practices. She stated that she preferred that the learners be "continuously assessed" during their schooling. In the first interview Melania also questioned the validity of the ANAs as the school results could be "inflated" as the test "papers are marked by the teachers themselves". Besides her criticism of this form of assessment Melania indicated how the ANAs influenced her teaching in terms of language and in-class learner questioning. Thus she said, "I think if (ANA) they did anything I realised how they are asking questions and I try to use the same type of language when I am working with numbers". In relation to this Melania had also journaled how the SANC homework books improved learners' reading of instructions, a skill she noted learners "struggled with in the ANA tests".

Aside from the language influence, Melania's primary maths practices were hardly influenced by the ANA tests. Her position in relation to the ANAs illuminates distinct aspects of the therapeutic teacher identity category which according to Bernstein (1999) has a

humanistic orientation and is dependent upon internal sense-making procedures. Melania's preferences are similar to Ball & Wilson (1996, p. 156) portrayal of primary teachers whose concern according to them, is for both the "knowledge endeavour... and the moral nature of the work". Melania's teaching and assessment practices with their focus on primary maths knowledge and the humanistic and moral concern led to a disregard for the ANAs.

Melania's position was said to be driven by the need to develop the learners' understanding of key mathematical concepts (aligned with CAPS) yet her discourse was non-aligned to national standardised assessment tests thus embedding both aspects of the market and the therapeutic identity positions which are concerned with teaching as a moral, humanistic and intellectual enterprise (Ball & Wilson, 1996; Woods & Jeffrey, 2002).

10.2.3 Critical market – Robert

This category combines the market (also called instrumental) pedagogic identity category and the critical alignment position described by Jaworski (2005; 2006). According to Jaworski (2005, p. 17) the critical alignment notion entails "questioning the demands of the existing norms of practice and starting to formulate new possibilities". This form of alignment also allows individuals to "act on their own understanding and to negotiate their place in the larger schemes of things" (Wenger, 1998, p. 181). Like all the sampled teachers Robert's primary maths practices aligned with the CAPS position however he had a 'critical' approach to the national external assessment policy.

Robert expressed that he was "very positive" about the primary maths teaching and learning practices promoted in the new CAPS. Robert highlighted that the new curriculum focused on cognitive learning, the levels of taxonomies and collaborative and co-operative learning which resonated with his practices. Of particular interest to him was the cognitively guided instruction approach which he had known about through "NICLE and his further studies" and which he said was

...a good way to approach problem-solving. Most of the teachers could understand what theory they are using. I think it's a good change there (Robert, Interactive interview, November, 2012).

According to Robert the CAPS reform, its informing theories, the resulting teaching approaches and primary maths knowledge emphasised aligned with his classroom practice:

I would support the CAPS initiative because that's what I always try to do. It's just you have your theoretical framework where you put all these actions that you can execute in the class (Robert, Interactive interview, November 2012).

One of the areas that the CAPS curriculum emphasised, which Robert highlighted in the interview as central to his practices, was the need for improving the learners' understanding of problem solving. Problem solving created a context for the development of higher order mathematical concepts (DBE, 2011b; DBE, 2011c). The new curriculum policy document encourages an active and critical approach to learning in which learners "do, talk, demonstrate and record" their mathematical thinking (DBE, 2011b, 9; DBE, 2011c). Robert's utterance in relation to his teaching practices, which encompassed collaborative and cooperative learning approaches, aligns with such a position and corresponds with Bernstein's (1999) Market pedagogic position whose features are evident in the CAPS document's focus on 'engaging learners' to develop the recommended mathematical concepts and discourse (DBE, 2011b & 2011c).

Whilst Robert's primary maths teaching and learning practices were said to align with the CAPS position, he took a critical stance on the ANAs. Robert appreciated the ANA tests for their control, monitoring and evaluation of the education outcomes (Bernstein, 1999), which relates to the national monitoring function assigned to the ANAs by the department of education (DBE, 2011a; DBE, 2012). Thus in the both interviews Robert expressed that the ANAs were a "good way of setting a benchmark. It's a good way of setting external papers". He went on to explain that the ANAs had

...a role to play. It highlights different things. Like for instance, on what level the learners are. It also brings out the challenges that our education system needs to address....It is a useful tool to measure performance I think (Robert, Interactive interview, November 2012).

Whilst standardised testing was an important accountability tool Robert said it had some weaknesses and challenges. In the first interview Robert expressed reservations on the validity of the ANAs as they were marked internally and did not cover all the aspects of the primary maths curriculum. He also suggested that exemplar papers must be provided, as is done with high school subjects, "where teachers are given a skeleton of sections and

subsections that include certain concepts learners will be tested”⁶⁷. Furthermore according to Robert the ANAs were “designed in such a way that context is often put aside” with learners also being unfamiliar with the assessment rubric. Given such challenges Robert suggested that the ANAs, at times,

...becomes a burden for the learners. Especially the amount of question they have to answer and even the amount of reading that goes into answering the questions (Robert, Interactive interview, November 2012).

Robert’s interview utterances show how he appreciated, questioned and formulated new strategies regarding standardised testing.

As a self-identified leader teacher, Robert had more agency and was decisive in his class and gave less power to the department. Given the accountability and monitoring function, and the challenges facing the ANAs, Robert took a critical approach to external assessment in relation to his teaching practices. Thus he said

...perhaps my experience is helping me out. I would be lying if I said I didn’t have experience, I think I would just be blindly lead, but as a leader teacher from Rhodes I have realised you can’t just be lead, sometimes you take leadership within mathematics and manage your teaching and know when to scale down and give an overview... (Robert, Interactive interview, November, 2011).

Thus Robert’s position and practices in relation to the standardised tests and the new curriculum suggest a Critical market position that reflectively aligned with the ANA tests whilst supporting and actively engaging learners in mastering fundamental maths concepts. The notion of ‘critical alignment’ informed the design of NICLE and is also mentioned in Chair documents as a key aspect of the promoted professional numeracy teacher identity (SANC, 2011; SANC, 2012).

10.2.4 Shifting-market: Ruth, Pamela and Mary

The word “shifting” is borrowed from Bernstein (2000, p. 74) who suggested that identities can “shift to other resources in the field”. Ruth, Pamela and Mary indicated this shifting market position. Their stated practices within the local primary maths education changes indicated both Market features and movements across the pedagogic identity categories.

⁶⁷ The first ANA tests did not have exemplar papers but these were introduced in the following year in 2012.

Basically these teachers explained that their practices were positively aligned to the new CAPS curriculum yet they all indicated experiencing tension in relation to the national assessments.

The three teachers expressed that their primary maths teaching practices related with the CAPS curriculum position, which they all described as ‘user-friendly’. Ruth also explained that the primary maths departmental documents were “very-detailed” and “logically sequenced” which to her was very “encouraging”. Similarly both Pamela and Mary commented that the policy document was easy for educators to interpret with Mary adding that it was “straight forward” with prepared lesson plans. These three teachers explained that the CAPS curriculum emphasised key numeracy concepts and knowledge as well as encouraging learner-centred pedagogical approaches. Thus for example Pamela said

They are encouraging that the mathematics class should be very friendly... There should be mental (maths) that should be done, there should be counting on a daily basis. There should be problem solving...number operations and relations. And that is the very best learning outcome for mathematics. For our learners to achieve anything through mathematics they should be able to count, they should know how to write, how to read numbers (Pamela, Interactive interview, November 2012).

Mary also outlined that the new primary maths subject guidelines encompassed everything required including “number concepts, data handling, geometry, space and shape. I mean it covers all the elements”. Mary also explained how the practical and concrete teaching approaches promoted in the new curriculum suited her pre-primary teaching practices. Similarly Ruth expressed that the CAPS emphasised

Real understanding using working from the practical to the abstract, and I am trying to relate to all the topics whether addition, or its problem solving or measurement...so I think as a one liner I would say giving practical experience, moving from the practical to the abstract, to further understanding of number...I think the CAPS document does well for the average and the whole group teaching situation... (Ruth, Interactive interview, November 2012).

The CAPS emphasis is on common and detailed subject guidelines that foreground key numeracy concepts such as numbers, mental maths, problem solving, geometry and data handling whilst encouraging practical and active learning (DBE, 2011b, 2011c). As discussed in Chapter 2 it thus relates with the Market pedagogic identity position.

Thus the three teachers' primary maths practices positively related with CAPS and resonated with the market position which is orientated towards teaching key disciplinary knowledge, has 'personalised practices' which manifest in learner centred approaches and has a common national curriculum framework that enables the homogenisation of educational practices, thereby creating indicators for efficiency (Bernstein, 2003; Tyler, 1999, p. 267).

In relation to the national standardised tests the teachers in this category explained that they experienced a tension. Thus they said their primary maths classroom practices were being both positively and negatively influenced by the ANAs. These teachers indicated both regard and a disregard for the annual national assessments with their identities shifting between different identity positions. Such tension is clearly illustrated by Pamela, who when asked if the ANAs influenced her teaching, said:

They haven't and also, we are forced to be... to, use ANA. I am sure for the next ten years in South Africa, so they said, they are not going to change it. Then I have got to adapt and teach according to ANA's styles (Pamela, Interactive interview, November 2012).

Pamela had suggested in the first interview that the ANA tests items should cover all the learning outcomes thus she said

It's my understanding that each and every question of ANA should have at least one of the learning outcomes in it so that those five learning outcomes will be covered in the paper⁶⁸ (Pamela, Interactive interview, November 2011).

Besides feeling compelled to teach to the tests and suggesting ways of strengthening the validity of the tests, in the first interview Pamela had highlighted that in teaching numeracy her concern were the "LOs with their assessment standards". She also explained and journaled on the numerous challenges associated with ANAs such as not considering the learners 'background', creating a frightening environment and not allowing teachers to read the tests questions for the Grade 3 learners. Pamela's utterances concerning her ANA position shows a primary maths teacher identity in tension.

Mary similarly expressed that while her perceptions of ANAs were informed by her daughter's and other teachers' ANA stories (as she teaches grade R) from these stories she had learnt that the ANAs didn't seem "very popular thing amongst some of the teachers" and

⁶⁸ The ANAs are written three months before the end of the school year thus they do not assess the whole year's work.

had unfamiliar terminology with learners “struggling to read instructions”. Beside her negative perception of the ANAs Mary expressed that if she was teaching the Grade 1 classes her practices would be positively influenced by the tests as she said

I mean if I was teaching grade 1, I don't think it would be a problem to write the ANAs. I mean I'd probably welcome it because I would like to see how we...how we are doing...I think I probably would because if I knew we were going to be rated I'd make sure. I'd probably want to work that extra mile (*sic*), you know, to get them sort of understand or try... (Mary, Interactive interview, December 2012).

Thus both Mary and Pamela's expression of their positions in relation to ANA indicates identities that shifted between the therapeutics' moral humanistic concern for learners and the pure-market's emphasises on standardised tests, which in Pamela's case extended to enabling learner's understanding of key learning outcomes.

On the other hand Ruth's practices in relation to the ANAs shifted across the three identity positions previously described in this chapter. Thus Ruth expressed the value of national assessments, the importance of teaching learners to understand key numeracy concepts and critically reflected on the ANAs. In both interviews Ruth had admitted that the ANA tests had positively influenced her numeracy teaching practices. She said she would ensure that her learners

...understand the system, because they are being assessed in a certain system and they need to be familiar with it.....they need a lot of revision and exposure to the format of the tests, they need time limit, they need all those things that formal assessment require... (Ruth, Interactive interview, November 2011).

To refocus her teaching Ruth expressed that she had made a “little revision booklet with all those ANA papers”. Ruth had also written on her 27-31 August 2012 journal entry that she “made revision ANA booklets”. Her other journal entries also show how her practices aligned with the ANA tests as she was “peer teach[ing] – using ANA revision booklets” and she would at times have a past exam ANA test paper “as a practice run” in which she motivated and rewarded her learners for their improvement on their previous ANA marks with a ‘fizzer’ (sweet). Besides her maths teaching practices being influenced by the ANAs, Ruth outlined some challenges with the national assessments such as learners having “difficulties in reading instructions” and not being used to its “format”. In relation to the former challenge Ruth suggested the need for some of the questions to be administered through “an oral test”. Whilst

Ruth indicated how the ANA tests positively and negatively influenced her maths teaching practice she critically aligned with the national assessments and expressed the need for balance and a dual focus on improving learner performance and the understanding of key numeracy concepts. Thus she said;

Personally I think it's better for them to understand the topic rather than do well in the tests but it's not my ultimate goal for them to fail in it, but to be able to do both would be the best I suppose (Ruth, Interactive interview, November 2011).

Ruth's primary maths teaching practices shifted between the pure market's emphasis on learner performance, the therapeutic and pure market's moral knowledge concern and the critical market's regard to reflective questioning of the status quo. Thus she argued for a dual focus that both ensured learners' mathematical understanding and doing well in the national tests.

Whilst Ruth's practices reflected aspects of all three market sub-categories, Mary and Pamela's positions moved across the pure market and market-therapeutic orientations. All the teachers indicated that their practices were being influenced by the ANA tests however the degree and extent of the influence differed. They also expressed the challenges and weaknesses of the ANAs and in the process both implicitly and explicitly expressed their humanistic and moral concern. Of the three teachers, Ruth went further and critically reflected on her position and in the process illustrated her view of the ideal primary maths teacher identity – one whose classroom practices ensures learners understand maths and raise standards (Hill et al, 2008), in education contexts characterised by standardised national assessments.

10.2.5 Combining different Market orientations – Calvin

Of the four teacher orientations that I have identified above this primary maths teacher position has no distinct category as it combines features of different pedagogic identities. This category arises from both Calvin's positioning in relation to the local primary maths educational changes and Bernstein's (2000, p. 67) suggestion that there can be "collaborations between these positions in the arena of the reform". Below I share data that shows Calvin's position in relation to the CAPS curriculum and the ANAs. His orientation suggests a combination of the Critical market and the Pure Market positions. Like all the sampled teachers in this study Calvin expressed how his practices positively related to CAPS

yet critically engaged with the ANAs and in the process explained their value, weaknesses and critically questioned the practices they promoted.

Calvin explained that his primary maths teaching practices resonated with the CAPS curriculum which specified content, concepts and teaching methodologies. Thus he explained that CAPS was much better (than the previous NCS)

...because teachers know exactly what they should teach. It's very specific and it's user-friendly. It gives much more scope to teachers. And there is examples of...if they talk about a concept, there is examples (Calvin, Interactive interview, November 2012).

Calvin also expressed that the content (e.g. 'numbers') that was specified by CAPS was better specified and integrated with other learning outcomes. With regard to this, Calvin explained that

...the learning statement is still 'numbers' but its 50% - goes to that. So they specify numbers the kids need to understand numbers to be able to...Data handling is numbers, so if he doesn't understand numbers he is going to struggle with data-handling. So if you make sure he understands then data handling, numeric patterns becomes easier. So 50% is LO 1. So in that they are very specific (Calvin, Interactive interview, November, 2012).

Calvin also outlined that the CAPS curriculum privileged "co-operative learning...investigative maths-based teaching...problem solving...CGI⁶⁹" and pedagogical approaches that reflected on the taxonomy levels. Calvin said his primary maths teaching practices related well with these learner-centred approaches which he had learnt during his further studies at RUMEP where they had learnt about "constructivism and co-operative learning". Calvin said his practices had been positively influenced by the CAPS curriculum's specification of key and fundamental numeracy concepts such as numbers, patterns, data handling and problem solving as well as its learner centred approaches. Calvin's engagement of learners in fundamental maths concepts resonates with Bernstein's (2000, p. 71) Market pedagogic position, which is orientated both towards "the intrinsic value of the discourse" and "transforms the regulative discourse". The transformation of the regulative discourse results in learner-centred or learner engaging practices.

⁶⁹ CGI refers to Cognitively Guided Instructions - a research-based teaching model in which teachers use their student's mathematical thinking as a basis for their classroom teaching (Fennema et al, 1996).

Calvin's position on the ANAs revealed a combination of the Market and Critical-market category features. Like the other teachers whose practices are inclined towards the market position Calvin expressed the value and importance of national assessments. Thus in both interviews he expressed that the ANAs were an essential learner baseline evaluation and a measure for teacher effectiveness. Regarding the latter he had said

I think ANA will become a reflection of you as a teacher even if you can't help it, but if they...if they look at results. 'Your result is not nice, so what is the problem?' (Calvin, Interactive interview, November 2012).

On the other hand Calvin highlighted the challenges and weaknesses of the ANAs which he said influenced his teaching practices negatively. Calvin expressed that the ANAs format in which learners had to "go through 13 pages" resulted in a "cultural shock to the kid". Calvin also mentioned that the ANAs "pressurised the teacher to make sure that [he] finishes the syllabus and what the kids know is a different story". Besides these negative aspects of the national standardised testing programme Calvin explained how he prepared learners for the test.

[I] concentrate on the exam papers and how they are asking questions and I try, when I do my tests, I try to ask my question in the ANA way. If I give assignments the questions are based on the way ANA is asking the questions... (Calvin, Interactive interview, November 2011).

According to Calvin the national tests forced teachers to teach to the ANAs rather than to teach at the learners' pace. Calvin expressed that he felt "forced" into a "teaching to the test" practice which he disagreed with. He said

...it's like in the olden days when you teach the child for the question paper and it shouldn't be like that. But they force you because at the end of the day you want the results to be pushed up (Calvin, Interactive interview, November 2012).

Besides the tension brought by the ANA for his teaching practices Calvin reflectively explained that he still felt the need to ensure that learners understand the basic mathematical concepts and thus would not rush through the syllabus. He said, the ANAs

...influence the way you try to make sure that a learner understands. You can say I don't care if I don't finish with my syllabus. The kid understands what he learnt so that in the next year he will be able, he has the basic knowledge for those things.... (Calvin, Interactive interview, November 2011).

Calvin's position in relation to the ANAs incorporated the Market position which encourages national standardised testing to measure the schooling system's efficiency (Tyler, 1999), yet he expressed humanistic and moral concern (Ball & Wilson, 1996; Woods & Jeffrey, 2002) for the learners and critically aligned with the ANAs and in the process was "questioning the demands of the existing norms of practice" (Jaworski, 2005, p. 17).

In Summary

In this part of the study I interrogated part of third research question that relates to, how teacher evolving numeracy identities and practices relate or align to the broader official pedagogic identities promoted nationally. Given the current South African primary maths education changes the study investigated how the sampled teachers relate to the new CAPS curriculum and annual national assessments. Whilst most of the primary maths teachers indicated that their practices are positively influenced by CAPS they however took different positions in relation to the ANAs. Their alignment to the new CAPS and the arising teacher positions relates well with the nationally promoted Market pedagogic identity. Interpreting the empirical findings using Bernstein (2000) and Tyler's (1999) pedagogic identity categories the study identified four teacher positions namely: pure market, critical market, market-therapeutic and shifting-market. The other teacher identity orientations combined different features of two of these categories.

In instrumental contexts of education change and curriculum reforms marked by a common national curriculum framework and universal standardised tests primary teachers are expected to guide learners to understand maths and raise standards (Hill et al, 2008). This position is illustrated and articulated by Ruth who ensures in her primary maths teaching practices that learners, "do both" – "understand the topic" and "do well in the test". In this position teachers have the dual responsibility of teaching key knowledge and having a moral and humanistic concern for their learners, as proposed by Ball and Wilson (1996). Above all in curriculum reform and education change contexts primary maths teachers as autonomous professionals need to 'critically align' (Jaworski, 2005; 2006) with education policy and so 'keep in mind' their mathematical moral obligation, whilst at the same time being concerned with their

learners' performances and the repercussions of their performance - a stance taken by Robert when he says his practices will not be 'blindly lead'. Robert's assertion relates with Wenger's (1998, p. 181) explanation that fitting and aligning within broader structures "can be blind and disempowering" – thus pointing to the need for critical alignment which entails "questioning the demands of the existing norms of practice and starting to formulate new possibilities" (Jaworski, 2005, p. 17). As described earlier in Chapter 6, this is indeed what was promoted in NICLE - that teachers should critically engage with education policies and curriculum documents.

Ruth and Everton's 2012 interview utterances portray CAPS as a 'very prescriptive' curriculum. Such over prescription of curriculum content according to Morgan (2005, p. 10) can erode primary teachers' professional autonomy and identity, leading to the "loss of ethical responsibility". Using Dowling's (1998) principles, Morgan (2005) argues that the over-specification of content and the concern with assessment leads to a focus on the *procedure* which distribute to learners and teachers 'dependent' voices rather than focusing on strategies that promote the *understanding, competences and reasoning* behind the mathematics. I will discuss in the conclusion chapter how local primary maths teachers may deal with such a tension and yet focus on teaching for conceptual understanding.

Having discussed how the sampled teachers relate to the broader national education changes I now explain how the working context, which comprises of the classrooms and school settings influences primary maths identities and practices.

10.3 Working context: classrooms and school settings

Local (Samuel, 2008; Ensor, 2001) and international studies (Day et al, 2006; Clandinin & Connelly, 1996; Marsh, 2002a) discuss how teacher identities are influenced by the school organisational culture as well as teachers' classroom relationships with pupils. The school organisational culture entails its visions, standards, departmental structures, school leadership, forms of relationships and interactions within a school set up. The teachers' utterances and some of their journal entries indicate that teachers' mathematical identities and practices are influenced by the school context and in classrooms during the maths teaching and learning process. The data presented here is gleaned from the 2011 interactive interview question 10 in which the sampled teachers were asked to explain how the school setting and

their school maths classes supported or constrained their teaching. Some of the information was also from related teacher utterances across a range of other questions. Such information will illustrate teachers' explanations on how their identities are influenced by the school and classroom level factors.

10.3.1 School setting or environment

Ruth, Calvin and Melania's interview utterances indicate how their school maths department at their respective schools influenced and affected their primary maths teaching practices. For Ruth and Melania who taught Grade 3 at a fee paying ex model C preparatory school, said their school maths department promoted their primary maths teaching. Thus it seems a relatively collaborative culture was promoted and existed in the school partly perhaps because the school is small. However whilst Ruth indicated how the school peer teacher culture enabled teacher learning she also expressed that such meetings, if held frequently, can restrict and inhibit the development of one's practices.

Ruth and Melania were 'direct-partners' who had daily classroom meetings on teaching with their school principal, who had "a passion for maths". They also explained that the principal gave them guidance and resources on teaching maths. Regarding this Ruth said

Our school principal gives us a lot of guidance. She is passionate about maths so she has given me various guidelines and our direct partner we work very-very closely together we have daily meeting...so yes I think within our peer group we support each other (Ruth, Interactive interview, November 2011).

Ruth went on to elaborate how their school had

...a tradition of teaching things in a particular way and they have very good results and not only in numeracy as well as in language ... in numeracy ... We have been given very specific instruction not just on how to teach but what to teach and what the...emphasise should be on...(Ruth, Interactive interview, November 2011).

Similarly Melania explained how their school's leadership, expectations, standards and her relationship with Ruth (the other Grade 3 teacher) promoted her teaching practices. Thus Melania said

Then my school principal, Mrs Mayor is also very good and she is a very good maths teacher and I also have got a lot of guidance resources...Well I think that everybody is on the same page...we work together we try and be uniform...we have got our own standards that we

aspire to, and I must say the Heritage standards have always been very high and very good and the children that have moved off from here and gone to other schools have all been top in Maths in the school that they have gone to... (Melania, Interactive interview, November, 2011).

Ruth and Melania explained the school mathematical vision and the collaborative teacher interactions as positively influencing their practices. Day et al (2006, p. 606) also noted that, “co-operation between colleagues in general and between those who teach the same subject influences teacher identities in a positive manner”. Regarding teacher collegiality, both local and international studies have also noted that same-grade level peer teaching encourages teachers to share knowledge and should be stimulated by the school leaders (Lieberman, 1995; Garet, et al, 2001; Taylor et al, 2013).

However on the other side, Ruth painted a different picture that revealed that her school’s peer teacher approach restricted both her teaching practices and professional autonomy. Ruth’s wording above of “being given specific instruction” to maintain a certain tradition indicates some tension within this ‘school vision’. The fact that the teacher meetings had to be held daily was to Ruth a “crazy” idea. She also felt that such a school arrangement was “autocratic”, “limited” her as it was “very prescriptive” “not negotiable” and deprived her of the “freedom to teach when it suits” her (Ruth, Interactive interview, November 2011). Ruth explained that her participation in NICLE had helped her cope with such a tension as it had instilled “confidence” in her enabling her to “listen to her own gut feeling”. The dilemma faced by Ruth shows that whilst teacher interactions should be promoted at school tension can also arise and the frequencies of such meetings should be reasonable and one should be aware of possible loss of teacher professionalism and autonomy, if power relations are unequal.

Calvin’s school maths department focused too much on administration that he said limited his learning as it was

...not very really vibrant enough. We have meetings but I don’t think we have enough meetings. There is not enough opportunity to develop. We usually talk about problems and how to solve the problems but we don’t give opportunity to really to talk about maths content it is more about admin stuff and things like that (Calvin, Interactive interview, November 2011).

Edna and Mary (both Grade R teachers and studying for a diploma in education) had requested from their school leadership to allow them to offer after school Grade 3 maths classes. The responses of their respective school leaders illustrate how school management can support or constrain initiatives that enable teacher learning and new identities and practices identities to evolve. Edna's school had accepted her request to offer after school Grade 3 maths classes and this she explained had enabled her practices to evolve in relation to her NICLE learning. On the other hand Mary's similar request at Martindale had "fallen on deaf ears" and this made it difficult for her "to put into practice what [she] had learned [at NICLE]". In this case it can be seen that the school leadership's response to teacher initiatives influence and affect the evolvement of teacher's identities and practices.

Another school contextual factor that can negatively affect primary maths teacher identities, highlighted in primary maths education, concern the low amount of teaching time that learners receive (Carnoy et al, 2011; Taylor, 2011). In relation to this challenge at her school Everton had said

I have a major constraint in the time table that we have and that is that we don't teach enough here. The children have a long break...a very long break and the periods all have to be contracted and shortened...the break is half an hour, we finish at quarter past one not halve past one, you know we have time taken off wherever we work. The bell goes late in the morning, there is a punctuality problem...it's a serious problem... (Everton, Interactive interview, November 2011).

Everton's utterance illustrate how Martindale school's time management restricted learners opportunity to learn as it resulted in not enough teaching and learning time of all school subjects. This could negatively influence the opportunity for take-up of primary maths teaching practices promoted in NICLE.

The above discussion has illuminated the way in which primary teachers in this study had their mathematical identities informed and shaped differently by their schools' visions/standards, expectations, time management approaches and school leadership relationships with teachers.

10.3.2 Attributes of learners in their classrooms

Another external factor that closely relates to the school context which can affect and influence primary maths teacher identity is the attributes of learners in their classes during the

teaching and learning process. Both Calvin and Edna explained and wrote about their classrooms' maths language challenges, thus Edna had written that she faced "a huge problem concerning languages at [her] school". Calvin also noted in his journal how "language was a big problem...as learners are isiXhosa speaking and [he] was Afrikaans speaking". As a solution to this challenge both teachers would find a learner in the class who could translate what they said in English or Afrikaans into isiXhosa. Thus Calvin said

So then, I, I will say can you maybe translate, someone in the class, what he is saying or what she was saying. They normally, I'm lucky, that in most classes there will be someone like that that will respond in English (Calvin, Interactive interview, November 2011).

Edna also employed a similar pedagogical strategy, during the interview she recalled one learner - Makane who could speak Afrikaans, English and isiXhosa and served as the teacher's translator as Edna would "ask her something in English, and then she will ask that person in Xhosa and then she will answer me back in Afrikaans". Thus both Ruth and Edna found opportunities within their maths classroom language challenges to improve their primary maths teaching practices, in terms of communicating with the help of their learners.

However for Ruth and Melania they noted that their learners' behaviour problems tended to hinder their evolving teaching practices. Thus Melania said "maybe the discipline I have got very difficult children so that is a bit of a problem". Ruth also explained how some of the learners' problems negatively affected the teaching and learning process

...you know the tragedy is that children who need most help are the ones who are difficult to help mainly because of their restlessness. I think the children's own, trying to cope with their own lives...we have many children whose fathers are totally absent, and there are turning their preteens, those are the limitations of individuals that come into the group (Ruth, Interactive interview, November, 2011).

Ruth and Melania's utterances indicate that learner behaviour negatively affects the teaching and learning process and this can inhibit or limit the evolvment of primary maths teachers' take-up of new practices and ways of being in the classroom.

Overall teachers explained that the school culture its vision, standards, expectation, within school teacher-management relationships, time management and the attributes of learners in their classroom can negatively or positively affect the evolution of their primary maths teacher practices and identities.

10.4 Concluding remarks

This chapter has interrogated the last research question of the study that relates to how teacher evolving identities and practices relate to the broader official pedagogic identities promoted nationally and to other contextual factors external to the CoP, using the alignment component (Wenger, 1998) and Bernstein's (2000) pedagogic identity model generated four teacher categories. Given the current local primary maths education changes the study identified four market-related teacher categories. These positions show that most of the primary maths teachers' practices and identities are aligned to, and positively influenced by, the new CAPS curriculum though they take different positions in relation to the ANAs. Besides educational changes, the research findings also indicate that primary maths teacher identities and practices are also influenced by their classroom and school working contexts. In Chapter 11 I discuss the main findings, contributions and limitations of this study and suggest recommendations and avenues for further research.

Chapter 11: Conclusions

The study investigated primary maths teacher learning and how their identities and practices evolve in relation to participation in a CoP-informed in-service teacher education programme. It also explored activities, relations and forms of participation within the CoP which enable and constrain teacher learning, evolving identities and practices. This exploration was supplemented with an analysis of how teacher evolving identities and practices relate to the broader official curriculum discourse and to other contextual factors external to the CoP.

Interpreting the key data themes that emerged from the teacher utterances and their learning stories - *stelos* and drawing from the situative-identity theoretical framework (Lave; 1996; Sfard & Prusak, 2005; Lave, 1993b), the study dialectically explained the nature of the primary maths teachers' learning, participation and transformation experiences through participation in NICLE using the synonyms *reinvigoration*, *remediation* and *activation* and relating the semantics to the teachers' mathematical histories and identities. Also informed by Wenger's (1998) CoP theoretical elements and the empirical findings the study explained the processes through which numeracy teacher identities evolve in relation to participation in an in-service Community of practice as '*insiding*' and '*outcropping*' teacher identity trajectories.

Theoretically the teachers' utterances (verbs and phrases), from which emerge the synonyms *reinvigoration*, *remediation* and *activation*, support the claim that the process of 'transformation and change' in identity happens through participation in CoPs (Lave, 1993a, p. 30; Wenger, 1998; Rogoff, 1995). Thus the synonyms explain, through the social learning perspective, the dialectical transformation and identity changes experienced by teachers participating in a primary maths teacher CoP professional development initiative. Evidence, from the teacher learning stories - *stelos* showed that participation in the primary maths professional learning community, led to change and transformation of the teachers' identities towards more positively valued and stronger primary maths teacher identities and also referred to a shift of the teachers' mathematical understanding and their classroom teaching practices. The synonyms also *provide a language* to describe primary maths teaching 'learning mechanisms' within Communities of Practice (Lave, 1996, p. 157). Thirdly the synonyms expressed and captured the learning of the eight sampled teachers participating in the in-service programme and these *connect* with their mathematical learning experiences,

histories and trajectories. Thus from a socio-cultural perspective the synonyms provide a way to descriptively capture the transformative nature of CoP.

Discussing and analysing qualitative data from the empirical field using CoP's concepts (Wenger, 1998; Wenger et al, 2002) revealed that participating in professional teacher learning *communities* presented by primary maths experts (and focusing on *the primary maths domain's* key concepts and issues, informed by research and theory that link classroom *practices* with teachers collaboratively and actively engaging in a range of activities that relate to *teaching and learning practice*) enable evolving numeracy identities and practices. Teacher learning is also enabled by the ethos of NICLE practice that promoted friendly relations among teachers, project leaders and guest speakers with an emphasis on 'mutual respect' where teachers are regarded as professionals. Numeracy teacher identities and practices also evolved positively when teachers shared classroom experiences, actively participated in the CoP and engaged in maths overlapping communities of practices. According to all the sampled teachers, such activities, relations and forms of participation strengthened their mathematical understanding and teaching practices. On the other hand the study also indicated that teachers felt constrained by the travelling distance and limited time to engage in professional work. Teachers also commented on a need for more teachers from their own schools and from neighbouring schools to participate in the program. These raise the tension of how to scale-up maths professional development initiatives. This also relates to the issue of sustainability, which is about how such a model of professional development can continue over time after the withdrawal of funding.

Drawing mainly from Bernstein's (2000) pedagogic identity model, that generated four pedagogic identity orientations, the study identified four market-related teacher positions which showed that most of the primary maths teachers' practices and identities were aligned to and were positively influenced by the new CAPS curriculum - though they took different positions in relation to the standardised Annual National Assessments. Besides the influence of broader educational changes the empirical data also indicated ways in which teachers' classroom and school working contexts influenced their learning, evolving identities and practices.

This study makes a theoretical contribution through its complementary use of Bernstein's (2000) model of pedagogic identity and Tyler's (1999) interpretation of pedagogic identity positions, as a function of classification and framing, to analyse the officially projected South

African primary maths teacher identities and links these to the ‘educational knowledge code’ properties (Bernstein, 1971). The study also draws from the model to interpret how local teachers relate to the local and broader primary maths education changes or curriculum reform policies. The findings point to potential value in further research that uses this theoretical model to enable understanding of other school subjects’ envisaged identities and to comparatively analyse the officially projected and promoted teacher pedagogic identities in different countries. Bernstein’s (2000) pedagogic identity model, and its elaboration by Tyler (1999), thus provide theoretical and analytical tools to interrogate macro educational changes and connect these to the micro teaching and learning processes and teacher identities.

Through the methodological, empirical and theoretical orientations the study shows that the sampled primary maths teacher identities are transformed and influenced by a tripod of key aspects: i) by participation in teacher CoP professional development programmes, ii) by their personal maths learning experiences and their historical learning trajectories, and iii) by the official broader education changes or curriculum reforms and their school working contexts. Thus the data across this thesis, captured in the learning stories-*stelos* (in Chapter 7 and 8) of teacher learning and identity transformation has powerfully illuminated the influence of, and complex interconnectedness between, the NICLE CoP-promoted identities (Chapter 6 and 9), teaching and school contexts (Chapter 10) and the officially projected pedagogical identity (in Chapter 2 and 10). The PMTI of the sampled teacher is seen as constituted by these three key components. Figure 11.1 diagrammatically represents the core aspects of the sampled Primary Maths Teacher Identity.

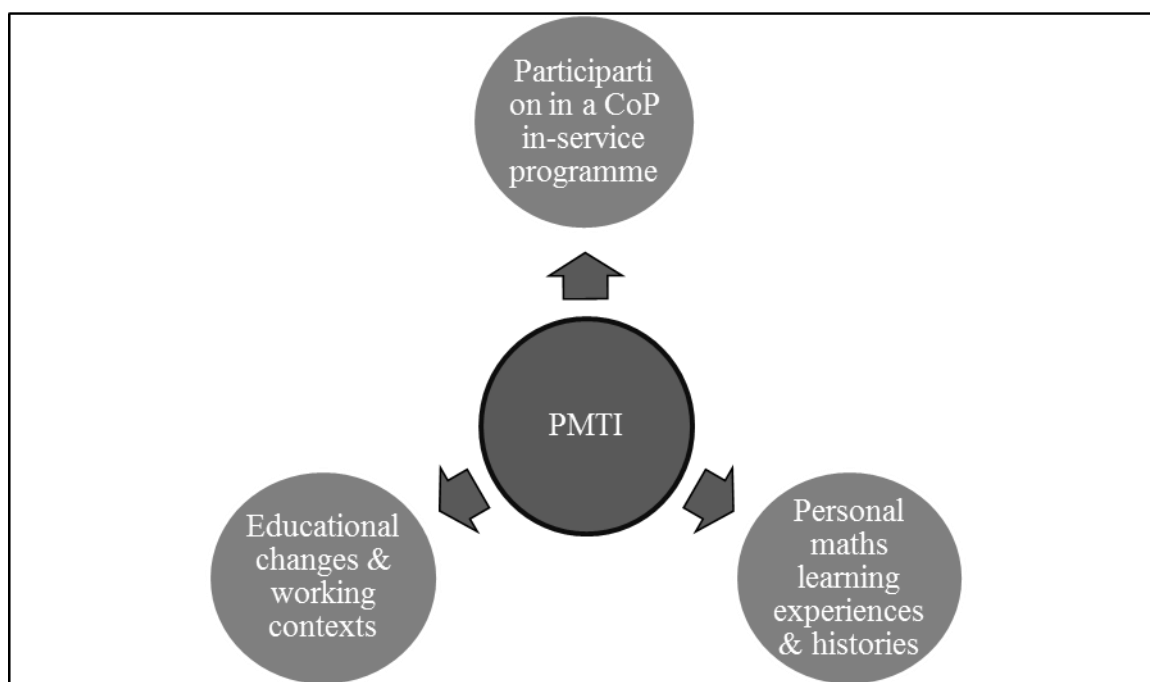


Figure 11.1: The core constituents of the sampled Primary maths teacher identity

In light of the study's findings I tentatively make the following recommendations for the South African primary maths in-service teacher education policy and practices. Rich qualitative data from the empirical field indicates that participating in a primary maths in-service community of practice has potential to transform primary maths teacher identities and in the process improve their understanding of key primary concepts and classroom teaching practices. This concurs with local and international research in maths teacher education which cites professional teacher learning communities as a means of enabling successful teacher learning (Little et al., 2003; Adler, 2000; Matos, 2009; Farmer et al, 2003; Graven, 2004; Graven 2012; Brodie, 2013).

Recent local in-service teacher education policies are promoting the establishment of professional teacher learning communities where teachers collectively participate and learn together with knowledgeable colleagues (DHET, 2011a). Based on my findings in this study I would suggest that envisaged district level teacher learning communities be structured to accommodate a community of practice type model which includes the invitation of motivating and expert guest presenters whose work is informed by current research in a way that links theory with local conditions of classroom practice. However most importantly such engagement must position teachers as experienced professionals who collaboratively and actively engage in these professional activities in relationships of trust and mutual respect.

Jita and Ndlalane (2009) similarly argue that the formations of clusters and communities do not, in and of themselves, result in positive teacher learning if such an ethos is absent. Furthermore the domain of mathematics should be foregrounded to enable rich teacher learning in terms of key aspects of the domain and the teaching of the domain. Local universities can play a role in linking professional learning communities and teacher education experts.

In line with the envisaged professional learning communities, and in the light of the processes through which the numeracy teacher identities evolved, it would seem sensible for the districts to both encourage and draw on school and teacher ‘leaders’ (those whose identities are ‘outcropping’ into leadership roles, as was the case for several teachers in NICLE). In this study I have illuminated how ‘outcropping’ identities can collectively work with ‘insiding’ teacher identity trajectories in professional learning communities to share knowledge, experiences and strategies and improve their practices. Such outcropping teacher trajectories should be supported to establish and take leadership roles in school or district learning communities at cluster level and lead or facilitate sessions so as to be sources and catalysts of other teachers learning in terms of the domain, identities and practices. This could be one possible avenue of overcoming the challenge of sustainability.

However whilst there is much potential and need for professional CoPs such as NICLE, as indicated by all teachers sampled, and by the broader context of poor mathematical performance and low teacher morale outlined in the first two chapters, there is an urgent need for further research pertaining to how such CoPs can be *scaled up* or adapted to cater for larger teacher audiences or for mainstream teacher education whilst not compromising the benefits of smaller intimate maths teacher learning communities. Besides scalability there is also the issue of sustainability. In relation to the former challenge on-line or virtual communities are one possibility worth exploring and NICLE and the SANCP invested in the development of a strong online system of support through a website, Facebook page and e-mail newsletter as well as cell phone connectivity. However with high speed internet connectivity still being expensive and not available in most schools (including NICLE schools) there are limitations to this.

There is however also a theoretical tension in scaling-up CoPs as initial conceptualisation of the theory was based on relatively small number of participants or learners (if we consider the

Liberian tailors, midwifery exemplars, nondrinking alcoholics and navy quartermasters) (Lave & Wenger, 1991). Furthermore smaller maths teacher CoP professional development models are manageable and allow for closer and more intimate interaction which was reported by several teachers as key to enabling and supporting learning. There are also logistical requirements and the need for more financial resources for larger communities. In rescaling CoPs the question therefore arises of how the learning benefits and enablers noted by teachers may be affected by larger communities. Perhaps the question is: How large is too large and what changes as a community gets bigger? On the other hand there are larger professional learning communities that cater for a larger maths teacher audience such as professional associations (e.g. AMESA). However I have not come across any research focused on the nature of teacher learning through participation in these larger communities. There is thus need for further research pertaining to how such teacher professional development organisations, perhaps including unions, can be conceptualised to cater for in-service teacher development needs and supplement and support local in-service teacher learning without compromising quality learning opportunities.

The study also leads me to suggest, given the market-instigated changes and reforms in local primary maths education (marked by a common national curriculum framework and a focus on improving learner performance in standardised annual national assessments) that primary maths teachers as autonomous professionals need to ‘critically align’ (Jaworski, 2005; 2006) with education policy, and so ‘keep in mind’ their mathematical intellectual-moral obligation (Ball & Wilson, 1996; Ball, 1993). The notion of critical alignment can be encouraged and promoted in schools, at cluster level and within the envisaged professional learning communities.

In the thesis I have argued that it is important to note that in instrumental contexts of education change the over-prescription of curriculum content can erode primary teachers’ professional autonomy and identity (Morgan, 2005). Morgan (2005) argues that the over-specification of content and the concern with assessment leads to a focus on the *procedural aspects* which distribute to learners and teachers ‘dependent’ voices rather than focusing on strategies that promote the *understanding, competences and reasoning* behind the mathematics. Several teachers in this study expressed a tension in relation to balancing these needs. In this respect I would suggest caution for the emphasis and faith in the Annual National Assessments as a key driver for the improvement of mathematical learning implied

in the Foundations for learning campaign (DOE, 2008). Several teacher utterances, shared in this study, indicate a range of possible unintended consequences of such national assessments including the large amount of time spent preparing learners for the ‘tests’ (for example: practicing exemplar ANAs can take up to 6 weeks of teaching time, see Graven & Venkat, 2013). Several teachers expressed a dilemma of ‘teaching to the test’ rather than teaching for conceptual understanding. If this is the case more broadly across the province or country then perhaps the ANAs could be restricted only to exit level grades of each school phase, that is Grade 3, 6 and 9 and not to all primary grades as is the current situation.

The study mainly reports on data and information gathered from interactive interviews, teacher journal dairy entries, through observations and document analysis. Several researchers have similarly focused on interviews (Woods & Jeffrey, 2002; Morgan et al, 2002; Lerman, 2012a; 2012b; Brown & McNamara, 2011) and document analysis (Morgan, 2005; Parker, 2006; Johansson, 2010; Graven, 2002b) rather than through classroom observations when researching learning particularly from an identity perspective. The study’s findings however could have been strengthened by observing the sampled primary teachers’ maths lessons. However in this limitation also lies the strength of this study in that it has allowed a detailed and thick rich description and analysis of teacher descriptions and explanations of their learning and experiences. Even in cases of similar research, where classroom observations were used as part of a multi-method strategy for accessing the nature of teacher learning and identity change, the contribution of this aspect was secondary to interview data (e.g. Graven, 2002a) and this classroom observational data was not drawn on in subsequent publications emanating from the study. However, since the SANC project has gathered video recordings of the teachers in my study (as part of the NICLE program), post-doctoral research could interrogate this data.

Though my description of NICLE learning experiences of teachers with valued maths histories and identities as reinvigoration cannot be generalised for teacher learning within CoPs or other professional development programmes, the study is generative of rich insights into the nature of teacher learning and enablers and constraints to learning. While my study pointed to primary teachers with histories of weak mathematical identities becoming *remediated* and new mathematical identities *activated* through participation in NICLE, the extent to which this may be the case for teachers with weak mathematical histories in other communities, with a similar learning design and ethos, would need further research given the small number of teachers in my study. Thus further research with a larger number of

participating teachers would be needed to see whether these synonyms resonate with other primary maths teachers with negative histories participating in similar programmes. Thus my sample of teachers with devalued identities is too small to allow for generalisations and also the findings pertaining to teacher participation and learning experiences are limited to primary maths teacher learning and identities. This said my study has been richly generative of insights and the resonance of my study with those who read it will speak largely to the value of the study and its possible contributions.

This study provided rich and in-depth explorations on the dialectical transformation and identity changes experienced by teachers participating in a primary maths teacher in-service CoP. It also discussed and analysed the processes through which these numeracy teacher identities evolve and activities, relations and forms of participation that afford or constrain teacher learning. Finally it explained how the broader educational changes and school working context influence teacher identities and practices. This study thus illuminated the teacher learning-transformative power of a primary maths teacher in-service CoP within the interplay of personal maths learning experiences and the broader educational landscape.

REFERENCES

- Abdal-Haqq, I. (1996). *Making Time for Teacher Professional Development*. Washington DC: ERIC Clearinghouse on Teacher and Teacher Education.
- Adler, J. (1998). Light and Limits: Recontextualising Lave and Wenger to theorise knowledge of teaching and of learning school mathematics. In A. Watson (Ed.), *Situated Cognition and the Learning of Mathematics* (pp. 161-177). University of Oxford: Centre for Mathematics Education Research University of Oxford Department of Educational Studies.
- Adler, J. (2000). Social practice theory and mathematics teacher education: a conversation between theory and practice. *Nordic Mathematics Education Journal (NOMAD)*, 8(3), 31-53.
- Adler, J., & Reed, Y. (Eds.). (2002). *Challenges of Teacher Development: An investigation of take-up in South Africa*. Pretoria: Van Schaik Publishers.
- Andrade, A. D. (2009). Interpretive Research aiming at theory building: Adopting and adapting the Case Study Design. *Qualitative Report*, 14(1), 43-60.
- Askew, M., & Brown, M. (2003). *How do we teach children to be numerate?* London, King's College: British Education Research Association's Professional User Review.
- Askew, M., Brown, M., Rhodes, V., William, D., & Johnson, D. (1997). *Effective teachers of numeracy*. London: King's College, University of London.
- Askew, M., Venkat, H., & Matthews, C. (2012). Coherence and consistency in South African primary mathematics lessons. In T. Tso (Ed.), *36th Conference of the International Group for the Psychology of Mathematics Education Opportunities to learn in mathematics education. II*, pp. 27-34. Taipei, Taiwan: IPME.
- Ball, D. L. (1993). With an Eye on the Mathematical Horizon: Dilemmas of Teaching Elementary School. *The Elementary School Journal*, 93(4), 373-397.
- Ball, D. L. (1996). Teacher learning and the mathematics reforms. *Phi Delta Kappan*, 77(1), 500-508.
- Ball, D. L., & Cohen, D. K. (1999). Developing Practice, Developing Practitioners: Towards a Practice-Based Theory of Professional Education. In G. Sykes, & L. Darling-Hammond (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3-32). San Francisco: Jossey Bass.
- Ball, D. L., & Even, R. (2009). Strengthening Practice in and Research on the Professional Education and Development of Teachers of Mathematics Teachers. In R. Even, & D. L. Ball (Eds.), *The Professional Education and Development of Teachers of Mathematics, The 15th ICMI Study* (Vol. 11, pp. 255-260). Springer.
- Ball, D. L., & Wilson, S. M. (1996). Integrity in Teaching: Recognising the Fusion of the Moral and the Intellectual. *American Educational Research Journal*, 33(1), 155-192.
- Beauchamp, C., & Thomas, L. (2009). Understanding teacher identity: an overview of issues in the literature and implications for teacher education. *Cambridge Journal of Education*, 39(2), 175-189.

- Bell, J. (1989). *Doing your research project*. Buckingham: Open University Press.
- Bernstein, B. (1971). On the classification and framing of educational knowledge. In M. F. Young, *Knowledge and Control: new directions for the sociology of education* (pp. 202-232). London: Collier Macmillian.
- Bernstein, B. (1975). *Class, Codes and Control Volume 3*. London: Routledge & Kegan Paul.
- Bernstein, B. (1995). A Response. In A. R. Sadovnik (Ed.), *Knowledge and Pedagogy: The Sociology of Basil Bernstein* (pp. 385-424). London: Ablex Publishing.
- Bernstein, B. (1999). Official knowledge and pedagogic identities. In F. Christie (Ed.), *Official knowledge and pedagogic identities. Pedagogy and the Shaping of Consciousness* (pp. 246-261). London: Continuum.
- Bernstein, B. (2000). *Pedagogy, Symbolic Control and Identity Theory, Research, Critique* (Revised ed.). New York: Rowman & Littlefield Publishers.
- Bernstein, B. (2003). Social Class and Pedagogic Practice. In B. Bernstein, *The Structuring of Pedagogic Discourse, Voume IV: Class, Codes and Control* (pp. 63-93). London: Routledge.
- Bernstein, B., & Solomon, J. (1999). Pedagogy, Identity and the Construction of a Theory of Symbolic Control: Basil Bernstein questioned by Joseph Solomon. *British Journal of Sociology of Education*, 2(20), 265-279.
- Best, J. W., & Kahn, J. (2006). *Research in Education* (10th ed.). London: Allyn and Bacon.
- Bishop, J. P. (2012). "She's Always Been the Smart One. I've Always Been the Dumb One": Identities in Mathematics Classroom. *Journal for Research in Mathematics Education*, 43(1), 34-74.
- Boaler, J., & Greeno, J. M. (2000). Identity, Agency, and Knowing in Mathematics. In J. Boaler (Ed.), *Multiple perspectives on Mathematics Teaching and Learning* (pp. 171-200). London: Ablex Publishing.
- Borko, H. (2004). Professional Development and Teacher Learning: Mapping the terrain. *Educational Researcher*, 33(8), 3-15.
- Botha, M. (2012). *Sustaining the professional identity of beginning teachers in early mathematics, science and technology teaching*. University of Pretoria. Pretoria: Unpublished doctoral dissertation.
- Brodie, K. (2013). The power of professional learning communities. *Education as Change*, 5-18.
- Brown, A. L., & Campione, J. C. (1990). Communities of Learning and Thinking, or A Context by Any other Name. In D. Kuhn (Ed.), *Developmental Perspectives on Teaching and Learning Thinking Skills* (pp. 108-126). Basel, Karger: Contributing Human Development.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, 18(1), 32-42.
- Brown, T., & McNamara, O. (2011). *Mathematics Teaching and Identity: Identity and identifications*. London: Springer Science + Business Media.

- Cain, C. (1991). Personal Stories: Identity Acquisition and Self-Understanding in Alcoholics Anonymous. *Ethos*, 19(2), 210-253.
- Carnoy, M., Chisholm, L., Addy, N., Arends, F., Baloyi, H., Irving, M., et al. (2011). *The process of learning in South Africa: The quality of Mathematics teaching in North West province*. Pretoria: Human Sciences Research Council.
- Carraher, T., Carraher, D. W., & Schliemann, A. D. (1985). Mathematics in the streets and in schools. *British Journal of Developmental Psychology*, 3, 21-29.
- Chirema, K. (2006). The use of reflective journals in the promotion of reflection and learning in post-registration nursing students. *Nurse Education Today*, 27, 192-202.
- Chisholm, L., Lubisi, C., Mahomed, H., Malan, B., Muller, J., Ndhlovu, T., et al. (2000). *A South African Curriculum for the 21st Century: Report of the Review Committee on Curriculum 2005 presented to the Minister of Education*. Pretoria: Ministry of Education.
- Clandinin, D. J., & Connelly, F. M. (1994). Personal Experience Methods. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 413-427). Thousand Oaks, CA: Sage.
- Clandinin, J., & Connelly, M. (1996). Teachers' Professional Knowledge Landscapes: Teachers Stories. Stories of Teachers. School Stories. Stories of Schools. *Educational Researcher*, 25(3), 24-30.
- Cochran-Smith, M., & Lytle, S. L. (1999). Relationships of Knowledge and Practice: Teacher Learning in Communities. *Review of Research in Education*, 24, 249-305.
- Cohen, L., Manion, L., & Morrison, K. (2010). *Research Methods in Education* (6 ed.). New York: Routledge.
- Connelly, M. F., & Clandinin, D. J. (1990). Stories of Experience and Narrative Inquiry. *Educational Researcher*, 19(5), 2-14.
- Corbin, J., & Morse, J. M. (2003). The Unstructured Interactive Interview: Issues of Reciprocity and Risks when Dealing with Sensitive Topics. *Qualitative Inquiry*, 9, 335-354.
- Cunliffe, A. N. (2004). On Becoming a Critically Reflective Practitioner. *Journal of Management Education*, 28, 407-426.
- Day, C., Kington, A., Stobart, G., & Sammons, P. (2006). The personal and professional selves of teachers: stable and unstable identities. *British Educational Research Journal*, 32(4), 601-616.
- DBE. (2010). *The status of the language of learning and teaching (LOLT) in Schools: A quantitative overview*. Pretoria: Department of Basic Education.
- DBE. (2011a). *Annual National Assessments: A guideline for the interpretation and use of ANA results*. Pretoria: Department of Basic Education.
- DBE. (2011b). *Curriculum and Assessment Policy Statement (CAPS): Foundation Phase Mathematics, Grades 1-3*. Pretoria: Department of Basic Education.

- DBE. (2011c). *Curriculum and Assessment Policy Statement (CAPS): Intermediate Phase, Grades 4-6*. Pretoria: Department of Basic Education.
- DBE. (2012). *Report on the Annual National Assessments 2012: Grades 1 to 6 & 9*. Pretoria: Department of Basic Education.
- DHET. (2011a). *Integrated Strategic Planning Framework for Teacher Education and Development in South Africa, 2011-2025*. Pretoria: Department of Higher Education and Training.
- DHET. (2011b). *National Qualifications Framework Act (67/2008): Policy on the Minimum Requirements for Teacher Education Qualifications*. Pretoria: Department of Higher Education and Training.
- DOE. (1997a). *Foundation Phase Policy Document (Grades R to 3)*. Pretoria: Department of Education.
- DOE. (1997b). *Intermediate Phase Policy Document (Grades 4 to 6)*. Pretoria: Department of Education.
- DOE. (1997c). *Curriculum 2005: Lifelong learning for the 21st century*. Pretoria: National Department of Education.
- DOE. (2000, February 4). *Norms and Standards for Educators*. Pretoria: Department of Education.
- DOE. (2002a). *Revised National Curriculum Statement Grades R-9 (Schools) Overview*. Pretoria: Department of Education.
- DOE. (2002b). *National Curriculum Statement Grades R-9: Parents' Guide*. Pretoria: Department of Education.
- DOE. (2002c). *Revised National Curriculum Statement Grades R-9 (Schools) Mathematics*. Pretoria: Department of Education.
- DOE. (2003). *Revised National Curriculum Statement Grades R-9 (Schools), Teacher's Guide for the Development of Learning Programmes*. Pretoria: Department of Education.
- DOE. (2007). *National Curriculum Statement; National Policy on Assessment and Qualifications for Schools in the General Education and Training Band*. Pretoria: Department of Education.
- DOE. (2008). *Foundations For Learning Campaign*. Pretoria: Department of Education.
- Dos Santos, M. P., & Matos, J. P. (2008). The Role of Artefacts In Mathematical Thinking: A Situated Learning Perspective. In A. Watson, & P. Winbourne (Eds.), *New Directions for Situated Cognition in Mathematics Education* (Vol. 45, pp. 179-204). Springer.
- Drake, C., Spillane, J. M., & Hufferd-Ackles, K. (2001). Storied identities: teacher learning and subject-matter context. *Journal of Curriculum Studies*, 33(1), 1-23.
- Ensor, P. (2001). From Preservice Mathematics Teacher Education to Beginning Teaching: A study in Recontextualizing. *Journal for Research in Mathematics Education*, 32(3), 296-320.
- Ensor, P., & Galant, J. (2005). Knowledge and pedagogy: sociological research in mathematics education in South Africa. In R. Vithal, J. Adler, & C. Keitel (Eds.), *Researching*

- mathematics education in South Africa; Perspectives, practices and possibilities* (pp. 281-306). Cape Town: HSRC.
- Farmer, D. J., Gerretson, H., & Lassak, M. (2003). What teachers take from professional development: Cases and implications. *Journal of Mathematics Teacher Education*, 6, 331-360.
- Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, V. R., & Empson, S. B. (1996). A Longitudinal Study of Learning to Use Children's Thinking in Mathematics Instruction. *Journal for Research in Mathematics Education*, 27(4), 403-434.
- Fetterman, D. M. (1997). Ethnography. In L. Bickman, & D. J. Rog (Eds.), *Handbook of applied Social Research methods* (pp. 473-504). London: Sage Publications.
- Fleisch, B. (2008). *Primary education in Crisis: Why South African schoolchildren underachieve in reading and mathematics*. Cape Town: Juta.
- Garet, S. M., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, S. K. (2001). What makes professional development Effective? Results from a National sample of teachers. *American Educational Research Journal*, 38, 915-945.
- Gee, J. P. (2001). Identity as an Analytical Lens for Research in Education. *Review of Research in Education*, 25, 99-125.
- Ginsburg, H. P. (2006). Mathematical play and playful mathematics: A guide for early education. In K. Hirsh-Pasek, & D. Singer (Eds.), *Play=Learning* (pp. 145-165). New York: Oxford University Press.
- Graven, M. (2002a). Mathematics Teacher Learning, Communities of Practice and the Centrality of Confidence. Unpublished doctoral dissertation. Johannesburg: University of the Witwatersrand.
- Graven, M. (2002b). Coping with New Mathematics Teacher Roles in a Contradictory Context of Curriculum Change. *The Mathematics Educator*, 12(2), 21-27.
- Graven, M. (2003). Teacher Learning as Changing Meaning, Practice, Community, Identity and Confidence: the Story of Ivan. *For the Learning of Mathematics*, 23(2), 25-33.
- Graven, M. (2004). Investigating Mathematics teacher learning within an in-service Community of Practice: The centrality of confidence. *Educational Studies in Mathematics*, 57, 177-211.
- Graven, M. (2005a). Mathematics teacher retention and the role of Identity: Sam's story. *Pythagoras*, 61, 2-10.
- Graven, M. (2005b). Dilemmas in the design of in-service education and training of mathematics teachers. In R. Vithal, & J. Adler (Eds.), *Research Mathematics Education in South Africa: Perspectives, practices and possibilities* (pp. 206-230). Pretoria: HSRC Press.
- Graven, M. (2012). Changing the Story: Teacher Education through Re-authoring their narratives. In C. Day (Ed.), *The Routledge International Handbook of Teacher and School Development* (pp. 127-138). Abingdon: Routledge.

- Graven, M., & Lerman, S. (2003). Book Review of Wenger. *Journal of Mathematics Teacher Education*, 6, 185-194.
- Graven, M., & Venkat, H. (2013). *ANA Discussion document*. Grahamstown, Johannesburg: Rhodes & Wits University.
- Greeno, J. G., & MMPP. (1998). The situativity of knowing, learning, and research. *American Psychologist*, 53(1), 5-26.
- Grootenboer, P., & Zevenbergen, R. (2008). Identity as a Lens to Understanding Learning Mathematics: Developing a model. In M. Goos, R. Brown, & K. Makar (Ed.), *Proceedings of the 31st Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 243-249). Brisbane: MERGA Inc.
- Grootenboer, P., Lowrie, T., & Smith, T. (2006). Researching identity in mathematics education: The lay of the land. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Ed.), *Proceedings of the 29th annual conference of Mathematics Education Research Group of Australasia*. 2, pp. 612-618. Canberra, Australia: MERGA.
- Grossman, P., Wineburg, S., & Woolworth, S. (2001). Towards a Theory of Teacher Community. *The Teachers College Record*, 103, 942-1012.
- Harley, K., & Parker, B. (1999). Intergrating Differences: Implications of an Outcomes-based National Qualifications Framework for the Roles and Competencies of Teachers. In J. Jansen, & P. Christie (Eds.), *Changing Curriculum: Studies on Outcomes-based Education in South Africa* (pp. 181-202). Cape Town: Juta & Co Ltd.
- Henning, E., & Dampier, G. (2012, September 8). *Simple language is the answer to "difficult" assessment tests*. Retrieved 28 February, 2013, from Mail and Guardian: <http://mg.co.za/article/2012-09-08-simple-language-is-the-answer-to-difficult-assessment-tests>
- Heyd-Mertzuyanim, E., & Sfard, P. (2012). Identity struggles in the mathematics classroom: On learning mathematics as an interplay of mathematizing and identifying. *International Journal of Educational Research*, 51-52, 128-145.
- Hill, H. C. (2004). Professional Development Standards and Practices in Elementary School Mathematics. *The Elementary School Journal*, 104(3), 215-231.
- Hill, H. C., & Ball, D. L. (2004). Learning Mathematics for Teaching: Results from California's Mathematics Professional Development Institutes. *Journal for Research in Mathematics Education*, 35(5), 330-351.
- Hill, H. C., Blunk, M. L., Charalambous, C. Y., Lewis, J. M., Phelps, G. C., Sleep, L., et al. (2008). Mathematical Knowledge for Teaching and the Mathematical Quality of Instruction: An Exploratory Study. *Cognition and Instruction*, 26, 430-511.
- Hoadley, U. (2007). The reproduction of social class inequalities through mathematics pedagogies in South African primary schools. *Journal of Curriculum Studies*, 679-706.
- Hodgen, J., & Askew, M. (2007). Emotion, identity and teacher learning: becoming a primary mathematics teacher. *Oxford Review of Education*, 33(4), 469-487.

- Howie, S. J. (2001). *Mathematics and Sciences Performances in Grade 8 in South Africa: TIMSS-R 1999 South Africa*. Pretoria: Human Sciences Research Council.
- Jansen, J. (2001). Image-ning teachers: Policy images and teacher identity in South African classrooms. *South African Journal of Education, 21*(4), 242-246.
- Jaworski, B. (2005). Learning Communities in Mathematics: Creating an Inquiry Community between Teachers and Didacticians. *Research in Mathematics Education, 7*(1), 101-119.
- Jaworski, B. (2006). Theory and Practice in Mathematics Teaching Development: Critical Inquiry as a mode of Learning in teaching. *Journal of Mathematics Teacher Education, 9*, 187-211.
- Jaworski, B. (2009). Learning in and from Practice. In R. Even, & D. L. Ball, *The Professional Education and Development of Teachers of Mathematics, The 15th ICMI Study* (Vol. II, pp. 143-147). Springer.
- Jita, L., & Mokhele. (2012). Institutionalising teacher clusters in South Africa: Dilemmas and contradictions. *Perspectives in Education, 30*(1), 1-11.
- Jita, L., & Ndlalane, T. (2009). Teacher clusters in South Africa: opportunitites and constraints for teacher development and change. *Perspectives in Education, 27*(1), 58-68.
- Jita, L., & Vandeyar, S. (2006). The relationship between the mathematics of primary school teachers and new curriculum reforms in South Africa. *Perspectives in Education, 24*(1), 39-51.
- Johansson, M. (2010). Pedagogic Identities in the Reform of School mathematics. In U. Gellert, E. Jablonka, & C. Morgan (Ed.), *Proceedings of the Sixth International Mathematics Education and Society Conference*. Freie Universitat, Berlin: Mathematics Education and Society.
- Katz, S., & Earl, L. (2010). Learning about networked learning communities. *School Effectiveness and School Improvement, 21*(1), 27-51.
- Kazemi, E., & Hubbard, A. (2008). New Directions for the Design and Study of Professional Development: Attending to the Coevolution of Teachers' Participartion Across Contexts. *Journal of Teacher Education, 59*, 428-441.
- Kennedy, M. (1998). *Form and Substance in Inservice Teacher Education*. University of Wisconsin-Madison. Madison: National Institute for Science Education.
- Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it Up: Helping Children Learn Mathematics*. Washington DC: National Academy Press.
- Kretchmar, K., Nyambe, J., Robinson, M., Sadeck, M., & Zeichner, K. (2012). Policies and practices for the continuing professional development of teachers in South Africa and Namibia. In C. Day (Ed.), *The Routledge International Handbook of Teacher and School Development* (pp. 281-291). Abingdon: Routledge.
- Lampert, M. (2010). Learning Teaching in, from, and for Practice: What Do We Mean. *Journal of Teacher Education, 61*(21), 21-34.
- Lave, J. (1988). *Cognition in Practice*. New York: Cambridge University Press.

- Lave, J. (1993a). The practice of learning. In S. Chaiklin, & J. Lave, *Understanding practice* (pp. 3-32). New York: Cambridge University Press.
- Lave, J. (1993b). Situating Learning in Communities of Practice. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on Socially Shared Cognition* (pp. 63-82). Washington D C: American Psychological Association.
- Lave, J. (1996). Teaching, as Learning, in Practice. *Mind, Culture, and Activity*, 3(3), 149-164.
- Lave, J. (1997). The Culture of Acquisition and the Practice of Understanding. In D. Krishner, & J. A. Whitson (Eds.), *Situated Cognition* (pp. 17-35). Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.
- Lave, J., Murtaugh, M., & de la Rocha, O. (1984). The dialectical construction of authentic practice. In B. Rogoff, & J. Lave (Eds.), *Everyday Cognition: Its Development in Social Context* (pp. 67-94). Cambridge, MA: Harvard University Press.
- LeCompte, M. D. (2000). Analyzing Qualitative Data. *Theory into Practice*, 39(3), 146-154.
- Lerman, S. (1998). Learning as Social Practice: An appreciative Critique. In A. Watson (Ed.), *Situated Cognition and the learning of mathematics* (pp. 33-42). Oxford: Centre for Mathematics Education Research University of Oxford Department of Educational Studies.
- Lerman, S. (2000). The Social Turn in Mathematics Educational Research. In J. Boaler, *Multiple Perspectives on Mathematics Teaching and Learning* (pp. 19-44). Westport C T: Ablex Publishing.
- Lerman, S. (2001). Getting used to mathematics: alternative ways of speaking about becoming mathematical. *Ways of Knowing*, 1(1), 47-52.
- Lerman, S. (2012a). Agency and identity: Mathematics teachers' stories of overcoming disadvantage. In T.-Y. Tso (Ed.), *Proceedings of the 36th Conference of the International Group for the Psychology of Mathematics Education* (pp. 99-106). Taiwan: Department of Mathematics National Taiwan University.
- Lerman, S. (2012b). 'Identity' as a unit of analysis in researching and teaching mathematics. In H. Daniels (Ed.), *Vygotsky and Sociology* (pp. 175-191). London: Routledge.
- Lieberman, A. (1995). Practices that support teacher development. *Phi Delta Kappan*, 76(8), 591-596.
- Little, J. W. (2002). Locating learning in teachers' communities of practice: opening up problems of analysis in records of everyday work. *Teaching and Teacher Education*, 18, 917-946.
- Little, J. W. (2003). Inside Teacher Community: Representations of Classroom Practice. *Teachers College Record*, 105(6), 913-945.
- Little, J. W., Gearhart, M., Curry, M., & Kafka, J. (2003). Looking at Student Work for Teacher Learning, Teacher Community, and School Reform. *Phi Delta Kappan*, 185-192.

- Ma, L. (2010). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, N.J: Lawrence Erlbaum Associates.
- Maistry, M. (2008). Transcending traditional boundaries for teacher professional development: exploring a community of practice approach to CPD. *Journal of Education*, 43, 127-153.
- Marsh, M. M. (2002a). The shaping of Ms. Nicholi: The discursive fashioning of teacher identities. *International Journal of Qualitative Studies in Education*, 15(3), 333-347.
- Marsh, M. M. (2002b). Examining the Discourses That Shape Our Teacher Identities. *Curriculum Inquiry*, 32(4), 453-469.
- Matos, J. F. (2009). Mathematics Teachers' Professional Development: Processes of Learning in and from Practice. In R. Even, & D. L. Ball (Eds.), *The Professional Education and Development of Teachers of Mathematics, The 15th ICMI Study* (Vol. 11, pp. 167-184). Springer.
- McMillan, J., & Schumacher, S. (2001). *Research in Education: A Conceptual Introduction* (5 ed.). New York: Routledge.
- Mendick, H. (2005). Mathematical Stories: Why do more boys than girls choose to study mathematics at AS-level in England. *British Journal of Sociology of Education*, 22(6), 225-241.
- Merriam, S. B. (2001). *Qualitative Research and Case Study Applications in Education*. Francisco: Jossey-Bass Publishers.
- Miles, M. B., & Huberman, A. M. (1986). *Qualitative Data Analysis: An Expanded Sourcebook* (2nd ed.). London: Sage Publications.
- Morgan, C. (2005). Making Sense of Curriculum Innovation and Mathematics Teacher Identity. In C. Kanes (Ed.), *Elaborating Professionalism, Innovation and Change in professionalism* (pp. 107-122). New York: Springer.
- Morgan, C., Tsatsaroni, A., & Lerman, S. (2002). Mathematics Teachers' Positions and Practices in Discourses of Assessment. *British Journal of Sociology of Education*, 23(3), 445-461.
- Muller, J. (1998). The Well-tempered Learner: Self-regulation, pedagogical models and teacher education policy. *Comparative Education*, 34(2), 177-193.
- Muller, J. (2006). Differentiation and progression in the curriculum. In M. Young, & J. Gamble (Eds.), *Knowledge, Curriculum and Qualifications for South African Further Education* (pp. 66-86). Cape Town: HSRC Press.
- Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 International Results in Mathematics*. Chestnut Hill: TIMSS & PIRLS - International Study Centre Boston College.
- Nel, B. (2012). Transformation of teacher identity through a Mathematical Literacy re-skilling programme. *South African Journal of Education*, 32(2), 144-154.
- Neuman, L. (2009). *Social Research Methods: Qualitative and Quantitative Approaches* (6th ed.). London: Pearson International.
- OECD. (2008). *Review of National Policies for Education: South Africa*. Pretoria.

- Parker, D. (2006). Official pedagogic identities from South African policy - some implications for mathematics teacher education policy. *Pythagoras*, 63, 2-17.
- Pausigere, P. (2014). On South African primary mathematics learner identity: a Bernsteinian illumination. In P. Webb, M. G. Villanueva, & L. Webb (Ed.), *New Avenues to transform Mathematics, Science and Technology in Africa: Proceedings of the 22nd Annual meeting of the Southern African Association for Research in Mathematics, Science and Technology Education* (pp. 113-128). Nelson Mandela Metropolitan University, Port Elizabeth: SAARMSTE.
- Pausigere, P., & Graven, M. (2012). Primary Teachers' imagination and the emergence of numeracy teacher identities through participation in a Numeracy Community of Practice. In S. Nieuwoudt, D. Laubscher, & H. Dreyer (Ed.), *Proceedings of the 18th National Congress of the Association of Mathematical Education of South Africa* (pp. 276-286). North-West University, Potchefstroom: AMESA.
- Pausigere, P., & Graven, M. (2013a). On the Constituents of Primary Maths Teacher Identity: towards a model. In S. K. Kwofie, M. B. Ogunniyi, O. Amosun, K. R. Langenhoven, & S. Dinie (Ed.), *Making Mathematics, Science And Technology Education, Socially And Culturally Relevant in Africa: Proceedings of the 21st annual meeting of the Southern African Association for Research in Mathematics, Science and Technology Education* (pp. 184-196). University of the Western Cape, Cape Town: SAARMSTE.
- Pausigere, P., & Graven, M. (2013b). Affordances and constraints in a Primary Maths Community of Practice in-service programme. In N. Mpalami, & Letlatsa R (Ed.), *Proceedings of the Fourth Regional Congress of the International Commission on Mathematics* (pp. 104-111). Lesotho: AFRICME 4.
- Pausigere, P., & Graven, M. (2013c). Using Bernstein to analyse primary maths teachers' practices and identities in the context of education change: the case of ANA. *Journal of Education*, 58, 1-22.
- Pausigere, P., & Graven, M. (2013d). Unveiling the South African official primary maths teacher pedagogic identity. *Perspectives in Education, Special Edition*, 12(6), 1-13.
- Pausigere, P., & Graven, M. (2014). Learning metaphors and learning stories (stelos) of teachers participating in an in-service numeracy community of Practice. *Education As Change*, 18(1), 33-46.
- Putman, R. T., & Borko, H. (2000). What Do New Views of Knowledge and Thinking Have to Say about Research on Teacher Learning? *Educational Researcher*, 29(1), 4-15.
- Reddy, V. (2006). The State of Mathematics and Science education: Schools are not equal. In S. Buhlungu, J. Daniel, R. Southall, & J. Lutchman (Eds.), *State of the Nation Address: South Africa 2005-2006* (pp. 392-416). Cape Town: Human Sciences Research Council.
- Reeves, C., & Muller, J. (2005). Picking up the pace: variation in the structure and organisation of learning school mathematics. *Journal of Education*, 103-130.
- Rogoff, B. (1994). Developing understanding of the idea of communities of learners. *Mind, Culture and Activity*, 1(4), 209-229.

- Rogoff, B. (1995). Observing sociocultural activity on three planes: participatory appropriation, guided participation, and apprenticeship. In J. V. Wertsch, P. del Rio, & A. Alvarez (Eds.), *Sociocultural Studies of Mind* (pp. 139-146). Cambridge: Cambridge University Press.
- Sadovnik, A. R. (1995). Basil Bernstein's Theory of Pedagogic Practice. In A. R. Sadovnik (Ed.), *Knowledge and Pedagogy: The Sociology of Basil Bernstein* (pp. 3-35). London: Ablex Publishing.
- Sadovnik, R. (2001). Basil Bernstein 1924-2000. *Prospects: the quarterly review of comparative education*, 31(4), 687-703.
- Samuel, M. (2008). Accountability to whom? For what? Teacher identity and the Force Field Model of teacher development. *Perspectives in Education*, 26(2), 3-16.
- Schoenfeld, A. H. (1996). In Fostering Communities of Inquiry, Must it Matter That The Teacher Knows "The Answer"? *For the Learning of Mathematics*, 16(3), 11-16.
- Schollar, E. (2008). *The Primary Mathematics Research Project 2004-2007*. Johannesburg: Zenex Foundation.
- Setati, M. (2005). Teaching Mathematics in a Primary Multilingual Classroom. *Journal for Research in Mathematics Education*, 36(5), 447-466.
- Setati, M., & Planas, N. (2012). Mathematics education across language contexts: A political perspective. In O. Skovsmose, & B. Greer (Eds.), *Opening the Cage: Critique and Politics of Mathematics Education* (pp. 167-186). London: Sense Publishers.
- Sfard, A. (1998). On Two Metaphors for the Learning and the Dangers of Choosing Just One. *Educational Researcher*, 27(2), 4-13.
- Sfard, A., & Prusak, A. (2005). Telling Identities: In Search of an Analytic Tool for Investigating Learning as a Culturally Shaped Activity. *Educational Researcher*, 34(4), 14-22.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.
- Shulman, L. S., & Shulman, J. H. (2004). How and what teachers learn: a shifting perspective. *Journal of Curriculum Studies*, 36(2), 257-271.
- Silver, A. (2009). Towards a More Complete Understanding of Practice-Based Professional Development for Mathematics Teachers. In R. Even, & D. L. Ball (Eds.), *The Professional Education and Development of Teachers of Mathematics, The 15th ICMI Study* (Vol. 11, pp. 245-248). Dordrecht: Springer.
- Smylie, M. A. (1989). Teachers' Views of the Effectiveness of Sources of Learning to Teach. *The Elementary School Journal*, 89(5), 543-558.
- Tatto, M. T., & Senk, S. (2011). The Mathematics Education of Future Primary and Secondary Teachers: Methods and Findings from Teacher Education and Development Study in Mathematics. *Journal of Teacher Education*, 62(2), 121-137.

- Taylor, N. (2011). *The National School Effectiveness Study (NSES)*. Johannesburg: JET Education Services.
- Taylor, N., & Vinjevold, P. (1999). *Getting Learning Right: Report of the President's Education Initiative Research Project*. Johannesburg: Joint Education Trust.
- Taylor, N., Draper, K., Muller, J., & Sithole, S. (2013). *The National Report 2012: The state of Literacy Teaching and Learning in the Foundation Phase*. Pretoria: NEEDU.
- Even, R., & Ball, D. L. (Eds.). (2009). *The Professional Education and Development of teachers of Mathematics: The 15th ICMI Study. II*. New York: Springer.
- Tyler, W. (1995). Decoding School Reform: Bernstein's Market-Orientated Pedagogy and Postmodern Power. In A. R. Sadovnik, *Knowledge and Pedagogy: The Sociology of Basil Bernstein* (pp. 237-258). London: Ablex Publishing.
- Tyler, W. (1999). Pedagogic identities and educational reform in the 1990s: the cultural dynamics of national curricula. In F. Christie (Ed.), *Pedagogy and the Shaping of Consciousness* (pp. 262-289). London: Continuum.
- Van der Berg, S., & Louw, M. (2006). Unravelling the Mystery: Understanding South African Schooling Outcomes in Regional Context. *Conference of the Centre for the Study of African Economics* (pp. 1-33). London: Oxford University.
- Van Putten, S. (2011). *Professional mathematics teacher identity in the context of pre-service training*. University of Pretoria. Pretoria: Unpublished doctoral dissertation.
- Walls, F. (2008). "Down In The Dark Zone": Teacher Identity and Compulsory Standardised Mathematics Assessment. In J. F. Matos, P. Valero, & K. Yasukawa (Ed.), *Proceedings of the Fifth International Mathematics Education and Society Conference* (pp. 485-494). Lisbon, Portugal: Mathematics Education and Society.
- Watson, A. (1998). Why situated Cognition is an issue for mathematics education. In A. Watson (Ed.), *Situated cognition and the learning of mathematics* (pp. 1-12). University of Oxford: Centre for Mathematics Education Research University of Oxford Department of Educational Studies.
- Wenger, E. (1998). *Communities of Practice: Learning, meaning and identity*. New York: Cambridge University Press.
- Wenger, E., McDermott, R., & Sydner, W. (2002). *Cultivating Communities of Practice: A guide to managing knowledge*. Boston, Massachusetts: Harvard Business School Press.
- Wenger-Trayner, E., & Trayner-Wenger, B. (2011). *What are the three key success factors of Communities of Practice*. Retrieved January 28, 2013, from <http://wenger-trayner.com/resources/key-success-factors/>.
- Wilson, S. M., & Berne, J. (1999). Teacher Learning and the Acquisition of Professional Knowledge: An Examination of Research on Contemporary Professional Development. *Review of Research in Education*, 24, 173-209.

- Wilson, S. M., Penelope, P. L., Ball, D. L., & Cohen, D. K. (1996). Learning by All. *Phi Delta Kappan*, 77(7), 468-476.
- Winbourne, P., & Watson, A. (1998). Participating in Learning Mathematics through shared local practices in classrooms. In A. Watson (Ed.), *Situated Cognition and the learning of Mathematics* (pp. 93-104). University of Oxford: Centre for Mathematics Education Research University of Oxford Department of Educational Studies.
- Wineburg, S., & Grossman, P. (1998). Creating a Community of Learners among High School Teachers. *The Phi Delta Kappan*, 79(5), 350-353.
- Woods, P., & Jeffrey, B. (2002). The Reconstruction of Primary Teachers' Identities. *British Journal of Sociology of Education*, 23(1), 89-106.

Appendices

APPENDIX 1: INTERACTIVE INTERVIEW SCHEDULES

INTERACTIVE INTERVIEW SCHEDULE 1 - 2011

1. How would you describe yourself as a numeracy teacher?
 2. Describe your numeracy teaching practice to me?
 3. On a scale of 1-10 how would you rate your understanding of mathematics/numeracy? Why do you say that?
 4. On a scale of 1-10 how would you describe your enjoyment (or lack of it) for numeracy/mathematics teaching? Explain why you say that?
 5. What if anything might you want to change/strengthen in relation to your current teaching practices?
 6. Why are you participating in NICLE?
 7. What type of numeracy teacher do you hope/imagine to be at the end of the NICLE programme? Describe that teacher to me?
 8. Explain to me how you came to being a numeracy teacher?
 9. Who do you draw on for support in your numeracy teaching? (Who do you talk to about numeracy or teaching numeracy?)
 10. How does each of these; school setting, school maths department, your maths class(es), the District Office and Cluster meetings support or constrain your numeracy teaching ? (The interviewer must ask each separately).
 11. What is your opinion on the Annual National Assessment tests? What happened to them once they were written? Have they influenced your teaching at all?
 12. Before (NICLE) what opportunities/experiences within your teaching career supported your numeracy teaching? (Probe participant to explain the nature of these experiences/workshops/courses?)
 13. Could you describe in your own words to me the way those experiences influenced your learning (if at all)?
 14. Has NICLE supported your understanding of mathematics *teaching* at all so far? If so explain?
 15. Has NICLE supported your mathematics/numeracy teaching at all so far? If so explain?
 16. What do you think are some of the advantages of participating in NICLE Some disadvantages?
 17. Do you feel NICLE is providing an opportunity for learning? If so what kind of learning explain?
- Anything else you would like to say or add that I have not touched on?

Thanks you so much for your time.

INTERACTIVE INTERVIEW SCHEDULE 2 – 2012

Primary maths teacher identity

1. How would you describe yourself as a teacher?
2. Do you see yourself as a specialised teacher at all and if so in what?

Teachers' mathematical understanding and enjoyment

3. On a scale of 1-10 how would you rate your understanding of mathematics at the *grade(s)/level* at which you teach? Why do you say that?
4. On a scale of 1-10 how would you rate your understanding of mathematics at the *Matric level*? Why do you say that?
5. On a scale of 1-10 how would you describe your enjoyment (or lack of it) for mathematics teaching? Explain why you say that?

Teachers' Imagination

6. How would you describe your NICLE experiences? How do you *see* yourself in the future in terms of primary maths/numeracy teaching?

Teachers' Alignment

7. What is your opinion on the Annual National Assessment tests? Have they influenced your teaching? Last time you highlighted that they were some difficulties/challenges with ANA what is the situation now?
8. What is your opinion on the new CAPS document? Could you explain what type of primary maths teaching and learning practices are being encouraged by CAPS? Does the CAPS position *fit* with your own beliefs about how primary maths should be taught and enjoyed by learners?

On Teachers' Engagement

9. During the period of your participation in NICLE were there any other opportunities/experiences that supported your primary maths teaching? (Probe participant to explain the nature of these experiences/workshops/courses/conferences)
10. Which NICLE activities/sessions did you enjoy most? Why did you enjoy these activities? Which activities or materials did you *used* in your maths classes? Which activities or materials do you *intend to use* in your maths classes?

On the nature of teacher learning in NICLE

11. Did NICLE support your *understanding of mathematics* at all? (The interviewer must seek an explanation for each respond)

12. Did NICLE support your *mathematics teaching* at all? (The interviewer must seek an explanation for each respond)

13. What do you think were some of the advantages of participating in NICLE? Some disadvantages?

14. Could you describe the type/kind/nature of learning that you encountered/experienced in NICLE?

15. What will you remember about NICLE, later in life?

Anything else you would like to say or add that I have not touched on?

Thanks you so much for your time

PARTICIPANT SPECIFIC QUESTIONS

MARY

1. Can you explain how this school's approach to teaching numeracy is similar or different to your previous school?
2. Last time you hoped to have extra maths sessions with the grade 3 classes, what do you think about this now?
3. How did you reconcile between your participation in NICLE and your further training at NMMU?
4. In our first interview you had imagined that after participating in NICLE you would be 'a lifelong learner...to develop to a stage where I can do an honours or a Masters'. Can you explain if NICLE enabled you to live up towards this imagination?

EDNA

1. What has been your teaching experience in offering 'extra Maths time classes to the Grade 3s'?
2. How did you reconcile between your participation in NICLE and your further training at NMMU?
3. Why did you decide to drop out from NICLE for 8 months? (Interview must probe the participant)
4. In our first interview you had imagined that after participating in NICLE you would 'be like Zonia ... and let the learners feel that Maths is not a death sentence or a gogga'. Can you explain if NICLE enabled you live up to this imagination?
5. In our first interview you had imagined that after participating in NICLE you would be 'a critical and reflective' maths teacher. Can you explain if NICLE enabled you live up to this imagination?

MELANIA

1. In the last interview you outlined that you needed to strengthen you primary maths teaching especially on how to extend intelligent students NICLE has helped you in this regard? (Explain why you say that)
2. You explained last time that your school maths approach - 'standards' affected the way that you taught maths is this still the case?
3. In our first interview you had imagined that after participating in NICLE you would make your learners, 'confident and daring when faced with a (maths) problem'. Can you explain if NICLE enabled you live up to this imagination?

ROBERT

1. How did you reconcile between your participation in NICLE and your further/Masters Studies in maths education?
2. During your early primary maths teaching how did you reconcile between your secondary school subject specialisations and teaching intermediate phase primary maths?
3. In our first interview you had imagined that after participating in NICLE you would 'show confidence... be competent in all aspects of what is required in the intersen phase'. Can you explain if NICLE enabled you live up to this imagination?

CALVIN

1. Can you explain to me your intermediate phase CAPS maths training experiences?
2. How did you reconcile between your participation in NICLE and being involved in training other teachers at cluster or district level and also being the school's deputy principal?
3. In our first interview you had imagined that after participating in NICLE you would 'the perfect teacher... one of the best maths teachers'. Can you explain if NICLE enabled you live up to this imagination?

PAMELA

1. You said you had a fear of maths before coming to NICLE can you explain how this fear started in your life?
2. What was the nature of your initial teacher training programme when you trained as a teacher at college?
3. From our last interview it seems that your teaching is influenced by the department's policy/documents, what is your opinion on this?
4. In our first interview you had imagined that after participating in NICLE you would 'be able to produce learners who are independent in numeracy'. Can you explain if NICLE enabled you live up to this imagination.

RUTH

1. Having taught both primary and high school how do you compare between these two school levels?
2. You explained last time that your school maths teaching and learning approach 'tradition' affected the way that you taught maths, is this still the case? (Explain why you say that)
3. In our last interview you had some tension that you had immediately completed a UNISA art course and now you were in NICLE, did you manage to resolve this tension? (The interviewer must seek an explanation for each respond).

EVERTON

1. Tell me your teaching career history which spans across primary and high school?
2. How did you reconcile between your maths teaching and the other subjects that you teach and also being a multigrade teacher?
3. You had problems with school times and time tabling has this issue been resolved? (The interviewer must seek an explanation from the participant's respond).
4. In our first interview you had imagined that after participating in NICLE you would be 'a critical and reflective' maths teacher. Can you explain if NICLE enabled you live up to this imagination?

APPENDIX 2: PARTICIPANT INFORMATION AND INFORMED CONSENT FORM

PARTICIPANT INFORMATION AND INFORMED CONSENT FORM

Dear Sir/ Madam

I am a full-time PhD fellow in the Numeracy Chair and carrying out research on how Numeracy teachers learn and how their identity evolves within a Community of Practice-Inquiry setting, called NICLE. NICLE is the acronym for Numeracy Inquiry Community of Leader Educators, which is a numeracy teachers' professional development programme for primary Foundation and Intermediate Phase educators. The programme was conceptualised by Professor Mellony Graven, who is the South African Numeracy Chair, at Rhodes University's Department of Education. The aim of this numeracy teacher professional development initiative is to support quality primary maths teaching and learning and to search for sustainable solutions to the challenges in numeracy education.

Part of the research study will involve interviewing Foundation and Intermediate Phase teachers in Grahamstown and the greater area's primary schools who attend NICLE sessions. Using an interactive interview format I will interview teachers concerning how they learn and how their identity and practices evolve through participation in NICLE and in other broader educational contexts. The interviews will be carried out, at the teacher's school and not during the teachers teaching hours. I will carry out approximately two interview sessions during school terms from October 2011 up to December 2012. These will be audio recorded unless the teacher requests otherwise.

The teachers selected for the study will be requested to write a reflective journal in which they reflect upon their experiences in NICLE, in their numeracy classrooms, in maths departments, in schools, at the District office and in other overlapping educational contexts that are related to how they learn as teachers and how their numeracy identities evolve within such contexts. At regular periods (to be negotiated) the contents of the journal will be photocopied and the original journals will be returned to the teachers. Participating teachers will also be given the option of "journaling" using a voice recorder.

This form serves to inform you that participation in this research is voluntary. You can refuse to participate in this research at any time if you so wish and there will be no repercussions. In participating in this research there are no foreseeable risks. You and your schools anonymity in relation to my PhD study and in any publications arising from this study will be protected. Only my Supervisor and I will have access to the raw data (interviews; journals) that I collect.

For any details you can contact my Supervisor, Professor Mellony Graven on 046 603 7268 or alternatively Peter Pausigere on 083 958 0700.

I therefore kindly invite you to participate in this research. If you agree to participate in this research you can sign on the space provided below.

PARTICIPANT'S SIGNATURE: _____ DATE _____

Thank you.

APPENDIX 3: REFLECTIVE JOURNAL GUIDELINES

REFLECTIVE JOURNAL GUIDELINES

Dear Sir/Madam

I would like to invite you to participate in my research study as outlined in the attached letter. As part of this research you are kindly requested to write a reflective journal (learning journal). A reflective journal is a research diary (record) of *your learning experiences*. This record reflects *the progress (journey) of your learning*. In the reflective journal you think deeply, critically evaluate (question) and write your experiences in NICLE, in numeracy classrooms, in maths departments, in schools, at the District office and in other overlapping educational contexts in relation to how you learn as a numeracy teacher. You reflect on how the way you participate in each of these communities and settings may or may not shift and what enables and constrains such shifts. In addition to these you can also outline contextual factors (within and out of NICLE) which enhance (allow) or obstruct (restrict) your numeracy classroom teaching practices to evolve. In the journal feel free to record your ‘aha’ moments, critical learning incidents, feelings (joys/excitements or problems), anxieties, emotions and frustrations.

The reflective journal writing exercise will be throughout the period of NICLE. You will be kindly requested to write your reflections, at least once a week or regularly and particularly after attending each NICLE session and other significant maths learning experiences or key learning events/occasions that you encounter in your classroom, in maths departments, in schools, at the district and other extended educational settings. In some instances, if need be, you can draw images (pictures) to illustrate your thoughts and ideas. As a participant in this research you also have the option of “journaling” using a voice recorder, if you so wish.

Basically in the reflective journal *you write, clarify, infer, recapture, analyse and express your experiences, opinions, observations, ideas, insights, thoughts and feelings on or about the nature of teacher learning within NICLE.*

The contents of the reflective journal will primarily be used for the purposes of research and to investigate how you learn as a numeracy teacher in NICLE and in relation to NICLE. A small token of appreciation will be awarded for your effort in writing the journal. I will request to engage with you about the contents of your journal on a regular basis and provide you with feedback on how to improve your future journal entries. At the end of the professional development programme the contents of the journal will be photocopied and the original journal will be returned to you. The photocopied material in the journal entries will be kept confidential, furthermore, pseudonyms will be used to protect you and for any unanticipated consequences that might arise.

Thank you for agreeing to participate in this research and in writing the reflective journal.

APPENDIX 4: PROVINCIAL DOE ETHICAL CLEARANCE

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STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
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Enquiries: Dr Heckroodt

Email: bernetia@africa.com

26 September 2011

Prof Mellony Graven
SA Numeracy Chair
Education Department
Rhodes University
PO Box 94
GRAHAMSTOWN
6140

Dear Prof Graven


PERMISSION TO UNDERTAKE A STUDY: THE NUMERACY INQUIRY COMMUNITY OF LEADER EDUCATORS (NICLE) AND THE NUMERACY LEARNER CLUBS PROGRAM

1. Thank you for your application to conduct research.
2. Your application to conduct the above mentioned research in fifteen (15) Primary Schools in the Eastern Cape under the jurisdiction of the Grahamstown District is hereby approved on condition that:
 - a. there will be no financial implications for the Department;
 - b. institutions and respondents must not be identifiable in any way from the results of the investigation;
 - c. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the District Directors before any research is undertaken at any institutions within that particular district;



- d. you will make all the arrangements concerning your research;
- e. the research may not be conducted during official contact time, as educators' programmes should not be interrupted;
- f. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to the Director: Strategic Planning Policy Research and Secretarial Services;
- g. the research may not be conducted during the fourth school term, except in cases where a special well motivated request is received;
- h. your research will be limited to those schools or institutions for which approval has been granted;
- i. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 – 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis. This must also be in an electronic format.
- j. you are requested to provide the above to the Director: The Strategic Planning Policy Research and Secretarial Services upon completion of your research.
- k. you comply to all the requirements as completed in the Terms and Conditions to conduct Research in the ECDE document duly completed by you.
- l. you comply with your ethical undertaking (commitment form).
- m. You submit on a six monthly basis, from the date of permission of the research, concise reports to the Director: Strategic Planning Policy Research and Secretariat Services.

3. The Department wishes you well in your undertaking. You can contact the Director, Dr. Annetia Heckroodt on 043 702 7428 or mobile number 083 271 0715 and email: annetia.heckroodt@edu.ecprov.gov.za should you need any assistance.


Dr AS HECKROODT

DIRECTOR: STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES



APPENDIX 5: LIST OF SANC DOCUMENTS & REPORTS ANALYSED

- Graven, M. (2010). Initial Proposal for the South African Numeracy Chair (SANC). Grahamstown.
- Graven, M. (2011a). Graven's invitational letter to Principals. Grahamstown: Rhodes University.
- Graven, M. (2011b). Orientation document for negotiation teacher participation. Grahamstown: Rhodes University.
- Graven, M., & Schafer, M. (2011). Report for the Joint Advisory Board. Grahamstown: Rhodes University.
- SANC. (2011). Discussion document for Annual CoP forum. Grahamstown: Rhodes University.
- SANC. (2012). South African Numeracy Chair Community of Practice forum discussion document. Rhodes University, Grahamstown.
- SANC. (2013). South African Numeracy Chair Community of Practice forum discussion document. Rhodes University, Grahamstown.

APPENDIX 6: SANC LEADER ROLES INDICATORS 2011-2013

2011 to 2013

