Transformation of teacher identity through a Mathematical Literacy re-skilling programme

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Wenger's community of practice theory is used to illustrate how, through careful curriculum design, teacher identity can be developed by participation in a re-skilling programme. In the context of learning, a community of practice involves the complex intersection of various components of learning, namely, meaning (learning as experience), practice (learning as doing), identity and community (learning as belonging). The Advanced Certificate in Education in Mathematical Literacy programme was designed to expose participants to knowledge and understanding of the ML curriculum (meaning), development of an integrated approach to teaching and learning, classroom didactics, lesson plans (practice), and group work activities where active participation and dialogue in lectures were encouraged (community). The programme design aimed to promote a change in the teachers' way of being (identity). Through semi-structured interviews with teachers their journey as individuals was revealed. The findings indicate how by focusing on both content and on the teacher's becoming a professional can assist educational specialists in their quest for improved teacher development.

Keywords: community as practice; identity transformation; learning as becoming; mathematical literacy; re-skilling

Introduction

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

Mathematical Literacy (ML) as an alternative to Mathematics is a new learning area introduced in South African schools since 2006. The learning area ML is defined as "driven by life-related applications of mathematics" (DoE, 2003:9). Christiansen (2006:10) claims that the two main reasons for introducing ML were to reach the Grade 12 school leavers without Mathematics, as well as the large number of learners who fail the subject each year. While Mathematics is not only a gateway subject to many disciplines, a citizen needs to have some form of mathematical literacy to be a productive independent member in the society. Therefore either Mathematics or ML was made a compulsory subject for all South African learners in Grades 10–12 since 2006 (Vithal & Bishop 2006:2). This severely impacted teacher training as it placed an extra burden on South Africa's already short supply of qualified Mathematics teachers. As a result, many teachers from other learning areas were employed to teach ML and this raised questions as to their competence and capabilities in this learning area.

To enable teachers from other learning areas to cope with the teaching of ML, a Uni-

versity in Gauteng province introduced an Advanced Certificate in Education in Mathematical Literacy (ACE ML) in 2007. This programme was designed to not only provide subject content, but also promote an identity transformation amongst participants towards becoming ML teachers. The rationale for this was that the mathematics experience of teachers during their school years often leaves them with a negative attitude and fear, because they lack confidence in their own ability to cope with mathematics. According to Wenger (1998) in a community of practice (COP) identity is reflected in the way we talk about how learning changes who we are. This article reports on teachers' identity transformation in the process of becoming ML teachers which took place in terms of meaning (learning as experience), practice (learning as doing) and community (learning as belonging). The notion of identity related to being a professional and "learning as becoming" is explored.

Theoretical framework

Wenger (1998) conceptualises learning through participation in a community of practice, involving four components: practice, meaning, identity, and community. He provides a conceptual framework to analyse learning as a social entity by using identity and community of practice "as the main entry points into a social theory of learning" (Wenger, 1998:12). Graven (2002:144) supports this view when emphasising interaction and the variety of roles the participants play during this interaction as important contributors to an effective learning experience. Wenger further considers the way a person talks about a learning experience as a reflection of changes in the person's identity, as the meaning attached to experiences forms identity. This also relates to teachers who learn to become professionals through a process of transformation during which their identity as teachers changes (Dall'Alba, 2009:37).

Jansen (2001:242) defines teacher identity as "their sense of self as well as their knowledge and beliefs, dispositions, interests, and orientation towards work and change". Therefore, when one looks at ML teachers' identity transformation, one has to look at their "new" sense of themselves, their knowledge and beliefs about ML teaching, their dispositions and their orientation towards teaching ML after (and during) their participation in the ACE programme.

The ML curriculum clearly defines the ideal identity of a ML teacher. The concern for teacher education is whether the identity as projected in the curriculum matches that of the teachers who participate in ML training. Jansen (2001) warns that the conflicting policy and actual teacher identities can create a barrier to effective implementation and therefore hampers educational reform (Jansen, 2001:242). To avoid this possible implementation dilemma, it was necessary to establish whether the ACE ML programme assisted the participants to learn in such a way that their teacher identities could transform towards what was stipulated in the programme outcomes as "being a professional teacher".

Participation, according to Wenger (1998:4) is more than just to engage in local events or specific activities with certain people. It is a "more encompassing process of being active participants in the practice of social communities and constructing identities in relation to these communities". In an educational setting learning to think and act according to the rules of the discipline and being able to communicate as a member of the specific educational community (Wenger, 1998:81) are essential for successful teaching. In the ML study discussed here the aim was to establish whether teachers became active participants in the practice of the ML community and how, through their participation, they constructed ML identities as they participated in programme activities. During the programme participants had to design lesson plans, critique each other's presentations and use the internet as a tool to prepare lessons and

assessments. Wenger also argues that active participation "shapes not only what we do, but also who we are and how we interpret what we do" (1998:4). Therefore the teachers' way of doing (did it change and how), how they perceive themselves as teachers and how they interpret what they do as ML specialists was monitored. In this way the teachers' views of their own process of becoming an active participant in the ML community, their level of participation in this community of practice, and their sense of belonging would reflect their identity formation in the "new" discipline.

This process of becoming happens over a period of time during which participants should be exposed to purposefully designed learning activities. De Saint-Georges & Filliettaz (2008: 220) refers to this process as a "trajectory of learning". This trajectory is however not only dependent on the learning activities, but also on the participant, and therefore has no fixed outcome. The learning activities in the ML programme were aimed at facilitating each individual participant's learning process by providing opportunities for identity change towards becoming a professional teacher.

Wenger (1998:125) emphasises the close connection between learning and changes in identity. From the analysis of the ML curriculum, it is evident that ML requires teachers to develop new beliefs, perform new roles and construct new identities in relation to other learning areas. ML is different 'in purpose and kind' from Mathematics and so requires a shift in identity. Furthermore, the contextualisation and newness of the subject require that teachers put the mathematical content into real life context and become participants in the classroom rather than didactical leaders. The National Curriculum Statement (NCS, 2003a:9) defines ML as "a subject driven by life-related applications of mathematics". It requires teachers to develop new beliefs (for example, marrying content and context), perform new roles (for example, teachers should act as facilitators in classroom) and construct new ways of doing in the classroom (away from superficial and abstract manipulation of numbers).

To apply Wenger's model (1998) either for the design or analysis of an ML curriculum is appropriate because of the four premises this model is based on:
• people as social beings is a central aspect of learning;
• knowledge is about competence with respect to 'valued enterprises';
• knowing is about active engagement in the world;
• meaning is ultimately what learning produces.
Graven (2002:141) states that "mathematics educators are increasingly noting the importance of Lave and Wenger's (1991) work for analysing mathematics teacher education" and that this theory can be used to understand teacher development. How the four premises of Wenger's 1998 model are incorporated in the ACE ML curriculum is explained below.

Wenger's belief that knowledge is about competencies related to valued enterprises is reflected in the inclusion of knowledge that is considered to be essential in a mathematics community. For example, in the various modules participants are exposed to numbers, space, shapes, and measurement; financial mathematics and functional relationships; statistics and probability. To add practical value to the content teachers are assisted with activities as such, reading maps, calculating time differences when travelling internationally, and adjusting recipe quantities. This content not only serves to make participants aware of what the "valued enterprises" pertaining to ML are, but also enables teachers to act as facilitators who can integrate content and context in the classroom. It thus engages them in real world activities related to both their professional and their personal lives.

The notion of identity and learning as becoming in an ML community of practice is

explored in this article. The focus is on practice (learning as doing) and meaning (learning as experience), both in relation to identity. "Learning is first and foremost the ability to negotiate new meaning" (Wenger, 1998:226) and "because learning transforms who we are and what we can do (practice)" (Wenger, 1998:215), it allows for new identities to develop. Learning as becoming thus takes place within a community of practice where membership "is a matter of mutual engagement" (Wenger, 1998:73).

Research methodology

A qualitative approach (Strauss & Corbin, 1998:11) was selected for this study to enable analysis of the identity transformation, that took place in one group of teachers participating in an ACE ML reskilling programme, presented by a university in Gauteng province in part-nership with a non-profit organisation. Because this study investigates lived experiences and behaviours it is in keeping with the qualitative approach (Strauss & Corbin, 1998:11).

Data collection and analysis

Participants were selected from the first group of students enrolled in this programme who started in January 2007. There were 18 participants in the programme of whom I selected the eight participants that already taught ML. One withdrew, due to time constraints, leaving seven teachers who took part in the semi-structured interviews. All participants were informed as to the goal of the research, as well as the procedures they would be involved in, and written consent was obtained (Vos, Strydom, Fouche & Delport (2005:65). The interviews were voice recorded and transcribed and the different interviewees were numbered to protect interviewees' identities for ethical reasons.

Thematic analysis was used to analyse the interview transcriptions by using the themes of Wenger's theoretical framework, namely meaning, practice, community and identity. This process of thematic analysis "involves the identification of themes" when analysing data, in this case the interviews (Fereday & Muir-Cochrane, 2006:3). The students' study material of Modules 1 and 2 of the ML programme were used as a means of collecting data in order to illustrate how the course was structured and set out to develop teachers' identity. Vos et al. (2005:323) refer to this way of data collection as the method of document study and classify these documents as official documents. Although there were four modules, only two were analysed as they were the only modules already covered at the time of the study. The focus of the interviews was captured by the following question:

> How do you feel you have changed from when you began this programme to now?
> (Prompt if necessary):
> • in your teaching
> • in your experience/understanding of what ML is about
> • in the way you interact with others about ML (parents, other teachers, etc.)

The aim of the document study was to get clarity about the relation of each modules' outcomes and content to Wenger's four components, namely, practice, meaning, identity, and commu-nity. Module 1 is an introduction to Mathematical Literacy and Module 2 deals with numbers, space, shapes, and measurement. The following broad outcomes of Module 1 are (ACE ML Module 1 course outline, 2007:2):

• Critical analysis of national and international literature on mathematical literacy
• Introduction to the new FET curriculum documents
• Discussion of the implementation of the Mathematical Literacy Curriculum and the design

of learning units for use in South African schools
• Analysis of Mathematical Literacy learning materials and text books
• Critical analysis of issues related to the contextualisation of mathematics

These outcomes suggest a focus on understanding curriculum issues as well as the implementation thereof, which relates to Wenger's learning component of meaning. The contextualisation of mathematics envisages that the teachers who exit the ACE ML course will have the ability to work with mathematics in real life contexts (practice component). Participants need to reflect on their practice during this module, which can assist them in critically evaluating their practice and challenge their beliefs about mathematics. By discussing the content of the material, the community of practice is strengthened and an environment conducive to change is created, since new insights and changes in perspective and identity can occur. The overarching purpose of Module 1 thus relates to changing and developing teachers' ways of being and their practice in the classroom by strengthening teachers' competence and confidence as ML teachers in today's classroom.

The outcomes of Module 2 require participants to:
• demonstrate knowledge and understanding of the mathematics in the course content;
• demonstrate the ability to solve problems based on the content as embedded in real-life contexts;
• demonstrate the ability to apply the knowledge and skills attained to the teaching and learning of Mathematical Literacy in the FET band in accordance with the ethos developed in Module 1.

The first outcome emphasises the content knowledge and understanding of numbers, shapes and measurement and relates to Wenger's learning component of meaning. The second outcome focuses on problem-solving, based on the content as embedded in real-life contexts. Participants need to develop competence in putting mathematical content in context, which deals with learning as experience. The third outcome of Module 2 emphasises the application of the content and skills learned in the classroom. This relates to Wenger's component of practice and experience since it involves learning by doing.

Findings and discussion
The results of the interviews and the document study are reported together, categorised according to Wenger's four components in his conceptualisation of learning.

Meaning
As a relatively "new" learning area, teachers initially were not very well versed in either the ML curriculum or its aims and objectives, despite the fact that some were already teaching this new learning area. In Module 1 of the ACE ML programme teachers were exposed to the curriculum document and readings related to ML to give them a better understanding of the nature of the learning area. Some of the teachers first explained that they had little prior knowledge of the nature of ML as a learning area. Teacher 1 said:

Actually I did not have a choice. Yah, I didn't know anything about it. Yah, so the principal told me that … they are looking for people who can attend ML programme — those who don't have ACE. Yah, that's how I've attended the programme. I was reluctant to do it. Yah, because it was for ML, and I didn't know anything about ML … And then I was told that I was given ML classes. But by then I was very nervous because I was asking myself what am I going to do in the class because I don't know anything about this subject.

Later on in the interview she expressed her better understanding of ML as a learning area:

> "*But then, since I attended ACE I found that ML is a very simple subject for me …*",

and even later:

> "*Now I am able to distinguish between ML and Mathematics and it also helped me because ML is all about what we do every day*".

Teacher 2 confirmed the incremental learning after her initial lack of knowledge: "*And then after some time I got to know what it is really about* [ML]."

This shift indicates the learning experience caused change. This teacher, who was reluctant to attend the ACE ML programme, said later on that she did not want to teach any subject other than ML. This indicates a change from being forced into the subject to ownership of a longer term commitment to not only teach the subject but to prefer it.

In the interviews it became evident that the teachers' attitudes to ML had become more positive. Some teachers initially thought ML was a learning area of lower value and that teaching this learning area was "*impossible*", that it was a sub-subject to Math(ematic)s. Since their involvement in the ACE ML programme, their attitudes to ML have changed. This is illustrated in the following comments by two different teachers:

Teacher 2:   *I thought ML is, for what I know, its basic Math(ematic)s. I thought that was it. Little did I know that it is everyday things.*

Teacher 3:   *No I have changed. The thing is I had an attitude towards the subject because of I didn't have that knowledge. But my attitude has now been positive. I am now positive towards ML. When I started learning the content, understanding the content, then I started to know: No, this is not so much difficult.*

In the ACE ML programme teachers were confronted with, for example, the curriculum document, the content knowledge, the assessment policy, and how to approach the concepts. This is evident from an outcome of Module 2 which stipulates that students should be able to demonstrate the ability to apply the knowledge and skills attained to the teaching and learning of ML. This knowledge enabled them to change their understanding of what ML entails.

Participants' improved knowledge and understanding about the learning area also influenced their attitude towards it. Some of the teachers mentioned that ML is now a "*good subject*" because they are familiar with the content and the approach to the subject. I interpret this as teachers feeling more confident in interacting with and understanding ML content. Some of the participants, like Teacher 3, now call it a simple (easy) subject:

> *When I started learning the content, understanding the content, then I started to know: No this is not so much difficult … it made me to change towards the subject as a whole.*

They also appreciated the practical approach of ML like Teacher 4:

> *I've benefited a lot now because my mind was only focused on Math(ematic)s knowing that but only to find that we have to do things that are real in ML.*

Teachers' knowledge of ML increased and the application of this knowledge extended beyond the classroom. They claimed to have gained a great deal of knowledge of the subject in the ACE programme.

Teacher 4:   *I was not knowing about, anything about a graph and I was not interested in reading the newspaper, especially when I see this pictures of the graph or whatever, I was just lying. But now I learnt a lot …*

And later on in the interview:

> *Now my knowledge is broad concerning this subject. I can say the changing is that I now*

got ML based on real life situations and then it doesn't end up in the classroom, in the textbook, it goes broad.

The above quotes provide evidence of teachers noting the importance of their increased knowledge of the subject, as well as how an increase in mathematical ability strengthened them to experience the subject as meaningful. From knowing little about ML, participants came to understand its real world usefulness. Through their involvement in the ACE ML programme, teachers could see the specific emphasis ML has on content knowledge being linked to real-life situations. They not only understood the meaning of the module contents, it also gave meaning to everyday aspects of their lives.

Practice

Teachers' involvement in the ACE ML programme contributed to their learning as changing practice in the classroom. The teachers mentioned that their teaching had changed a great deal since they started the programme.

Teacher 6:   *Hey, I've changed a lot … I see myself as a changed person because some of us that are both me and my fellow teachers grappled with how are we doing this, how can I approach this concepts. So I found it* [a] *very challenging part that I am now coping …*

When asked how her teaching has changed, it became evident that she has adopted a new teaching approach:

I … would just teach and then sit down and try and see if I was on (the correct) track or not. It has empowered me. I would sit and come up with a different strategy so that my learners will be able to understand what I'm teaching. What is important for the learners to have listen[ed] *and then be able to understand what I was offering … them. At some stage these things have challenged me, but some of my colleagues in class assisted me as to how you approach this in class*.

It appears that this teacher's way of teaching changed due to her involvement in the ACE ML programme, in particular due to her interaction with colleagues in the ACE ML group. Teacher 4 said:

My teaching … day by day I'm doing better … Last year to be honest, I didn't know just what I was doing actually, but as time goes on then I started [to] learn a lot. This is how I should actually unlock this knowledge to the learners … I have different styles of teaching now that I can apply in my teaching.

This teacher acknowledges how her learning in the ACE ML programme changed her teaching style and way of 'doing' in the classroom.

Teachers indicated that they had learnt to relate their teaching to everyday experiences (activities), integrating Mathematics with contexts by linking context and the content and differentiating between the two. This was a significant shift to integration because, although it has always been a feature of good teaching, South Africa's education focus was not on integration before the introduction of Curriculum 2005. In Module 2 an outcome stipulates that participants must be able to demonstrate the ability to solve problems based on the content as embedded in real-life contexts. All seven teachers interviewed talked about how they could now apply ML knowledge in practice integrating mathematical content and context in real-life situations. The following excerpts support this.

When asked how they experienced the teaching of ML for the first time, Teacher 7 replied:

You see things you come across in everyday life activities. You talk about interest rate, ML will help you understand economy. You talk inflation, we don't know what is inflation. So more of a general knowledge, things you come across every day, you just need a bit of mathematics ... Well before I joined the ACE programme I was teaching mathematics. Purely mathematics in the class ... because I didn't understand the difference between ... I couldn't draw the line between the two subjects ... But after I came to the difference of ML, I could now see that the emphasis is now on the context not the mathematical content. You put the context and then look carefully at other things to ensure the content.

This teacher explains that making a mind shift in his teaching of ML by integrating the content with the context changed his practice.

Other teachers replied to the question of how they benefited from the ACE ML pro-gramme, as follows:

Teacher 5:   *It is really talking about real life situations. Things that we do in there we now can prepare for the learners before they can come face it outside. Now I under-stand what ML is all about.*

Teacher 3:   *And I can marry the two* [context and content] *so that the lesson can be more interesting and exciting to the learners… I am going to talk about things that learners see outside.*

In the past, the Mathematics was taught in an abstract way to the learners, but the classroom practice has changed in such a way that learners can now "see" it in their everyday lives.

Community

The teachers in this study attended the ACE ML programme for eighteen months. They became what they would describe as "*like friends*" and influenced each other in different ways. Wenger (1998:76) states that "each participant in a community of practice finds a unique place and gains a unique identity, which is both further integrated and further defined in the programme of engagement in practice". So people's membership in the same community of practice does not imply sameness in identity as each person's engagement and meaning making is different. Different identities will therefore evolve, even in the same community.

Teachers claimed they were now able to participate in discussions on ML, and even debate issues, due to the understanding of the subject. An example is found in Teacher 7's response to a question on the main benefits of the participation in the ACE ML programme:

I am now able to participate in discussions, but before I wouldn't have participated, you know. I wasn't confident, but now I am.

This indicates new forms of participating and engaging with people. Teachers got assistance through their involvement in the community of practice. This involvement led to better insight and understanding of the issues around ML.

Wenger (1998) defines identity as ways of talking about how learning changes who we are and what we see. Through the interviews where teachers talk about their journeys, it could be seen that their identities changed through their involvement in the ACE ML community of practice, as a comment by Teacher 5 related to interaction with others revealed.

You see, it really helped me a lot because when I talk to my colleagues, some of the things I thought I know then, only to find they also feel this in a different way and if I then start to compare mine with theirs, I see, hay, I must change there because this is very much good rather than the information I was having.

Through his interaction in the community this teacher gained new insights, and his way of

belonging changed too.

Teachers in the ACE ML programme assisted one another in gaining a better under-standing of this new subject and the teaching of it. Teacher 2 mentions that

… [if] *I have something that I do not understand, I always go to my colleagues and then they help me with 1, 2, 3. And when they cannot help me, I talk to my teacher* (course lecturer).

Later on she explains:

We exchange papers. How do you feel about my question paper? Then you moderate

This teacher claims to be comfortable to assist and be assisted, thus benefiting from these interactions and learning takes place in the process.

Teachers also learnt from each other in group work and presentations where ideas are shared. They found these interactions very helpful in their development, enabling them to grow and overcome challenges.

When asked what aspects of the programme led to the changes she was experiencing, Teacher 1 replied:

We used to make presentations. And then when you present there, and then they used to correct us: No you shouldn't do this, you must do that.

Later on she mentioned:

If you present something to your colleagues because they are my colleagues I believe they know more, better than the learners…I think you benefit a lot.

The participants, then, experience a new way of belonging. At first they were uncomfortable with comments about the presentations, but later saw the input from their colleagues as beneficial. So the nature of their positioning and their participation within the community changed. All these experiences contributed to the teachers' way of belonging within the community.

Identity

At the end of the interviews, teachers were asked how they saw themselves at that moment. The purpose of this question was to investigate the future trajectories of the different parti-cipating teachers in order to assess how, if at all, their identities had changed.

Teachers' sense of community changed their ways of belonging. They described their relationships with fellow ACE ML participants as being '*like friends*' who influenced each other in different ways. Where they might have been negative at first when receiving criticism from colleagues, they later saw it as a learning experience when advice was given. One par-ticipant felt so empowered and confident that she was willing to conduct workshops to share her knowledge of ML with newcomers in the ML community of practice. Their roles also changed within cluster meeting as they took up more prominent roles due to their confidence in the ML subject field.

The learning trajectories of teachers differed and the outcomes varied for each individual. The outcomes can be grouped into three categories:

• Teachers whose previous identities moved to the background and their ML identities to the foreground.

• Teachers who added their ML identity to their existing identity, leaving them with a dual identity: the one they had before their involvement in the ACE ML programme and the ML identity.

• Teachers whose identity before the ACE ML programme was maintained, while their ML identity was still developing .

The meaning of ML changed as teachers' knowledge of ML increased and their application of this knowledge broadened beyond the classroom. Their level of expertise increased as a result of their improved knowledge, and they appeared to have a new outlook on the subject. There was also an emerging identity of seeing the subject as a 'good' or 'easy' subject, in contrast to the earlier perception of ML as a learning area of lower value, an 'impossible' subject. The emerging identities reflected competence and confidence with, for example, the ML curriculum, the Mathematics content knowledge, how to read and interpret graphs, how to marry content and context, or how to work with probability.

In relation to practice teachers began to see themselves as facilitators in the learner-centred classroom, they became more competent in introducing new concepts, could use a broader variety of resources in the classroom and they started to enjoy teaching the subject. Their evolving identity emerged beyond the classroom to where participants saw themselves as leaders in aspects of their everyday life related to the field of ML.

Conclusion

The emphasis on mathematics related subjects as gateway subjects to further education, places extra demands on the preparation of teachers for these subjects. The changes that took place in teachers during the ACE ML programme indicate that the fear associated with these subjects can be dispelled by using an appropriate curriculum for the re-skilling of teachers who were not initially trained in any field of mathematics. For the participants in this study, the structure and nature of the ACE ML programme was conducive to identity transformation which assisted them on their trajectories of learning to become professional ML teachers. As they interacted with the ML curriculum content, with putting content within context and worked within a community of practice for one and a half years, their way of being changed. Although there were individual differences in the extent and nature of these changes, all participants reported some advances in their understanding of and attitude towards the new subject. Using Wenger's principles that foster identity change in a learning situation, this study showed teachers on their journey of becoming in a new subject area. For all the participants it contributed to changing ways of being in the world in terms of teachers' experiences (meaning), ways of doing (practice) and belonging (community). For teacher educators it implies that programmes can be designed to not only provide teachers with the necessary knowledge and skills during re-skilling programmes, but also to develop an appropriate teacher identity for a specific subject area. Teacher educators need to design programmes keeping in mind what the identity(s) of participants they envisage and to then incorporate ways in which they foster it (them) in their programmes.

I would predict that, with more exposure to this kind of learning, more participants' identities will shift to foregrounding their ML identity and their ML identity growing stronger. Some participants' previous identities will be backgrounded even more as the ML identities come to the fore.

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