Learning metaphors and learning stories (stelos) of teachers participating in an in-service numeracy community of practice

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Abstract

This paper uses metaphors to describe how nine selected teachers are learning and developing maths identities through their participation in a primary maths focused in-service education teacher community, called the Numeracy Inquiry Community of Leader Educators (NICLE). The metaphors emerge from data obtained in interactive interviews about their learning and participation in the NICLE, focusing on their evolving mathematical identities. The focus on metaphorical terms is informed by the sociocultural-participationist theoretical perspective. The learning stories of these educators point to the emergence of two metaphors, namely activation and reinvigoration, in relation to their mathematics learning experiences and participation in the primary maths teacher in-service programme. Teachers with a history of mathematical competence reinvigorated their mathematical identities through participation in the NICLE with some of the teachers' identities outcropping into a wider range of mathematical and maths education practices. The identities of teachers with weak mathematical histories (stunted by negative school mathematical experiences) become remediated, and new mathematical identities are activated through participation in the NICLE Communities of Practice. We conclude the paper by discussing the potentials and limitations of the Communities of Practice teacher in-service model for primary maths teachers and teacher education.

Keywords: Communities of Practice, identities, metaphors, learning stories (*stelos*), reinvigoration, activation

Introduction

This paper explores the development of a language of description of teacher stories relating to the process of learning and acquiring maths identities, through participation in a community of practice-informed teacher professional development programme called the Numeracy Inquiry Community of Leader Educators (NICLE). To describe the process of the primary maths teachers' learning and evolving identities we have chosen to use metaphors that emerged from teacher utterances in interviews. The focus on the use of figurative expressions or metaphors in educational research was sparked by Sfard's (1998) seminal paper that identified and distinguished the 'acquisition' and 'participation' learning metaphors. This article is in fact theoretically informed by the latter metaphor. Important also to this study is Lerman's (2000) suggestion of using metaphors to describe the nature of learning or 'learning mechanisms' in Communities of Practice (Lave and Wenger 1991; Wenger 1998). We pursue this agenda by using metaphors to explain teachers' learning and developing maths identities through their participation in NICLE.

Our research on teacher learning is informed by the situative-participationist framework (Lave and Wenger 1991; Lave 1996; Wenger 1998; Sfard and Prusak 2005). Under this perspective, learning within a Community of Practice is a dual process transforming knowledge and 'who we are', a process of becoming involved in the construction of identities of participation (Wenger 1998; Lave and Wenger 1991). Wenger (1998:152) explains that 'identity is an experience and a display of competence', which 'translates' through participation in a Community of Practice. This study foregrounds this sociocultural epistemological principle, which assumes that learning and identity formation are inseparable and intertwined (Lave & Wenger, 1991). Learning thus implies new ways of 'being', which entail 'new ways of knowing' and participating (Lave and Wenger 1991:32; Wenger 1998:215). Because identities 'are temporal' and 'work in progress' they are constantly evolving through participation in Communities of Practice (Wenger 1998:158; Lave and Wenger 1991). Our metaphorical ideas on how primary maths teachers learn and fashion their identities are underpinned by these sociocultural theoretical and ontological assumptions.

A definition of the term metaphor relevant to our research interests of answering the 'how' question of teacher learning (and evolving identities) is borrowed from the Collins (2012) online dictionary, which defines metaphor as 'a figure of speech (or expression) in which a word or a phrase is applied to an object or an action … in order to imply a resemblance'. Lakoff (1993) suggests that there are two categories and usages of metaphors, namely the traditional literal-figurative expression and the contemporary conceptual mapping function. The Collins (2002) definition above falls into the traditional category. We use metaphors, in this paper, to symbolically represent and figuratively express how primary maths teachers describe their learning through participation in a professional development programme. The metaphors are related to the teachers' maths learning-cum-identity formation through participation in NICLE. The metaphors are derived from the teachers' own stories on how they are learning and their participation experiences in NICLE. Metaphors are a linguistic resource that enables us to describe teacher learning, a view that Lakoff (1993) explains as the classical function of metaphors. Even early theorists such as Vygotsky (1978) implicitly encouraged the deploying of metaphors to describe the process of learning and understanding, writing that they provide more colourful ways of expressing learning. Sfard (1998) also argued that metaphors are 'sense-making tools', which are essential for growing new insights and ideas about learning. Through metaphors we develop a language that can be used to describe teacher learning within communities of practice professional development programmes.

In this paper we link teacher learning metaphors with stories gleaned from interactive interviews carried out with nine sampled teachers from the 45 regular participating NICLE teachers. The metaphors emerge from teacher utterances in interactive interviews. Theoretically we link the concept of identities as stories (Sfard and Prusak 2005) with metaphors (Sfard 1998), Lave's (1996:156) notion of *telos*, which is 'changes implied in notions of learning', and Wenger's (1998) characterisation of identity as a learning trajectory. These situative theoretical formations and our empirical data inform our coinage of the term, *stelos*, and the metaphors used in this study. The *stelos* of these educators points to the emergence of two metaphors, namely *activation* and *reinvigoration* in relation to their mathematics learning through participation in the maths primary teacher in-service programme. Teachers with a strong mathematical identity and a history of mathematical competence *reinvigorated* their mathematical persona through participation in NICLE, with some teachers' identities *outcropping* into a wider range of mathematical and maths education practices. Using metaphorical language the learning trajectory of teachers with a history of weak mathematical identities (having been *stunted* by negative school mathematical experiences) becomes *remediated*, and new mathematical identities are *activated* through participation in maths communities of practice.

The NICLE primary mathematics teachers' professional development programme forms the empirical field of research in this study, with the unit of analysis being 'the teacher-in-NICLE'. This in-service

teacher professional development initiative has been explicitly designed and conceptually framed as both a Community of Practice (Wenger 1998; Lave & Wenger 1991) and a Community of Inquiry (Jaworski 2006) approach to teacher development. The NICLE initiative focuses on numeracy (primary maths) teacher development within the Foundation and Intermediate phases in 15 primary schools in the greater Grahamstown area, and currently has about 45 teachers who attend fortnightly seminars and inquiry sessions at Rhodes University. Having outlined the empirical field of study we will proceed to a literature-informed discussion of maths community of practice-based professional development models.

Teacher professional development learning communities

The literature on teacher education has called for a shift from traditional in-service teacher training models to more effective teacher professional development approaches. Both local and international teacher education literature has heavily criticised traditional formal and mandatory one-shot 'workshops' sponsored by the school districts as irrelevant (Maistry 2008), unrelated to practice (Chisholm *et al*. 2000), lacking in intensity, content and follow-up (Chisholm *et al*. 2000; Maistry 2008), and having little effect on teacher learning and practice (OECD 2008; Maistry 2008; Askew, Rhodes, Brown, William and Johnson 1997). Locally, the 'cascade model' of implementation used for the introduction of Curriculum 2005 highlighted the need for alternative forms of in-service teacher development (Chisholm *et al*. 2000; OECD 2008).

Because of the limitations of conventional forms of teacher professional development, teachers, educational researchers and teacher educators have instead argued for collaborative ongoing teacher learning through participation in professional teacher learning communities. To this effect, Adler (1998) and Maistry (2008) concur that social practice theory (Lave and Wenger 1991; Wenger 1998) is a useful and powerful framework for the continuous professional development of teachers. Locally (Graven 2004; Hulliet 2007; Maistry 2008; Brodie and Shalem 2011) and internationally (Little 2002; Farmer, Gerretson and Lassak 2003; Little, Gearheart, Curry and Kafka 2003; Shulman and Shulman 2004; Jaworski 2006), there has been a steady increase in teacher professional development programmes underpinned by the community of practice framework. There has been a wide range of research into teacher communities of practice professional development models in primary mathematics (Farmer, Gerretson and Lassak 2003; Fennema, Carpenter, Franke, Levi, Jacobs and Empson 1996; Little *et al*. 2003), in high school mathematics (Hulliet 2007; Shulman and Shulman 2004; Little 2002) and across primary and high school mathematics (Graven 2004; Brodie and Shalem 2011). 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 one another, while 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, Gerretson and Lassak 2003; Shulman and Shulman, 2004). Successful teacher participation and learning in maths professional communities has been promoted in the USA (Fennema *et al*. 1996; Kilpatrick, Swafford and Findell 2001; Farmer, Gerretson and Lassak, 2003; Little *et al*. 2003), European (Jaworski 2006; Askew *et al*. 1997) and Asian countries (Ma 2010). Having briefly surveyed the potential of maths community practice-based professional development models, we now turn to focus on how educators learn in and from communities of practice teacher professional development programmes, which can justify our argument of using learning metaphors.

The perspective on learning in teacher communities of practice

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 2009:167; Cochran-Smith and Lytle: 1999). The conventional professional development approach views successful teacher learning as occurring after the transmission, acquisition and assimilation (internalisation) of 'knowledge-for-practice' and 'propositional knowledge' needed by teachers for classroom instruction and organisation (Cochran-Smith and Lytle 1999:250; Shulman 1986:10; Lave 1993b; Wenger 1998; Lave and Wenger 1991; Sfard 1998; Lave 1996). Within the situative perspective, learning was initially captured as 'legitimate peripheral participation in communities of practice' (Lave and Wenger 1991:31), as 'a process of transformation of participation' (Rogoff 1994:209), or as an 'an aspect of participation in socially situated practices' (Lave 1996:150). It featured mostly as 'social participation' (Wenger 1998:4), or simply as 'participation' (Sfard 1998). Common in all these definitions is the situative principle of learning as 'participation' in a practice.

Researchers in maths education have also drawn on the notion of teacher learning as participation in teacher communities of practice (Lerman 1998; Adler 1998; Matos 2009). Close to our notion of using metaphors to describe teacher learning, Cochran-Smith and Lytle (1999) put forward the term 'knowledge-in-practice' as an 'image' of teacher learning within communities of practice, and this resonates with the 15th ICMI conference title 'learning in and from practice', which focused on studies of maths teacher communities of practice (Ruhama and Ball 2009). Drawing on these definitions, and yet keeping an eye on the empirical findings, in this study we use metaphors to describe how primary school teachers explain their participation experiences in NICLE. Lave and Wenger and other participationist theorists further agree that learning in the situated way involves the transformation of a person's identity (Lave 1993a; 1993b; 1996; Sfard 1998; Lave & Wenger 1991; Wenger 1998). This sociocultural-participationist notion of connecting identity formation and learning is key to this study. Lave (1996:157) succinctly captures the notion of coupling learning with identity formation in this formulation: 'Learning taken here to be the first and principally the identity-making life projects of participants in communities of practice.' It is such elucidation on the nature of learning within communities of practice that guides our development of metaphors of participation within the primary maths communities of practice.

Theoretical elements from this sociocultural perspective assist in enabling our description of the process of the primary maths teachers' identity formation and learning through participation in a numeracy community of practice (NICLE). Our study is mainly influenced by Wenger's (1998:5) concept of identity, which provides us with 'a way of talking about how learning changes who we are'. In the same manner, Sfard and Prusak (2005:19) claim that 'identities are crucial to learning'. Wenger's notion of a 'learning trajectory', which characterises identity as 'incorporating the past and the future into the experience of the present' (Wenger 1998:158) helped us understand the process of primary maths teacher learning and identity formation. This is similar to Sfard and Prusak's (2005:19–20) definition of learning as 'closing the gap between the actual/current[2] and designated identities'. Also useful to our analyses and discussion of the research findings is Lave's (1996:156) notion of *telos*, which concerns 'changes implied in notions of learning'. Lave's idea of *telos* is a 'liberating analytical tool' (Lave 1996:156) for discussing the learning process within communities of practice – a point acknowledged in maths teacher education (Lerman 2000; Matos 2009). Lave (1996:156) points out that *telos* is 'not the same as goal directed activity' but 'encourage[s] instead a focus on the trajectories of learners as they change'. In other words, the participants' trajectories and the community's *telos* are deeply linked, reciprocal and mutually inclusive. Learning and identity transformation comprise an encompassing process that 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). Thus, for example, the intention of members of Alcoholics Anonymous is to change their identity from alcoholic to non-drinking alcoholic (Cain 1991; Lave 1991). 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). Overall, the explained situative-identity framework provides us with an

analytical tool and a language to explore and describe how numeracy teacher learning identities evolve through participation in a primary maths teacher learning community.

In the next section we make an argument for the use of the term *stelos* to capture teacher learning stories and to help us explore the construction of maths identities. The term *stelos* is born out of our cloning of the words 'story' and '*telos*', or simply put: story + *telos* = *stelos*. We would like to argue that *stelos* are learning stories or stories about learning changes in one's identity through participation in a community of practice. Taking heed of our empirical setting we would want to employ the term *stelos* to imply and denote teachers' stories about their learning changes and formation of maths identities through participation in a teacher in-service community of practice. Such learning simultaneously changes one's understanding, practices and identity. The term *stelos* is informed by our participationist theoretical underpinnings and borrows from Sfard and Prusak's (2005) proposal that identities be equated with stories, and learning with ongoing movement between current and designated identities. We are also terminologically indebted to Lave's (1996) notion of *telos*, which closely relates to and resonates with Wenger's (1998) characterisation of identity as a 'learning trajectory'. These theoretical elements explain learning through the identity construct and account for our creation of the neologism, *stelo*.

Research methodology

Empirical site

The NICLE professional development programme forms the empirical field of research for this study. NICLE is a numeracy teachers' professional development programme conceptualised by the second author, as the South African Numeracy Chair at Rhodes University. The numeracy teacher development programme is explicitly designed and framed by Wenger's (1998) Community of Practice theory and Jaworski's (2006) concept of mathematics Communities of Inquiry, with its main focus being to support quality numeracy teaching in the broader Grahamstown area. In its first year of running, teachers have participated in 15 fortnightly numeracy sessions and they have been exposed to a regional, a national and an international maths conference. The NICLE fortnightly meetings have been presented by key and influential numeracy education guest speakers and chair team members, who provide teachers with a sense of the mathematics education community, its practices and diverse perspectives. NICLE is also informed and guided by numeracy research that envisions teachers who are 'effective teachers of numeracy' with 'connectionist' mathematical classroom practices (Askew *et al*. 1997). Portrayed in this vision is a projected professional numeracy teacher identity that involves constant inquiry into ways to strengthen numeracy teaching through doing maths and exploring ways to teach it in a community, thus promoting life-long learners and primary maths leader educators.

Educational ethnography

In carrying out this research we are using an educational ethnography (Merriam 2001) approach, so as to provide a rich or thick description of how primary teachers learn and fashion their numeracy identity through participation in NICLE. According to Lave (1996), the ethnographic approach is a good way for understanding learning practices. While the broader doctoral study of the first author uses participant observation in NICLE, interactive interviews and reflective journals to gather data, this paper presents part of the data obtained from interactive interviews carried out in November and December 2011. These interviews were conducted by the first author with nine selected primary maths teachers participating in NICLE. The interactive interview affords the teachers a voice in the research, with the

participants retaining considerable control over the course of the interview (Corbin and Morse 2003). A semi-structured interview schedule was used, with open-ended questions to enable 'conversational intimacy' (Corbin and Morse 2003:328) and permit the researcher to hear the *stelos* of the nine teachers. The average time for each interview was one hour; the interviews were conducted at the respondent's school and were audio-recorded and transcribed for analysis.

The sample

The nine teachers drawn from the NICLE were selected through a combination of purposive and stratified sampling strategies. We intentionally selected teachers who actively participated in and frequently attended NICLE sessions, and were willing to be part of this longitudinal research journey. Teachers in the sample are from four different types of schools in the South African education system. Three are from a Farm school, two are from an African township school, two are from a coloured school in a historically coloured area, and two are from an ex-model C preparatory school in a formerly white area. In this sample of teachers, two are Intermediate Phase maths teachers (both are male teachers, one of whom is a deputy principal); two are multi-grade teachers of grades 4–5 and grades 2–3 (one of whom is a school principal), and the other five are Foundation Phase teachers. Notably all the foundation phase teachers in the sample are female. The table below provides background information on the teachers, who have been given pseudonyms.

Table 1 Sample Teachers background information

School Type	Teacher Pseudonyms	Gender	Phase and Grade Taught	Teaching years Experience	Qualifications
Farm school with some multigrade classes	Swallow	F	F P – 2 &3	14	B.Ed. Primary
	Evelyn	F	I P – 4 & 5	20	B.Ed. Secondary
	Mary	F	F P - 0	6	Matric Final Year –- National Primary Diploma in Education
Preparatory public school in a historically white middle class surburb	Ruth	F	F P - 3	27	B. Ed. (Honours)
	Melania	F	F P -3	11	Higher Diploma in Education
Historically African school in a historically black township	Calvin	M	I P - 6	25	B. Ed. Maths
	Pamela	F	F P - 3	17	Further Diploma in Education
Historically coloured combined school in a historically coloured area	Edna	F	F P - 0	6	Matric Final Year - National Primary Diploma in Education
Historically coloured primary school in a historically coloured area	Robert	M	I P – 4 to7	19	M. Ed. Numeracy (current)

Data analysis

Our coding, exploration and analysis of data were mainly guided by the identity framework elements presented herein, namely Wenger's characterisation of identity as a 'learning trajectory', Lave's stipulations on how learning takes place as captured under the term *telos*, and Sfard and Prusak's (2005) identity-as-story construct. The outlined identity framework will be supplemented with emerging themes from the teachers' learning stories, *stelos*, and trajectories gleaned from some of the interactive interview questions in the semi-structured interview schedule. Such structuring of data places identity at the centre and assists in explaining how primary teachers develop and negotiate maths teacher identities through participation in NICLE.

Discussion

In this part of the paper we present *verbs* and *phrases* used by the teachers' to describe their participation and learning experiences within the primary maths teacher learning community. Reading from their mathematical stories, and with reference to Lave (1993a), we 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 teachers' stories about their school maths learning and/or classroom maths teaching experiences. We also categorise the teachers' maths identity according to their response to the question: How would you describe yourself as a numeracy teacher? It is important that we distinguish between devalued and valued maths teacher identities as these relate to how these two groups of teachers describe their participation and learning experiences from which we derive the learning metaphors. Thus we equate the seven primary maths teachers with positively valued maths identities' utterances of their learning experiences and the nature of their participation in NICLE with the term, *reinvigoration*. Three of the seven teachers with positively valued mathematical identity explained their identities as *outcropping* or extending into maths communities of practice beyond the professional primary maths learning community of NICLE. Drawing on the *stelos* of teachers with negatively valued mathematical identities, we argue that their participation in NICLE *remediated* and *activated* more positive and participatory mathematical identities. Table 2, below, summarises the teachers' articulated mathematical identities, their participation and learning experiences and the emerging metaphors.

Table 2; Teachers' articulated mathematical identities, their participation and learning experiences and the emerging metaphors

Teachers' Pseudonyms	Articulated mathematical identity	Teachers' verbs and phrases describing their NICLE participation and learning experiences	Emerging metaphors from the teachers verbs and phrases
	Valued maths identity (+)		
Ruth	+ 'very good number sense'	'*freshened* it up…has *awakened* that interest again'	Reinvigoration
Melania	**+** 'enjoyed maths and hopefully my enthusiasm for maths spills over to the children…'	'….*revitalised*….just sort of *refreshed* me given me new ideas *boosted my enthusiasm* again'	Reinvigoration
Robert	**+** 'pure love of teaching and a pure love of mathematics', '…an authority in the intermediate phase mathematics'	'*refreshed*…my understanding of mathematics was *stimulated*'	Reinvigoration

Evelyn	+ she 'really enjoyed her mathematics teaching'	'… *reinforcing* what I have, what I already do put into practice'	Reinvigoration
Edna	+ 'good understanding' and 'love of numbers'	'…opportunity ….. to *grow* in that field' (of primary maths education)	Reinvigoration
Calvin	+ 'liked teaching maths, in fact I wouldn't like to teach another subject'	'*my sense of mathematics are being tested*, and I am not talking of content based maths only but classroom management'	Reinvigoration
Swallow	+ she 'love(d) numeracy teaching. I am quite confident in teaching my maths'	NICLE enabled her not to be 'isolated' and *not 'to get stuck in a rut'* but helped her to 'see other ways and other approaches'	Reinvigoration
	Devalued maths identity (-) – Stunted		
Pamela	-'it (NICLE) has taken some (mathematical) fears that I did have'	'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*'.	Remediation and Activation
Mary	- I never had a very good foundation for mathematics especially in High school…initially I was scared'	'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*'.	Remediation and Activation

The *stelos* of teachers with positively valued mathematical stories and their 'reinvigoration'

Seven teachers articulated this position. Three of the seven teachers with positive maths histories of participation described their learning experiences within NICLE using the verbs *freshened* or *refreshed,* and these verbs are synonyms of the term, *reinvigoration*. In response to the question, 'how would you describe yourself as a numeracy teacher?', Ruth said that she had a 'very good number sense'. Explaining the nature of her participation in NICLE and how it supported her teaching of maths, Ruth said that NICLE had '*freshened* it up … ha[d] *awakened* that interest again'. Melania, in describing herself as a numeracy teacher, commented: 'I enjoy maths and hopefully my enthusiasm for maths spills over to the children so that it makes them enthusiastic and excited to do maths as well.' Describing the nature of her learning in NICLE, Melania said:

> I think it's 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 given me new ideas *boosted my enthusiasm again*.

Robert's positive mathematical history and identity are evident in his learning story, as he explained 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'. Like Melania, Robert said that his participation in NICLE *refreshed* him and to him that '*refreshment* is always welcome'. He went on to explain how his 'understanding of mathematics was *stimulated* and it was supported because the little I had I felt it was starting to

grow through participation in the numeracy professional teacher learning community'. Ruth, Melania and Robert described the nature of their learning through their participation in the NICLE with the following verbs, *freshened, awakened, refreshed, revitalised* and *stimulated*. Notably the verbs *freshened* and *refreshed*, which have the same verb root – *fresh* – was used by all the three teachers, even though the interviews were conducted separately and at different schools.

Evelyn, like the other three teachers, acknowledged that she 'really enjoy(ed) her mathematics teaching' and described the kind of learning within the NICLE as '… *reinforcing* what I have, what I already do put into practice'. The verb '*reinforcing*' used by Evelyn adds a new 'strengthening' or 'entrenching' dimension to the verbs *freshened* and *refreshed* used by Ruth, Melania and Robert to describe the nature of their learning within NICLE.

The other three of the seven teachers, who had positive maths histories prior to participating in the NICLE, used phrases that relate to *growth* to describe their learning experiences. Thus Edna, who had a 'good understanding' and 'love of numbers', felt that her participation in NICLE offered her the 'opportunity … to *grow* in that field' (of primary maths education). Calvin, one of the two Intermediate Phase male teachers described himself as a primary maths teacher who 'like[d] teaching maths, in fact I wouldn't like to teach another subject'. Calvin explained the nature of his participation in NICLE by saying, '*my sense of mathematics are 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. Swallow had a positive maths identity, as she outlined that she 'love[d] numeracy teaching. I am quite confident in teaching my maths.' Swallow expressed how her participation in NICLE had helped her not to feel 'isolated' and not 'to get stuck in a rut', and allowed her to 'see other ways and other approaches'. The opposite of being stuck in a rut implies *growth* of new practices and ways of being in the classroom. Edna's phrase of describing her learning experiences within the professional teacher learning community, as providing an 'opportunity to grow' contains the word '*grow-th*'. Likewise Calvin's statement that his 'sense of mathematics [was] being tested' and Swallow's idiomatic expression that participation in NICLE enabled her not 'to get stuck in a rut' are both closely linked to the notion of *growth* and the term 'growth'.

The argument of this paper is that the umbrella term *reinvigoration* can be substituted for the verbs and phrases used by the seven teachers with valued maths histories to explain their participation and learning experiences within the NICLE. The actual verbs used – *freshened, refreshed*, *reinforcing* and *growth* – are in the same semantic field as the umbrella term *reinvigoration,* which is our candidate metaphor to describe the nature of participation in NICLE of teachers whom we regarded as having positively 'valued' primary maths identities. *Reinvigoration* is thus the synonym-cum-metaphor that holistically captures all the teachers' verbs and phrases and in unison describes their participation and learning experiences in NICLE.

Outcropping maths identities

Outcropping maths identities also emerged in the case of three of the seven teachers whom we have identified as having strong maths histories. These teachers do not confine their participation to NICLE and their maths classes: the trajectories of their maths identities extend into a wide range of mathematical dispositions and mathematics education practices, crossing boundaries and linking overlapping communities of practice (Wenger 1989). This accounts for our use of the term *outcrop* to indicate the growth and expansion of such identities into other related maths communities or practices. The term *outcrop* relates to what Wenger (1989:154) identifies as *boundary trajectories*, which find value in 'spanning boundaries and linking communities of practice' (Wenger 1989:154). In the following passages we illustrate Edna's, Calvin's and Robert's unique and distinct outcropping maths identity

trajectories, which were triggered through their participation in the primary maths teacher learning community of practice.

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) six months after participating in the maths learning community. According to Edna, it was through participation in NICLE that her mathematical trajectory had extended into AMESA, as she expressed that NICLE 'introduced me to AMESA'. Using Wenger's (1998:154) 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] in addition to a field of influences [NICLE participation]'.

Robert, an intermediate phase maths teacher with a 'love for teaching mathematics', was awarded a scholarship by the Numeracy Chair and is currently pursuing a Master's degree in Maths Education. Robert's new interest in furthering his professional and academic qualifications resulted from participation in NICLE. In furthering his and the learners' interest in maths, Robert's school had taken part in the Conquest maths competitions held in KwaZulu-Natal, with one of his student doing 'tremendously well' in the competition. He also looked forward to joining AMESA in the following year. Robert's outcropping learning trajectory had expanded into overlapping maths education communities, with his identity forming trajectories 'both within and across (maths) communities of practice'. In his maths teacher identity was embedded the notion of life-long learning, which cohered with the desired 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 *stelo* illuminates Wenger's argument that 'a community of practice is a field of possible trajectories' (Wenger 1998:156). In Robert's case the possible pathways are various yet all relate to his maths teacher identity and learning trajectory.

Calvin, the other male intermediate phase maths teacher in the sample, acknowledged that AMESA was 'a thinking thing' and had been negotiating with his school principal for permission to join AMESA. Beside the quest to join a professional maths teacher association Calvin's engagement with maths extended into informal mathematical conversations with friends and colleagues, as he said:

> I talk to M … B…, she is also teaching at A … primary … we talk mathematics. N … is my neighbour … we also talk maths. V …W… we talk mathematics ... my friends … I am working with anyone who is doing maths.

Calvin had also conducted cluster maths demonstration lessons for other Intermediate Phase teachers, and his emerging identity trajectory as a primary maths teacher trainer was encapsulated in the district education office's request that he 'be part of the presenters for CAPS': 'so in March (2012) I will go for CAPS training and then I will train the teachers, and it will be interesting ... learning to teach others'. Calvin's distinct maths identity was 'spanning' from the NICLE into other maths education communities, thus giving him the opportunity to develop a maths identity that moved towards a maths teacher trainer trajectory. Calvin's *outcropping* maths identity trajectory, which, according to Wenger (1998:154), 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 with the intention of establishing specialised maths leader educators.

The *stelos* of teachers with stunted mathematical histories and their 'activation' in NICLE

In our sample we had two teachers whose identities before their participation in NICLE indicated weak

or negative mathematical histories. Pamela's past maths trajectory indicated that she feared maths as she acknowledged that participation in NICLE had obliged her to confront 'some [mathematical] fears that I did have'. Mary's life history was also marked by unpleasant maths classroom experiences as a student, which had resulted in a negative maths identity. 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.

This negative past maths identity is repeated in Mary's learning story, when she explained, 'initially I was scared [of maths] because of my lack of confidence and knowledge and experience'. When Pamela outlined her maths fears she did not explain when the problem began or what its cause was, while Mary's *stelos* clearly showed how she struggled with maths at high school and felt uncomfortable teaching maths in her early career experiences. Lave (1993b:77) gives an example applicable to Pamela's and Mary's fear of maths and, according to her, the statement that 'we don't know real maths' is associated with devalued or negatively valued identities. Using Lave's lens, both Mary and Pamela's past identity trajectories had 'negatively valued maths identities'. From Mary's learning story we deduce that her high school maths experiences *stunted* the emergence of a more positive maths identity. This is similar to Lave's (1993b) observation that schools contribute to the creation of negative identities. By *stunt* we mean life, school or career experiences or expectations that create trajectories that shy away from maths. The word *stunt* also comes from our theoretical framework, with the antonym/opposite of this term within the situative framework being *sustained*: according to Lave (1993b), identities and knowledge are formed and sustained in communities of practice.

Though Pamela said that she had a fear of mathematics, this had changed through her participation in NICLE: '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.'

NICLE thus enabled the *remediation* of these maths fears. According to Pamela, participation in NICLE had 'changed her thinking', helping her to shift to a new and transformed mathematical identity of one who 'loved mathematics'. This shift was thus *activated* through engaging in the primary maths teacher learning community. Mary had a similar though unique *stelos* – through participation in NICLE her numeracy teacher identity was being fashioned, 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.

From this utterance we can deduce that a new mathematical identity trajectory was being *activated* through Mary's participation in NICLE. Her words cohere with the primary intention and the future projected identity of NICLE, which aims at creating a numeracy teacher identity.

Furthermore Mary also attributed her reformulated numeracy teacher identity in part to her mother, saying,

> 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.

On the NICLE's refashioning of her prior devalued maths identity, Mary said: 'Well it is helping us develop professionally. It is helping … develop my self-confidence with Mathematics.' Mary through her narration and recalling of her mother's mathematical mind and participation in NICLE managed to *remediate* a mathematical persona. The concept of remediation, though emanating from our empirical data, is akin to the terms 'reconstruction' (Lave 1993b:73) and 'reconstitution' (Cain 1991:218) used by

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). We would like to use the term *remediation* in a similar sense. The generalisation that we can make from the *stelos* of Pamela and Mary is that a history of weak mathematical identities becomes *remediated* and new mathematical identities are *activated* through participation in maths teacher communities of practice. Such mathematical identities had been *stunted* by life, school experiences and/or career expectations to create identity trajectories that fear maths.

Conclusion: potentials and limitations of the Communities of Practice teacher in-service models

Lave (1993b: 77) has argued that 'identities are formed and sustained' in Communities of Practice. It is participation in communities of practice that 'makes possible certain kinds of transformations of understanding, identity and knowledgeable skills' (Lave 1993b:81). Several studies that have recontextualised the notion of community of practice in maths teachers' professional development have also reported maths teachers' transformation or changes in their mathematical identities, understanding and knowledge (Adler 1998; Matos 2009; Lerman 1998; Graven 2004; 2005b). Evidence from the teacher interviews – 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 into more positively valued primary maths teacher identities. Successful teacher participation, empowerment and learning occur in professional teacher learning communities, as is well documented in the literature (Little *et al*. 2003; Matos 2009; Farmer *et al*. 2003; Heaton and Mickelson 2002; Shulman and Shulman 2004). The literature and our empirical findings suggest that the formation of maths professional development programmes underpinned by Communities of Practice theory leads to beneficial change in primary maths teachers' identities.

The contribution of this paper is twofold: firstly, it illuminates the way in which the use of metaphors supports the idea of capturing the nature of learning within communities of practice as 'participation' that results in 'transformation and change' (Lave 1993a:30) in identity (Wenger 1998). The verbs and phrases used by the teachers conduced to the emergence of the metaphorical umbrella terms *reinvigoration* and *activation*, which support the postulate that 'transformation' happens through participation in communities of practice. *Reinvigoration* and *activation* are closely related to the word, transformation, which usefully characterises the knowledge and identity changes that arise from participating in communities of practice. The metaphors thus provide a language to describe 'mechanisms of learning' (Lave 1996) in communities of practice. Secondly, the paper proposed the two metaphors to capture the learning of the nine teachers in an in-service programme and connects these with mathematical histories and trajectories. The study argues that teachers with a history of maths competence have their maths identities *reinvigorated,* while teachers with identities that previously shied away from maths have their devalued maths identities a*ctivated* through participation in communities of practice. The result in both instances is the emergence of teachers with strong maths identities. Whilst there is empirical evidence of change in the primary maths teacher identities, as revealed in their utterances, we are still collecting more data that will help us confirm a shift of the teachers' mathematical knowledge, skill and understanding, and we will in due course report such findings.

However, while much is promised by professional teacher learning communities, the challenge is how such communities can be created for a larger audience or for mainstream teacher education. The potential and strength of maths communities of practice professional development programmes is well explained in the literature; but the major challenge facing this initiative is the question of how professional in-service development frameworks can be expanded to cater for a larger number of teachers, to maximise its

potential and enable effective teacher learning. Professional teacher learning communities are haunted by the disadvantage of scalability. Research studies we have drawn on here point to a small number of teacher participants, ranging from 6 to 40. For example Hulliet's (2008) maths research group had 6 educators, Graven's (2004) in-service Community of Practice consisted of 14 maths teachers, Fennema *et al*.'s (1996) numeracy professional development community had 21 primary teachers, Maistry's (2008) teacher learning community had 22 teacher participants, and Jaworski's (2006) maths Community of Inquiry had 40 teachers. The dilemma is that professional development approaches are under pressure to find ways to cater for a large number of teachers while not compromising the quality and effectiveness of teacher learning communities. Furthermore the upward rescaling of in-service programmes would need to consider the cost element (Graven 2005a). Perhaps the questions we need to ask are: how big is too big, and what changes emerge as a community gets bigger? There is thus a need for further research to investigate how smaller teacher communities of practices can be reformulated into bigger professional learning communities (or bodies), while yet retaining their teacher learning benefits and potentials.

NOTES

[1]   Lave (1996:156) defines 'learning mechanisms' as 'ways by which learning comes about'.
[2]   More recently Sfard has chosen to replace the term 'actual' with 'current' to avoid the term sounding declarative (see Graven 2012).

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