

## **Wenger's (1998) perspective on learning is 'ready for prime time' in some Mathematical Literacy classrooms**

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In 2007 Etienne Wenger visited Wits university where he presented a seminar on "Practice, community and identity: current issues in social learning theory". During this seminar, a colleague Erna Lampen, asked how notions of learning trajectories and identity relate to mathematics learning in school classrooms when a key problem here is that learner trajectories are outside of the classroom and generally away from Mathematics. Wenger's response was that perhaps his theory 'was not ready for prime time' for school classrooms since in schools we tend to put skills and information before meaning and curricula focus on cognitive aspects of learning while within his theory identity should drive cognition.

In this paper I explore the way in which the implementation of Mathematical Literacy (ML) in South Africa has opened up opportunity for the management of a journey with respect to identity. Learner and teacher interviews across a sample of schools highlight the way in which engaging with 'scenarios' enables increased (and new forms of) participation and negotiability which link to increased enjoyment, sense making and a confidence to extend learning beyond the classroom. The story highlights features of ML and its implementation in these classrooms that appear to be salient in opening the space for learning as changing mathematical ways of being and participating in classrooms and the world.

### **Introduction**

Mathematical Literacy (ML) was introduced in schools in the Further Education and Training (FET) post compulsory phase (grades 10-12, learners mainly aged 15-18) in South Africa in January 2006. The subject is structured as an alternative option to Mathematics, and all learners entering the FET phase since January 2006 are required to take one or other of these two options. ML is defined as a subject driven by life-related applications of mathematics that must develop learners' ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems (DoE, 2003). Emphasis in curriculum documents on developing 'mathematical' competence and confidence, and ways of being and acting in the world, highlights the aim of developing positive mathematical learner identities. Evidence from schools suggests that in practice, learners with weak mathematical histories, competence and confidence are generally the ones being guided towards taking this new subject.

In earlier research relating teacher learning within an in-service project aimed at supporting teachers in interpreting and implementing Curriculum 2005, the notion of learning in relation to developing mathematical confidences and identities emerged as particularly important components of learning (Graven, 2004). Thus Wenger's (1998) perspective on learning was particularly useful in understanding the nature of teacher learning. In this research most participating teachers did not have strong mathematical histories and had *not* themselves chosen to teach mathematics (their pre service studies had been in subjects other than mathematics). This indeed influenced the importance of developing new confidences and identities in relation to mathematics and mathematics teaching. In this study the development of new ways of being and ways of participating in relation to mathematics emerged as essential drivers and enablers of mathematical learning.

Despite the relevance of Wenger's (1998) perspective on learning in the abovementioned study, the relevance of this perspective on learning for Mathematics classrooms in South Africa was much less clear for me. While I agreed with Wenger on his point that his theory may not be ready for prime time in relation to investigating the nature of *student* learning in the majority of the mathematics classrooms I had visited over the past two decades the point did not equally apply to the newly introduced subject Mathematical Literacy. In Mathematical Literacy notions of changing ways of being and acting are incorporated in various aspects of the curriculum documents and documents guide teachers to put meaning before skills by encouraging them to "engage with contexts rather than applying Mathematics already learned to the context" (DoE, 2003, p42). In addition reflecting on the teaching and learning I had observed in some Mathematical Literacy classrooms the notion that teaching was the 'management of a journey with respect to identity' (Wenger, 2007) - in particular with respect to developing confident mathematical identities - resonated strongly.

The story that follows aims to highlight the features of Mathematical Literacy and the implementation of it in a small number of South African classrooms that appear to be central to opening up the space for learning with respect to changing mathematical ways of being and participating in classrooms and the world – when as noted earlier – in many mathematics classrooms such a notion of learning may not be ready for 'prime time'.

### **Data sources**

In telling this story I draw on data gathered by Hamsa Venkat and myself in a multiple case study research project as part of our work within the Mathematical Literacy thrust in the Marang Centre, Wits University. Our research work to date has primarily involved three case study schools - two private suburban and one inner city state school in Johannesburg. Our research traces the experiences of the first cohort of learners and teachers taking Mathematical Literacy and involves classroom observations, some video recording of lessons, as well as questionnaire and interview data from learners and teachers. The quotes and anecdotes I share are selected from the data collected in the classes of five teachers in these schools and I draw on the data collected in extended interviews with two of these teachers namely Edith (private suburban school) and Barry (inner city school).

The data is used to illustrate the nature of shifts in pedagogy and learner participation commonly noted across these classes and schools. The story does not claim to describe teaching and learning in Mathematical Literacy classrooms more broadly. However the story is important because it illuminates *what is possible* when the aims of the curriculum are interpreted as requiring a focus on active participation and engagement with scenarios with the purpose of preparing learners 'for life'.

Why was Mathematical Literacy introduced and who is it for?

Approximately 50% of all learners in the FET band of schooling (Grades 10 – 12) dropped Mathematics entirely as a subject in the past. There was widespread concern for high levels of innumeracy and poor performance on international studies. Mathematical Literacy was thus introduced so that all learners would study Mathematics (in some form) in the FET band.

As noted in the introduction, Mathematical Literacy curriculum in rhetoric is about becoming mathematically literate which is described as a way of being and acting in the world. The subject is defined as “driven by life-related applications of mathematics” (DoE, 2003a, p.9). Learning must be anchored in the real world and mathematics and context must be brought together in a dialectical relationship. Thus the Teachers’ Guide notes:

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

The purpose of Mathematical Literacy is stated in terms of what learners are to become and to be and within this rhetoric an underlying socio-cultural framework is evident. For example, “Mathematical Literacy should enable the learner *to become* a self managing person, a contributing worker and a participating citizen in a developing democracy...” (DoE, 2003, p10) and “to handle with confidence...enable them to deal effectively with mathematically related requirements in disciplines such as the social and life sciences. Mathematical Literacy should not be taken by those learners who intend to study disciplines which are mathematically based such as the natural sciences or engineering” (DoE, 2003, p11)

In contrast, while there is some mention of relatability to the real world in the Mathematics curriculum this curriculum states “Mathematics is a discipline in its own right and pursues the establishment of knowledge without necessarily requiring applications to real life” (p.9) The Mathematics curriculum is a much more knowledge driven curriculum with clear disciplinary boundaries and a focus on the vertical progression necessary for further studies. Thus the curriculum states: “If a learner does not perceive Mathematics to be necessary for the career path or study direction chosen, the learner will be required to take Mathematical Literacy” (P11).

In my previous work (Graven 2000a; Graven 2000b) I identified four orientations towards mathematics present in the curriculum for the compulsory senior phase of schooling (grades 7-9). In current work (see Graven & Venkat, 2007) we have noted that the offering of Mathematics and Mathematical Literacy as alternatives with differing definitions and rhetoric (discussed above) tends to split these four orientations as follows:

### **Mathematical Literacy**

Math for critical democratic citizenship      Math for practical relevance and applications

Anchored in the real world

Focus of rhetoric: Ways of being and acting confidently in the world

Learner histories: weak competence and low participation

Trajectory - into the world (citizenship) and social and life sciences studies

### **Mathematics**

Math for developing mathematical induction into mathematical working      Math for developing mathematical knowledge necessary for further math learning

Anchored in the discipline of Mathematics

Focus of rhetoric: Knowing and understanding

Learner histories: some strength, competence & participation within the disciplinary boundaries

Trajectory – into further mathematically oriented studies

## What curricula features open up spaces for teaching in new ways?

The learning process that results from the implementation of a curriculum is clearly complex with a multitude of factors impacting on the nature of learning. However, there are various features of the curriculum that teacher and learner interviews highlight as opening the space for prioritising participation, negotiation, sense making and ‘preparing learners for life’. These relate to: progression, contextualisation, ‘ways of being and becoming’, commonality in mathematical histories and trajectories into life, and ‘newness’. The table below relates each of these to the opening up of new teaching spaces. While each feature is tabulated separately they are complexly interconnected.

### Curricula feature

Progression is located in the complexity of contexts with less mathematical ‘content’ covered. From one grade to the next mathematical contents are often repeated with the recommendation that they are explored ‘in more complex contexts’.

Focus on contextualisation (and use of scenarios: e.g. electricity consumption, cellular phone packages etc.)

Focus on more ways of being and acting in the world (supported by underlying socio cultural learning theory).

Commonality in mathematical histories and trajectories into life. ML is predominantly taken by learners with weak mathematical histories and is explicitly stipulated as not being for learners who intend to study mathematically related further studies.

Mathematical Literacy is a new subject defined as different to Mathematics (emphatically not a watered down version of mathematics).

### Teaching space

Enables slower pacing and increased discussion. Learner centredness is noted and contrasted to mathematical teaching where pace is set according to stronger learners in order to “get through the curriculum”.

Edith “I am the facilitator and not the teacher, emphasis on understanding concepts rather than being driven by completing the syllabus... More relaxed slower pace... More pupil determined. Structure is more informal, co-operative learning”

Barry: “ It all comes under the heading of less stressful, waiting for the children to understand what is happening rather than pushed to finish the syllabus”

This necessitates discussion and participation in order to make sense of situations and furthermore brings in a personalisation of learning as multiple perspectives are part of the sense making process. Collaborative ways of working are essentially productive of learning (contrasted to group work in Mathematics requiring copying a student ‘in- the-know’). Contextualisation (as well as the ‘newness’ of the subject) also positions the teacher as a co-learner and facilitator of discussion rather than the authoritative source of knowledge – opening the space for a much more distributed locus of authority.

Edith: “We’re on a journey together”

Encourages teachers to focus on learners and their learning in a more ‘holistic’ way – participation, forms of participation and personalisation of learning are of primary importance.

Edith: “(Interaction with learners) is stunning – they are real live people & not just a vessel to fill with maths”

Leads teachers to focus on enabling participation and confidence building in many cases ahead of mathematical learning. (See Edith’s story below).

Less competition and more collaborative working: Barry: “these one’s feel they are all the same. .. I don’t see any of that competitive stuff in my class”.

Explicit departure from preparing learners for further mathematically related studies opens the space for teachers to focus on mathematical engagement necessary for preparing learners for life. Edith: “You know there are a whole lot of things: blood alcohol levels, that is where they are at, teenage pregnancies... its so important to their lives”

‘Newness’ frees teachers from their own schooling apprenticeship experiences to explore new ways of being in the classroom.

Absence of external assessment precedents<sup>1</sup> supports the focus on learning rather than assessment.

Edith: “(The curriculum is) wonderful, allows creativity & freedom to explore, invent, discover for yourself what works, how it works. We’re on a journey together.”

Barry: “This is totally new to me...I’m feeling like really free”

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<sup>1</sup> 2008 the first grade 12 external exit examinations will be written in Mathematical Literacy

Above I have provided some abbreviated quotes to illustrate the points being made in the table. Such abbreviated quotes in separated sections do not however paint a full picture and so below I share with you part of a story Edith wrote about her experience of Mathematical Literacy teaching:

As educators we seldom remember a situation where we have tried to study something and it simply won't sink in. I remember times like this and therefore understand those learners who enter the grade 10 maths lit class for the 1<sup>st</sup> time. Not only do they have these negative feelings but they arrive as mathematically abused young adults...

The Maths Lit teacher, as I have found, must be more than an educator – much coaxing and encouraging is needed... My aim was to coax each learner to participate.... The majority of learners fell into 3 categories – timid, uncertain or downright disinterested. When they were prepared to venture an answer they would want to suck back their words before it was even out of their mouths...

I wish I had a hidden camera in my classroom to show you the transformations of the human kind. Not only are these learners prepared to venture an answer or opinion, they're even prepared to debate their point of view. They have even progressed a step further – they are able to look at their answer – make sense of it and have the desire to rework it if they feel it is mathematically nonsensical. They have blossomed into learners who tackle any task set before them – with confidence.... in their final exam there was a question on scale factor which we had not even discussed – never mind covered. To my delight – every single learner attempted the question and approximately 33% of them did so correctly...

Due to these observations I feel confident that these learners will matriculate having the confidence to deal with numbers boldly in their lives. Maths Lit has given these learners a whole new lease on life – not only have they made friends with numbers but they have grown in confidence in leaps and bounds.

Edith's story above coheres with Wenger's point that identity should drive cognition in the sense that she focuses on encouraging and enabling participation, confidence and 'transformations of the human kind'. These transformations (considered especially important because of the polar opposite experiences in most of these learners mathematical histories) then enable the learning of mathematical literacy. Classroom observations confirm Edith's story.

In the next section I turn to focus on learners' experiences of Mathematical Literacy in relation to the teaching spaces that have been opened up in the three case study schools and which I have summarised in the table above. I focus my attention on the purpose of this paper which is to illustrate the way in which what has been discussed above has enabled transformation of learner identities from mathematically weak non participators to willing participating sense-makers who use mathematics to make sense of situations both within and beyond the mathematical literacy classroom.

It is my intention to tell this part of the story in the words of the learners as far as possible. It has of course been difficult to select illustrations given the vast amount of exciting data collected from schools. In each of the classes there is a multitude of data that could be used to tell a similar story. The quotes I use below are chosen because they exemplify the common themes across the classes and schools in relation to changing forms of participation within and beyond the classroom. In order to provide some structure to the story I organise learner's experiences in three parts:

First, I begin with general experiences of learners which illustrate a shift towards enjoyment, interest and a sense of competence in relation to mathematical engagement with situations.

Second I share learners' comments about the way in which learning in Mathematical Literacy enables crossing the boundary of the classroom and extending to forms of participation 'in life'. Finally in relation to the above I turn to focus on learners' reasons for why these shifts occur. Since these experiences are largely contrasted with polar opposites in earlier mathematical experiences it is important to explore learners' reasons for these changes. While multiple factors influence these shifts (some mentioned above such as slower pace) overwhelmingly learners' reasons centre around the nature of participation and engagement afforded in these Mathematical Literacy classrooms.

### **Learner experiences: a shift towards enjoyment, interest and a sense of competence**

General expressions of enjoyment of Mathematical Literacy and interest in the work were widespread across the data. For example:

"M literacy is the best thing that has happened to me in my entire school career"

A sense of 'I can do this' or 'I can figure it out' was noted by learners and related to slower pace, less vertical progression of mathematical concepts and more visibility of the mathematics and access to it through connection to contexts. In addition learners linked this ability to make sense and 'figure it out' to increased independence. The following quotes exemplify this:

"Its easier to like catch up because you can go home and you're able to do the work where like in maths if you're absent then like you go back and you're totally lost..."

"Its (ML) in English...Its easier to catch up because you can go home and you can read it.. Whereas Maths, you need someone to actually like intensely explain it.."

"Unlike in maths when they'll just say "aah come back after school for extra lessons, we have to move on". But for maths literacy they just give you time until they see that everyone understands. ... the topics they allowed us to have fun. Ja now we will land up discussing what we saw in the paper. Ja stuff like that."

"It's more interesting. The content is more interesting and more relevant than what we used to learn in normal mathematics. Like stuff that we used to learn in normal mathematics, you'd look at it and be like "when am I ever going to use this?" But something that I might learn in maths literacy during the week I can go on the weekend and maybe I *do* use it to do something."

The last two quotes above link interest and enjoyment to the contextualisation of mathematics and the way the work they do links to the world outside of the classroom. "I can go on the week-end...". Concern for the lack of 'transfer' of mathematics learnt in schools is widespread among teachers and researchers and is not particular to South Africa. Indeed the quotes relating to learners' predominantly negative mathematical histories are familiar to many teachers and researchers across the world. In contrast to this, it is particularly interesting that across the quite varied case study schools learners provide a wide range of anecdotal evidence which suggests that their learning crosses the boundary of the mathematical literacy classroom to the world outside. The next section focuses on these anecdotes.

## **Crossing the boundary from the classroom into life**

Throughout learner interviews a personalisation of learning was evident. Learners' noted that they could both bring their 'life' experiences and their opinions to the learning process (also discussed in more detail in the next section) and take their classroom learning experiences into their life. Thus the boundary between the Mathematics Literacy classroom and the world outside was increasingly experienced as permeable with increasing coherence between one's ways of participating and negotiating, being and acting in the world and in the classroom.

I begin with an extract from a whole class interview which indicates both use of mathematical learning outside of the class as well as broader discussions with others about the various scenarios engaged with in class. Several learners participate in this discussion. In the extract each learner contribution is given on a new line. Learners have not been given pseudonyms or numbers since it was difficult to ascertain from the recording when a learner spoke again.

MG: Can you think of any examples or any time when you've been at home and you had a discussion with anyone outside of this classroom about work that you did here in Maths Lit?

Like hire purchase when you're buying a car; I'm looking at buying a car so I've been having a look at all the different costs involved and monthly payments and everything.

Like banking for instance... a lot of people don't what they're doing... like interest rates and what sort of interest rates they can get. You know, we're actually learning about stuff like that which actually helps us in a way....

Well yeah, basically it's all stuff you need really; other than stuff that you probably will never use, as J said you know. It's not X to the power of Z blah-de-blah-de-blah. It's like you know serious stuff, like financial stuff as B said...

There was the Zimbabwean inflation rate and stuff, we actually discussed that in - I'm not sure which lesson it was in but ja...

MG: Can you think in particular what aspects of that project you kind-of found useful there?

No, just that I knew like what was going on in the country, for example, how the inflation rate was going up, for example it went up by like 6,600 percent in a year.

I was going to say it enhances your problem solving skills because in daily life you have so many different problems and it does help you sort out some things. Like, for instance, like I said, buying a car. Whereas for instance maybe if you weren't learning Maths Literacy, you think to yourself "that car looks nice let me just go get it". .. which is your problem solving; you're working it out. And it's the same thing with doing groceries or banking or anything else, so it teaches you other skills that most probably you wouldn't have learnt in maths at all.

I think I'm also - you like analyse a situation in your daily life, you'd see something and instead of just doing it on impulse whatever, you'd actually look at it.. not only in the - sort-of same thing as what you've been discussing.

Ja ma'am, I found when I was doing normal maths last year, is that you could only keep your conversation about maths in the classroom. So if you had to go talk to your parents about maths, they had no clue what was going on. I mean you wouldn't go to talk to friends about maths but at least with maths literacy there - it's a world problem, you know, with Zimbabwe and interest. At least it involves everyday life.

MG: So it is stuff that you can have conversations about outside of this class?

Ja-ja.

Ja well I mean, like I said, you can't – none of you would go and have conversation about maths outside of the classroom – (chuckling) – ja, I mean, I know I couldn't go to my parents and talk to them about maths because they would have no clue what was going on. So at least it's another thing that you can add to the conversation.

MG: So how many of you have possibly, in the last month, had conversations with your family about, for example, the Zimbabwe project or just anything about Zimbabwe? (Many hands go up.)

I've noticed when I read articles in magazines that have a lot of statistics and stuff like that, like a one in four or 60 percent, I look at those statistics and say "what does that actually mean? How many people is that actually affecting".

MG: And you reckon that you wouldn't have done that last year?

No.

Also we did this like at the very beginning, but we looked at like pyramid schemes and the whole lot. And like now if you look at the newspaper or in magazines and stuff, you see lots of those and you can almost immediately, just reading about them, see that there's faults and it's not really true what they say.

MG: So it's slightly more critical stance to pyramid schemes.

Ja.

MG: Does it go beyond pyramid schemes?

Ja, it goes with like most things, like when they've got like an advert for a car or something, you can see that it's not really as good a deal as they make it out to be.

The above extract illustrates the way in which learning in Mathematical Literacy transcends the boundaries of the classroom walls and extends to new (more critical and engaged) ways of acting and participating in the world outside the classroom. This is in direct contrast to the experience of 'normal maths' where 'you could only keep your conversation about maths in the classroom'. Increasing engagement of mathematical literacy learning with family members was also a recurrent theme which emerged in interviews across the schools. Thus, for example, learners gave anecdotal evidence of engaging with their parents for the *first* time in relation to their work. One referred to her mother being an interior designer and engaged with her on the plans for a redesign of a bedroom while another engaged with his father on his architectural plans. Another learner shared her learning on the BMI index with her mother and uncle and took their measurements while others discussed analysing adverts (e.g. car, banking loans, cellular phone packages) with their parents and encouraging parents to take a more critical analytic stance to these. In relation to these new forms of participation some learners explained that their families' perceptions of them and their identification in relation to mathematical competence (in the world) changed as a result. These changes in ways of participating at home were noted across the classes and schools even while anecdotes of students in the inner city school differed from learners in the suburban schools. The extract from an interview with an inner city learner captures the changing identification and changing roles (forms of participation) in the family:



“You know, at home I live with my grandmother. So every time where you like take your money to the bank or something she sends me because you know, I understand and like I’m the one who’s checking all that stuff and all that. That’s why its easier than – that’s why they ask for me.

MG: Because they see you as somebody who can do the maths?

“Yes”

MG: Do you think they’re doing that more this year than they would have done last year?

“ja this year they’re doing it more. Like every time, each and every month, I’m the one who goes there and deposit some money, draw some cash and that... because we understand the maths literacy, we’re open with our teacher, we kind of get overboard and try to do the same thing at home. We want our mum – our parents to understand. Now they think we are geniuses and so they want us to do it because they think we’re the best.”

### **Explanations given: Changing participation**

In the above we saw changing forms of participation with the world outside the classroom in relation to mathematical engagement. Learner comments primarily linked the reasons for this to their changing participation in the classroom in relation to two factors: ‘real’ collaboration and ‘real’ problem solving. The ‘realness’ of the collaboration and problem solving related to the similarity to real life – opinions and multiple methods are both valued and productive of both mathematical and contextual learning and the nature of the scenarios are messy. Mathematical Literacy requires active participation, engagement and negotiation. The freedom to engage with the ‘messiness’ of scenarios and negotiate the way forward without searching for ‘the right way’ opened a learning space that was previously closed in mathematics classrooms. Real collaboration and real problem solving are intertwined:

“In ML we get lots more group projects...that’s better I feel... Because you get a whole lot of points, you know it’s another side of somebody’s perspective so, therefore, you can like connect to the other person and solve the problem together. Each person has a different view of what to do...

After probing how is this different from Maths

“In normal maths.. – there’s like one answer and like if you didn’t know the answer, somebody else does so then you do that... somebody knows and then you just do it... But in Math Lit its different.. I think for Maths like you get the guy who knows whats going on and then we all like copy him. So we don’t have to discuss in the whole group. (In ML) like everybody was a mess... but when you put it together, then we work it out together, you understand it better”

The learner’s utterances above are also illustrative of the lack of competitiveness that Barry referred to earlier. Learners also noted that the nature of engagement with teachers was different and that there was greater independence from the teacher as a result of having their opinions count and their influence over the direction of the lesson:

“I think I understand it more because you like discussing with her... You are not just sitting and just listening to the teacher babble on you actually taking part”

Wenger (1998, 210) writes that negotiability can be described with phrases such as: ‘opening access to information, listening to other perspectives, explaining the reason why, ...inviting contributions, ... opening decision processes, argumentation, sharing responsibilities...’ The following extract from a whole class interview illuminates what learners mean by ‘real’ problem solving and the centrality of negotiability in this process:

L: Okay, when we were working in maths it’s - well we’re not actually doing problem solving, or at least that’s the way I think it is – Maths Literacy is problem solving. Whereas in maths there’s a right or a wrong answer; in maths literacy there are a whole number of different answers at the same time. So (inaudible - speaking softly) it’s different in my point of view.

L: I like the fact that we can use problem solving more because you can think about the answer. And you know that you can go and you can give your opinion on it; and the possibilities of you being wrong are very limited. Whereas in maths, if you don’t understand the work at all, the possibilities of you actually still getting that type of answer right are very limited.

L: I was going to say pretty much exactly the same thing as him.

L: With maths it was all Xs and Ys and so on and so forth. I think that with maths literacy, just as in problem solving, we can look at things and see them a lot differently to how the maths classes would see them because we’re now being getting used to having - looking at the subject and analysing it from different points and stuff. Whereas they’ve got their – like the maths class will use a specific formula to get to that answer, that one answer. I just think that we look at it differently.

MG: Do you think that that makes maths literacy easier or ... easier than maths?

L: No.

MG: But more accessible?

L: Ja. Well it's not easier... I'd say it's easier to apply than normal maths because we understand what we're doing. It's not like you just writing a formula and like you hoping that you're doing the right stuff because we actually know what we're doing. So ja, I'd say it's easier in that sense but like you also have to think a lot.

L: I'd say it could be easier in the sense like you've still got to do the work and get your answer and whatever but because it's put into a real life situation, you can kind-of tell if the answer is way off, that it can't be that answer and then you'll go back and correct it. So you're more likely to get a more correct answer because you can see if your other one is wrong.

L: It's really the fact that there's no right or wrong answer...and I think that applies to things wider than to maths or maths literacy, that you can't look at things in black and white.

No, I was going to say like the same thing, problem solving skills. The skills that we've learnt here.. for example when we get like the scenario, for example, like Zimbabwe again and they ask us questions on that, it's easier for me now to like take the information they've given me and to like make sense of it, to work things out on that, ja.

## **Discussion and conclusions**

The story I have told illuminates a journey of learning with respect to identity. Wenger (1998) notes that identity formation is a dual process of identification (‘providing experiences and material for building identities through an investment of the self in relations of association and differentiation’)

(p188) and negotiability ('the ability, facility, and legitimacy to contribute to, take responsibility for, and shape meanings that matter in a social configuration' (P. 197).

In this paper I have argued that several aspects of South Africa's Mathematical Literacy curriculum have opened the space for teachers in these case study schools to put meaning before skills and information and to let 'identity drive cognition' by focusing on developing in learners new ways of being and participating mathematically in class and in the world. Thus returning to the introduction I argue that Wenger's theory is 'ready for prime time' in a range of Mathematical Literacy classrooms in South Africa.

The negative histories and experiences of learners in relation to Mathematics is not a uniquely South African story – but the nature of our curriculum reform in Mathematical Literacy is a bold ambitious reform. The insights gained from researching the implementation of Mathematical Literacy have much to contribute to our thinking about mathematics education more generally as indeed the story I have told tells us a great deal about Mathematics in schools. The stark absence of 'sense making' noted by learners in the compulsory phase of schooling is indeed cause for alarm but more importantly the story illuminates both the *willingness* and the *capability* of learners to actively participate in mathematical sense making given opportunities for 'identification' and 'negotiation'. Indeed many of the teachers we have worked with note positive influences of their learning experiences in Mathematical Literacy on their Mathematics teaching. For example Barry notes:

"Well to some extent this new experience is actually blowing back into my normal maths lessons and improving that lesson because I said to myself: "Why are my other lessons so much more uptight? Why don't I have a more patient attitude?"

In conclusion:

"What makes information knowledge – what makes it empowering – is the way in which it can be integrated within an identity of participation. When information does not build up to an identity of participation, it remains alien, literal, fragmented, unnegotiable. It is not just that it is disconnected from other pieces of relevant information, but that it fails to translate into a way of being in the world coherent enough to be enacted in practice. Therefore to know in practice is to have a certain identity so that information gains coherence of a form of participation." Wenger (1998, 220)

The stories of the learners above provide a powerful illustration of Wenger's point. On the one hand they illustrate how an absence of opportunity to participate meaningfully in past mathematical learning experiences alienated learners from developing mathematical identities. Indeed in these learner stories previous knowledge gained was not empowering and remained literal and fragmented. On the other hand experiences of 'real' collaboration and 'real' problem solving in the Mathematical Literacy classroom led to more active forms of participation involving engagement and negotiation. This enabled the formation of positive identities of mathematical participation and the experience of mathematical knowledge as empowering, both in and beyond the classroom. The story illuminates the extent to which new mathematical identities of participation 'hold the key to real transformation – the kind that has real effects on people's lives' (Wenger, 1998, 85) – and as Edith pointed out enable 'transformations of the human kind'.

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