

CHAPTER EIGHT

Probing the relationship between theory & practice

'The question of implementation is simply whether or not a given idea, practice or program gets "put in place"²⁹

8.1 Introduction

In previous chapters, I described how and why Mathematical Literacy was being implemented in the way that it was in two South African schools. My research findings, resulting from an exploratory design, indicated that implementation was discontinuous with curriculum intentions in terms of practitioner understandings of purpose and pedagogy, and those teachers felt that their professional status and identity as mathematics educators was somehow under threat.

My observations suggest that the implementation of mathematical literacy is in difficulty, not because politicians and education department officials are deluded about the realities of the actual classroom situation in the majority of South African schools, but because this mandatory Mathematical Literacy curriculum is often advanced as a silver bullet to the mathematics crisis in this country without sufficient strategies, or insights into required strategies, to support those responsible for its actual implementation. Simply put, the new mandatory Mathematical Literacy curriculum does not have a strong theory of action that is suited to its broader purpose and its implementation context.

This final chapter will juxtapose the research findings with the extant literature on curriculum change and will further analyze the evidence from the two case studies through the lens of the deep change conceptual framework presented in Chapter Three. The analysis will also provide for reasons as to why this study advances new knowledge beyond what is already known about the implementation of mandatory curricula in

²⁹ Fullan (2001) *Implementing Change at the Building Level*. Paper prepared for W.Owings and L.Kaplan (Eds.). *Critical and Emerging Issues in Educational Leadership*. www.fullan.org

developing countries. Having previously argued for research that is specific to the work mathematics teachers do, (Shulman 1986 in Price & Ball 1997), the empirical evidence gathered in this study fronts the expansion of this argument to the limited knowledge base in developing countries. This chapter concludes with a discussion on the implications for future research and the significance of this study.

The question as to why some mathematical reforms flourish and others fail has been extensively researched (Burgher, 2000; Cockcroft Report, 1982; Cohen, 1990; Humenberger, 2000; Plowden Report, 1967). The perspective I offer, based on an analysis of the new Mathematical Literacy curriculum in South Africa, seeks deep change in the behaviours of teachers. This change is required not only in pedagogical content knowledge, but also in understanding the nature and value of mathematical literacy. It proffers evidence as to why the 'status-identity' of mathematical literacy teachers needs to be explicitly defined in both the personal and public arenas before any of these changes can begin to occur or be expected.

Such change is not only complex but also very personal. I conclude that unless a radical transformation in terms of accepting and forming new identities occur among teachers given the responsibility of implementing this educational change, mathematical literacy cannot but sustain traditional instructional practice. As this exploratory research was conducted in the first year of implementing the new curriculum, the findings are tentative but indicative of future problems in practice. It is of course unrealistic to expect that the deep change required will be evident so early on in the implementation process as the requisite changes in pedagogy and acceptance of new teacher identities will require time to develop and unfold even under optimal conditions of reform.

I argue that if inputs that can trigger this change, in the form of appropriate staff development programmes, and new and public discourses on what it means to be a Mathematical Literacy teacher, are not provided for early on in the implementation process, teachers will settle into teaching this curriculum falling back on knowledge and

beliefs already entrenched in their instructional practice. And they will do so in ways that do not embrace this reform as intended by the curriculum policy.

Drawing principally on Michael Fullan's work, and in particular his theory on 'deep change', the teacher data gathered from the two case studies revealed the following:

- that teachers had a very thin understanding of the mathematical literacy curriculum in terms of the required pedagogy, and also the subjects ontological and epistemological nature;
- their instructional practice was neither aligned to the curriculum nor to their claimed beliefs and understanding;
- collaboration and reflection was not evident in their teaching and learning of the curriculum;
- there was no collective moral purpose in their schools;
- and that teachers' old 'status- identities' as mathematics educators was under threat.

Most of these observations are commonly documented in the literature of educational change. What is not as widely found in scholarly text however is how the threat to the 'status-identity' of experienced teachers can actually preclude them from engaging with a curriculum policy in ways that allow for successful implementation.

The overriding insight gleaned was that teachers do not engage with the curriculum deeply or reflect on their mathematical literacy instructional practice because they feel that it further lowers their status as mathematics teachers. This is because they believe that to be told to teach mathematical literacy questions their mathematical ability, and thus to question and reflect on one's understanding of this curriculum is to somehow

concede that this perceived lowered 'status- position' in the mathematics department is suited to the teacher.

8.2 Thin and Disconnected Levels of Understanding

8.2.1 Teaching Mathematics in Context

Michael and Norman were both found to have a limited understanding of the curriculum requirements. This understanding varied in degree with both educators having a relatively deep understanding of most of the content but no other features of the curriculum, particularly with regards to purpose and pedagogy. The evidence from this study indicated that Michael and Norman used a traditional way of teaching mathematics, which was similar to that they had received as secondary school learners. This traditional way included the teaching and emphasizing of mathematical content. For Norman the use of context was a mandatory 'band aid' without any significant attachment to the pedagogical philosophies of the curriculum; while for Michael the use of context was an extension to be pursued if, and only if, time permitted. Michael stated that he taught the "basic skills first" and then extended these to real life applications, the evidence of which was lacking in his observed instructional practice. Both teachers also felt that this method of focusing on the mathematical content provided a strong foundation in developing the mathematical skills required by the curriculum and that without consolidating the basic mathematical content they could not move onto exploring and applying what was learned to contexts that were of relevance to their learners' lives.

The curriculum is explicit on what the required pedagogy should be³⁰, and does not include that content should be taught first but rather that the mathematics content should be taught and explored through the use of relevant contexts. By contrast, most of the observed lessons of Michael and Norman's instructional practice were indicative of lessons that provided instruction on the use of algorithms which only provides for

³⁰ (Doe, 2003:42): The approach that needs to be adopted in developing Mathematical Literacy is to engage with contexts rather than applying Mathematics already learned to the context. Research done internationally and in South Africa confirms this approach for young people as well as for adults.

instrumental understanding (Skemp, 1971), which is at the lowest level of the three philosophies of mathematics as psychological systems of beliefs³¹ (Ernest, 1998), and not the relational understanding that is required by the Mathematical Literacy curriculum. In reality, it is not likely that mathematical literacy is going to be implemented as intended by educators who do not understand the nature of mathematics. This dimension of the curriculum was not discussed in the available official documents and was also not part of the preparatory activities to ease teachers into the teaching of Mathematical Literacy. And, even though Michael did recognize that he was not aligning his instructional practice to the curriculum intentions by providing conceptualized questions and problems he was unaware as to how this delivery was recommended by the curriculum policy to take place.

Similarly Norman had also no clear understanding of this instructional feature of the curriculum. Michael's thin understanding was that this curriculum was different to standard grade mathematics in the sense that all it required was "a matter of adding a context". The distinction between mathematics and mathematical literacy is principally not a distinction in level, but a distinction in kind. The old mathematics higher grade was at a higher cognitive level to mathematics standard grade in the sense that standard grade was a watered down version of higher grade. There was very little sophistication in standard grade mathematics. In mathematical literacy however, the curriculum intention both explicit and implied, is that simple mathematics be used in sophisticated ways. Thus the cognitive demand in mathematical literacy is much greater than the cognitive demand in the old standard grade mathematics. Michael and Norman's lack of understanding of this, may also have be influencing their beliefs about the status of their work.

³¹ Ernest (1989) conjectures that three philosophies of the nature of mathematics are hierarchical. Instrumentalism is at the lowest, involving knowledge of mathematical facts, rules and methods as separate entities. At the next level is the Platonist view of mathematics, involving a global understanding of mathematics as a consistent, connected and objective structure. At the highest level, the problem solving view sees mathematics as a dynamically organized structure located in a social and cultural context.

Norman understood the required pedagogy as "you teach the content and then add the context". Michael and Norman had claimed to read the curriculum and their belief that they understood the curriculum to a large extent emanated from their claimed understanding of the content. This limited engagement with the curriculum reveals a superficial view of how these educators understood and perceived this new curriculum, mainly that the Mathematical Literacy curriculum was a mathematics curriculum with different content, with the occasional addition of context as an illustration of the importance and frequent occurrence of mathematics in everyday life.

This dissection of content and context by both Norman and Michael was mostly based on the reverence they both had for 'naked' mathematics. The privilege afforded to algorithms directed the implementation pathway with which both educators conducted their instructional practice. The skills and values associated with the curriculum were subjugated into a position with little value, and even though as Kay holds "appropriateness of method [is] highly circumstantial and generally unpredictable", (in Thompson, 1984) an awareness of the method required was neither evident in Michael or in Norman's practice.

For both educators it can be argued that this understanding they had of the curriculum was for the most part centered on their perception that the section in the curriculum focusing on the content was of primary importance, which in turn was for the most part a result of their own experiences in learning mathematics. It was however also reflected in their belief that teaching mathematics in terms of formulae and algorithms was less threatening to their 'status-identity' as 'intelligent and capable' mathematics teachers. So even though there is a need for these teachers to acquire content knowledge that is different to that which they received in secondary and tertiary studies, and that differentiates between numeracy and mathematics (Steen, 2001), there is a similar need to recognize how perceptions of the requisite knowledge positions the status of these teachers in both the public and private domains.

This shell of understanding of the curriculum features of required pedagogy, which can be captured in 'teaching mathematics in context', was further found to apply not only to their pedagogical styles but also to their thin use of contexts relevant to learner lives. The use of context is expounded on in the literature with theories and evidence as to what is of importance and danger to learners' learning (ILEA, 1983, Broomes, 1989). Such an analysis would however assume that Michael and Norman were consciously selecting the contexts that they were using, which during the classroom observations was found not to be the case.

The curriculum stipulation that the contexts should be 'rooted in the lives of the learners' is in keeping with Freudenthal's RME theory that 'mathematics must be connected to reality, stay close to children and be relevant to society in order to be of human value'. And even though RME theory has several proponents highlighting its limited³² use in developing democratic competence which is one of the main purposes of the Mathematical Literacy curriculum, as an ideal entrenched in the curriculum it was explored and found to neither be pursued nor engaged in with any significant depth by either teacher.

Michael and Norman recognized the discrepancy between their instructional practice and the curriculum policy only in terms of quantity that is, not using context as often as they should. However what they were both unaware of was that the curriculum did not prescribe context as a follow on to content but rather as a process. Given their understanding of the required pedagogy as thin, even if Michael and Norman had more time a resource they both stated they required, there was no indication that they would implement the curriculum as intended.

When they did use some semblance of context it was inevitably that which was offered up by the textbook and at no time reflected either context of elicited interest of the learners nor context that was consciously chosen as an empowering future benefit to the

³² See Cyril Julie, 2004. Can the Ideal of the Development of Democratic Competence Be Realized Within Realistic Mathematics Education? The Case of South Africa. *The Mathematics Educator*.14 (2) 34-37.

learners. This absence of selecting appropriate and relevant contexts was mostly based on the teacher's assumptions that once the mathematics had been taught and learnt it could be applied to contexts that required it.

Using the examples that the textbook offered was in one way less work for the two teachers but it was also used as given because the two teachers clearly believed that the application to other contexts would follow. This transfer of mathematics to other contexts and the 'everyday' lives of students cannot however simply be expected as it is widely recognized as a student and teacher difficulty (Michelsen, 2005, Boaler, 1993)

This surface use of context furthermore also limited the opportunities that Michael and Norman presented to their learners: as Skovsmose (1998:419) argues:

It is essential to consider students' interest. But the interest cannot solely be examined in terms of the background of the students. Equally important is the foreground of the students.

It is this "foreground" that is essential for the learners, if a new curriculum is to play any role in raising the unacceptably low levels of mathematical literacy in this country. For as Stigler and Hiebert (1999) suggest, it is the teaching methods and not the teachers *per se*, that is a critical factor in promoting and improving student learning.

The deep change required in their instructional practice needs external strategies and interventions that promote the required depth of understanding. The National Numeracy Strategy (1999) in the United Kingdom has included intervention in training teachers through observing other 'Leading Mathematics Teachers' that turns the delivery of the curriculum into concrete lessons that other teachers attend and observe. Such demonstration of lessons by teachers that have a deeper understanding and appreciation of the curriculum in a developing country become even more profound as they allow for collaboration, hands on experience of what is actually required, and learning a curriculum in a way that they were never taught. An opportunity, that Paulo's (1995) concurs with as being instrumental in learning and understanding the requirements of new mathematics

reforms. Furthermore it supports the setting up of learning communities where teachers can see best practice teaching and in doing so open themselves up to reflection and a deeper level of understanding the curriculum intentions. Fullan notes, "Clearly, deep pedagogy and deep learning cultures feed on each other" (Fullan, 2004a: 12).

Price & Ball (1997:661) reason that making change in mathematics presents unusual challenges for reasons including, that "mathematics reforms are far from a blueprint of action, a plan to be implemented" and secondly mathematics teachers "formal education is typically thin, and they often do not feel mathematically competent or confident". The surface change which was a common feature in both Michael and Norman's classrooms cannot be attributed to a 'thin education' as they were both qualified mathematics educators even though their levels of qualification were considerably different, nor can it be attributed to a lack of self confidence in subject knowledge. It would be more accurate to argue that the surface understanding occurred because these two educators had not constructed a sophisticated meaning of the change process required by the curriculum (Fullan, 1991). Such sophisticated meaning can only be arrived at when a fundamental change in the way that teachers think and behave occurs. Fullan (1995:23) explains this as follows:

It is no denial of the potential worth of particular innovations to observe that unless deep change in thinking skills occurs there will be a limited impact... [The] main problem in education is not the resistance to change, but the presence of too many innovations adopted uncritically and superficially and on an ad hoc fragmented basis.

Given the caveat that perhaps it is too soon to expect deep change in thinking for both Michael and Norman, it is pertinent to remember that unless this surface level understanding is not disturbed, expected changes will not occur. Neither Michael nor Norman expressed any real uncertainties or queries as to whether they were implementing the curriculum as intended. The lack of such tensions in their beliefs on the nature of mathematical literacy and hence their understanding of the required pedagogy of the curriculum, is indicative that these two educators had not as yet engaged the core issues of the curriculum. Ernest (1989) clarifies this as follows:

Mathematics teacher' beliefs have a powerful impact on the practice of teaching'. During their transformation into practice, two factors affect these beliefs: the constraints and opportunities of the social context of teaching, and the level of the teacher's thought. Higher-level thought enables the teacher to reflect on the gap between beliefs and practice, and to narrow it...The social context clearly constrains the teacher's freedom of choice and action, restricting the ambit of the teacher's autonomy. Higher level thought, such as self-evaluation with regard to putting beliefs into practice, is a key element of autonomy in teaching.

The absence of 'higher level thought' restricted the teachers from engaging with the curriculum on a deep level. This was evidenced in the teachers' understanding of the purpose of the required reform. Contexts were also found to play a commanding function in arbitrating the curriculum delivery. For, the teaching through the medium of context was extremely difficult not only because it was different to their traditional mathematics instruction but also because time available was insufficient.

Their response to curriculum policy was further a function of their understanding that the new curriculum undercut knowledge at the expense of process. This challenges mathematical literacy stakeholders not only to hold practitioners (practice) up for scrutiny but also the curriculum policy. It cannot simply be assumed that the policy is right and that the teacher's simply cannot make sense of it.

8.2.2 Purpose and spirit of a reform

When radical curriculum reforms are pursued and expected, a deep understanding of the purpose of such curricula is taken as a prerequisite in ensuring successful implementation. Extending on this, when transformation is addressing past equity issues, such as those in mathematics education in South Africa, understanding the purpose is deepened and broadened in not only understanding the reform intentions but also embracing the 'spirit' of the reform. Collectively this enlists the need of understanding both academic and moral purpose.

Norman and Michaels backgrounds although had many dissimilarities also had several poignant similarities. Norman was born and educated in Zimbabwe, and while growing up he lived through the transition of the end of racial discrimination in his country of birth. Michael was a South African Cypriot who as a secondary school learner served to defend the apartheid government only to find himself within the same decade living and educating in a country that went through transformation, in many ways similar to that of Norman's. Both these educators had lived through times where suffering and human atrocities were rife. They had also both witnessed and experienced education systems that were not only hugely transformed from the day that they had attended secondary school but also very different in equitable or the attempt for equitable delivery. As mathematics educators they had both experienced in their teaching careers the low levels of mathematical proficiency in both the students which they taught and the Grade Twelve mathematics results for many a year. It would thus be expected of them to be able to attach some sense of deep meaning as to what the purpose of this new reform entailed. And yet, both Norman and Michael had a thin and disconnected understanding of what the purpose of this curriculum was.

The reason that the reform was called for was not questioned and it was held by both that it was the alternative to the old Standard Grade Mathematics in the sense that the education department in getting rid of differentiating levels in all the subjects recognized that not all learners could do mathematics and as such had to offer an alternative. What was also similar for both the case studies is that they were aware of the unacceptably low levels of mathematical literacy in the country, the evidence of which was produced by the questionnaires.

However there was no deep link for either of them between the purpose they could recognize in the questionnaire and the purpose that they were capable of explaining during the interviews, or delivering in their classrooms. Their perception was a reflection of a poorly understood curriculum document, in terms of nature and pedagogy, and also a thin understanding of the purpose of the reform. Hill (1997) suggests that before accepting that change is necessary, teachers must believe it is worthwhile to put time and

effort into learning new ideas, be able to understand them, and be aware of and dissatisfied with their current conceptions. Neither Norman nor Michael expressed any dissatisfaction with the old standard grade curriculum that they both believed the new Mathematical Literacy curriculum had replaced.

Norman, as mentioned, felt that because the education department had done away with all standard grade curricula they had realized that they had to provide an alternative to mathematics, as they were aware that not all learners were capable of doing the core mathematics curriculum. His responses were also confused for in one instance he stated that Mathematical Literacy was more beneficial to the learners than some of the mathematics in the ordinary curriculum but did not hesitate to add that he was unsure as to why it had replaced the standard grade curriculum which he believed may be re-introduced after the revision period," [L]ike I said we are all confused why this subject has been introduced, but I do see that it can have real life application". Similarly Michael's perceptions also revolved around the new curriculum as a substitute for the old standard grade curriculum:

Because the government has done away with standard grade in all the subjects. In maths this is not possible, because they cannot all do maths. So they have provided an alternative for these children that struggle with normal mathematics. It is the government's way of making sure that every child has some maths even though it is not real maths. If taught properly it can be useful because at least these children can make sense of simple maths that they encounter in their lives

This perception of Michael and Norman limited their engagement with the curriculum document in that it allowed them to continue with a similar instructional practice as that with their past direct and/or indirect experiences of the standard grade curriculum.

This 'falling back on familiar routines' is widely evidenced but not as widely theorized as to why it occurs. This may occur because teachers do not embrace the 'spirit' of the reform, not because they choose not to, but because they do not have a deep understanding of what it is that they should be embracing. On the surface it may appear

that Michael and Norman are relying markedly on superficial resemblances amid their current practice and the reform ideas, and so the innovative aspects of the reform are eluded (Spillane *et al*, 2002). However the question is why do they rely on these resemblances? It would be naive to postulate that these educators have had such an intensification of work that they selectively choose to rely on the similarities, as it requires less work and less change.

Michael and Norman continue to deliver a new curriculum in a similar way as they did with the old standard grade mathematics not because they consciously choose to believe that standard grade mathematics was a better curriculum nor for the sole reason that they are overworked, but because they do not comprehend the massive negative implications that standard grade mathematics held for the majority of the countries learners. As Aarnout Brombacher (2004: 5) emphatically states:

That we should never again have a subject such as Mathematics SG with all the apartheid baggage that goes with it is not an issue here. Mathematics SG served nobody well.

What is an issue here is that Michael and Norman become aware of this failure of the old system and curriculum and recognize why a change is required. Not because what they have been doing in the past was wrong but rather that something different and new is required for the future. The awareness of the purpose and philosophy that underpins the Mathematical Literacy curriculum can be taught and as such becomes a matter of staff development, what is harder is the acceptance of the philosophy, which in this developing country includes, as a part, the matter of 'collective moral purpose'.

'The moral imperative means that everyone has a responsibility for changing the larger education context for the better' (Fullan *et al*: 2004b: 2). In FET High School and East Rand High School the responsibility lies solely on the shoulders of Michael and Norman. Their departmental heads and colleagues neither engage with nor inquire into the mathematical literacy beliefs and instructional practice of these two educators and nor do the principals of their schools.

The theory of action mentioned earlier needs to provide staff development not only for the educators but their department heads and principals. Such an approach, which was research and evidence based, was used in Ontario where principals received training on the *Expert Panel Report on Mathematics*, which was found to be of invaluable support to the staff entrusted with implementing the new reform (Campbell *et al* 2006). Developing moral purpose requires a deep belief in that what you are doing is not only of value but is also valued. Neither sign that was evidenced in either Michael's or Norman's support environment. A sign that would also go some way in changing the perception of the status of the curriculum, at least to begin with, within the confines of their working contexts, which in turn can start to relieve the threat that these educators feel towards their teaching identities. For if their colleagues believe and understand that what the two teachers are teaching is of value, they themselves can start to believe and understand that what they are teaching is valued.

Michael and Norman were found to value teaching and even though Michael conceded that this was not his first career choice, his responses were often indicative of a teacher who valued the work that he did. Statements such as " I love the classroom", " teaching mathematics is what I love", " I felt I could contribute so much to the pupils of this country", and " I am not saying I will not do my best, I will do all that I can to ensure that my maths literacy pupils pass" show that Michael's teaching was driven by a desire to assist learners in the teaching and learning of Mathematics. Likewise Norman expressed feeling very rewarded when several of the learners that he taught, at the inner city college in Johannesburg, passed Mathematics that had never before done so. His insistence that he would not lower his teaching standards despite numerous complaints and a lot of pressure from the parents also go towards showing up character traits of Norman's that lend themselves to a similar interpretation to that of Michael.

What is now required is a deep understanding of the purpose of the Mathematical Literacy curriculum which in turn may lead to a deeper ownership of the curriculum through a recognition of it's value in everyday numeric life. Owning a curriculum implies that the teacher believes in the reform and hence the new curriculum and as such finds it

easier to take up the necessary change in instructional practice and beliefs. What the findings of this study reveal is that this aspiration is not being translated into outcomes as it is hindered by a thin level of understanding of the broader purpose of the transformative nature of mathematical literacy. The illumination of which is clearly a responsibility not of the implementing agents like Michael and Norman but the collective leadership that lies above them. A leadership, that has not comprehensively included strategies that account for and make explicit the broader purpose and 'spirit' of the intended reform. Understanding the 'spirit' of a reform has been found to be habitually not understood and/or neglected in its entirety (Chisholm, 2000; Spillane, 2000). Strategies must also make explicit the goal of 'raising the bar and closing the gap' with respect to "numeracy, which is on the agenda of many countries whose performance is unacceptably low" (Fullan, 2005b: 4), such as those in South Africa.

In developing countries this has an explicit connotation in that deep transformation in the teaching and learning of mathematics relevant to everyday life can start to take place if and when educators believe and understand that what is needed goes beyond their interpretation of textbook content. Michael and Norman need to revisit on what it means to them to be mathematical literacy educators and their head of departments and principals need to acquire a deeper sense of what the introduction of mathematical literacy means for their schools and the community at large.

Such transformation requires the accepting that the teaching of mathematical literacy is needed, and is further enhanced through the recognition that 'teaching at its core is a moral profession' and as such that teaching mathematical literacy in South Africa may be a 'moral imperative'. This establishes that understanding the purpose of a new reform curriculum is of importance. It however does not establish that this understanding will lead to the required change, as the workload that it may entail may be more than teachers are willing to adopt as an effect of believing that what they should be doing is not as valued as what they were doing (teaching mathematical literacy as opposed to teaching mathematics).

8.3 Inconsequentiality

Both teachers expressed a love for teaching and a desire for their learners to achieve. Michael spoke of the initial sense of how important it made him feel when told he had so much to offer learners during his interview for a teaching bursary. Both these educators however at the time of the study showed distinct signs of burnout and frustration that significantly impacted on their delivery of the curriculum. In a comprehensive study on teacher burnout Farber (1991) exposed the demoralizing outcomes when educators started to believe that what they were doing no longer made a difference, he called this the escalating "sense of inconsequentiality".

It was a similar 'sense of inconsequentiality' that Michael and Norman were experiencing in teaching mathematical literacy. They were unsure as to why they were the teachers told to teach mathematical literacy, and were as unsure as to why the less experienced and less qualified teachers had not been told to do so. This was a concern, for neither the teachers nor the wider learning communities that they found themselves to be part of, at the time of the study, valued the Mathematical Literacy curriculum and the possibilities that it provided for, as perceived by the two teachers.

Michael and Norman taught Mathematical Literacy because they had to and not because they wanted to. How are such teachers to come to believe and understand that what they are doing and have been made responsible for is valued? For curriculum stakeholders this is a thought-provoking message. Teacher education programs and teacher development programs should not only enable teachers to develop a deep understanding required to meet the complex demands of a compulsory curriculum but also provide evidence for what they are doing both matters and is valued by the broader educational landscape. Teachers must develop understanding through acquiring knowledge on the need of the new reform by been exposed to and engaging in the purpose of the reform. Teachers must develop a sophisticated pedagogical knowledge of teaching mathematics in context, that together with a deep understanding of the need and nature of the reform enables them to

represent subject matter in multiple and meaningful ways that connect with the purpose and scope of the curriculum and not only the content.

It is also a powerful message in terms of offering rewards. For to bring about this momentous change, a reason that benefits the educators and is more concrete than moral imperative needs to be introduced. Once teachers want to teach mathematical literacy only then can the deeper moral purpose of why they are teaching it become entrenched in their belief systems. If such impetus is nurtured then the rewards become secondary to the bona fide quest of what was once a noble practice and as such gain what Fullan (2003:3) refers to as personal purpose:

Personal vision comes from within. It gives meaning to work, and it exists independently of the organization or group we happen to be in. Once it gets going, it is not as private as it sounds. Especially in moral occupations like teaching, the more one takes the risk to express personal purpose, the more kindred spirits one will find. Paradoxically, personal purpose is the route to organizational change.

How will Michael and Norman acquire this personal vision and consequently personal purpose when both at the time of the study were feeling a threat to their 'status- identity'? This finding adds to the literature for even though construction of teacher identity is extensively written about (e.g.Kalmbach Phillips, 2002; Estola, 2003; Soreide, 2006) there is a lack of empirical evidence on how threats to the 'status-identity' of an academic discipline impacts on vision and understanding of a reform curriculum.

8.4 Threat to Status of Teacher Identity

Teacher identity with regards to curriculum recommendations is an area that has been explored in the literature in terms of requirements and ability to fulfill either explicitly stated or implied curriculum and policy roles (Jansen, 2001; Soreide, 2007). Although this is an area of interest and concern for implementation of curricula, what emerged in this study is something variably different that was neither expected nor explicitly pursued in the original research questions. My main finding is that educators in South Africa that

are qualified as mathematics teachers are feeling a threat to their 'status -identity' by being identified as the mathematical literacy teachers.

In the curriculum document for Mathematical Literacy (DoE, 2003:5) 'The Kind Of Teacher That Is Envisaged' is given as follows:

All teachers and other educators are key contributors to the transformation of education in South Africa. The National Curriculum Statement Grades10-12 (General) visualizes teachers who are qualified, competent, dedicated and caring. They will be able to fulfill the various roles outlined in the Norms and Standards for Educators. These include being mediators of learning, interpreters and designers of Learning Programmes and materials, leaders, administrators and managers, scholars, researchers and lifelong learners, community members, citizens and pastors, assessors, and subject specialists.

This description of the South African teacher mainly revolves around the expectation that teachers are overtly expected to be part of transformation in the country and also life long learners. This duality in roles as moral agents and academic scholars does not provide however for how such roles are actually valued in domain specific contexts.

Both Norman and Michael were explicit in their need as to how they were to be referred to as educators, neither wanting to be known as a mathematical literacy educator. This unexplored field of what mathematics teachers in South Africa and perhaps other developing countries view themselves as, in terms of status held, is paramount in understanding why they do not engage in the curriculum document with any depth. As qualified mathematics teachers, they see it as subordinating themselves and their knowledge if they do not state that they can do and understand the curriculum. Somehow by questioning the curriculum they believe that their subject knowledge is been questioned and as such their identity as mathematics educators. What is clear is that these qualified mathematics teachers that have taught and teach Higher Grade senior phase Mathematics believe that they hold a status superior not only to other learning area educators but also to other mathematics educators who previously taught and teach Standard Grade Mathematics.

It is not difficult to understand why. In a country where the shortage of mathematics educators is widely known and reported not only in the literature but in the daily media these two educators have come to believe and accept a so called 'superiority' that has become deeply entrenched in their identity and in the pride this gives them in stating that they are mathematics educators.

Norman stated that he was perplexed as to why he had been asked to teach mathematical literacy as he believed that he should only be teaching mathematics as that is what he was qualified to do. He expressed that the parents would think that he was 'doff' and that is why he was told to teach the subject. What is more, the learners at his school also held a similar impoverished view of educators teaching mathematical literacy. This is evidenced in Norman's following expression:

In the beginning of the year my class asked me what I had done wrong to be given the mathematical literacy class to teach. As a matter of fact one of the girls asked me why I was being punished. Another asked if it was because the other mathematics teachers in my department were brighter. They were distinctly under the impression that I was weaker than the others.

Similarly Michael also inquired as to why he was told to teach mathematical literacy. He was academically the most qualified member of his five teacher department and with seventeen years of teaching experience was also considerably more experienced than the rest. In his view this qualified him an exemption from teaching mathematical literacy, which he believed should be done by educators that previously taught Standard Grade Mathematics, something that he claimed he had never done.

Michael's classroom also provided evidence that he did not identify himself as a mathematical literacy educator as there was a distinct absence of anything pertaining to mathematical literacy on his walls. The mathematics learning outcomes were neatly and effectively mounted on his pin-board walls but those for mathematical literacy were absent. Neither Michael nor Norman wanted to be known as mathematical literacy

educators. They were emphatic in proclaiming that they taught Higher Grade Mathematics and that Mathematical Literacy was only an addition on their timetables.

Norman expressed that if the school continued to give him mathematical literacy classes to teach that he would leave; "if they think I am going to be the mathematical literacy teacher, they best start looking for my replacement". Having expressed their dissatisfaction with having to teach mathematical literacy it was interesting as to why neither educator inquired from their head of department or principal as to why the decision had been taken. One almost got the sense that they did not want to ask in case their suspicions as being the least suitable to teach mathematics would be validated, whereas if it went unknown they could continue to justify this with reasons that made them more comfortable. Such reasons for Michael included politics and race, for Norman a past history of complaints that were embedded in xenophobia.

Somehow the perceived status of the curriculum in the larger community and the status of educators delivering this curriculum was seen to be synonymous not in how they viewed themselves but in how they believed learners, parents and peers viewed them. This is in keeping with the literature that includes the reinforcement of images of teachers in the face of public scrutiny (Weber & Mitchell, 1995; Allen, 2005). This was further intensified by the fact that in neither of these schools did the Head of the Mathematics Department teach mathematical literacy. Having been told to teach mathematical literacy and not been asked also seriously contributed to the threat that Michael and Norman were feeling against their 'status-identity' as mathematics educators.

This threat to the status of teacher identity is significant not only because it is a scarcely researched area but also may be unique to mathematics educators particularly in developing countries such as South Africa. The reasons include not only the inherent status of mathematics educators in terms of implied intelligence but also the monetary value that the education department attaches to incremental increases of their employees, which favor mathematics educators and as such further validates the status of being a mathematics educator in South Africa. Monetary value attached to mathematics

educators,' boxes' this group as an educational resource of higher value than most of the other learning areas.

This 'monetary value' was not expressed by either of the two educators in this research but goes to show the status with which such educators are regarded. Couple to this the scarcity of qualified mathematics teachers and it becomes clear why Michael and Norman felt this threat to their status and as such identity. For both these educators the feeling was so intense that they believed that the mathematical literacy label stigmatized them in a way that was not fair, as they did not deserve to be the ones chosen to wear this label.

This perception of not been fair also further led to internal competition and negative feelings towards the other departmental members and their heads of department that were not teaching mathematical literacy. Pfeffer & Sutton (2000:200) have found that such internal competition can manifest itself as a 'barrier to using knowledge':

When internal competition turns friends into enemies. Little attention is paid to the power expectations so people are labeled as losers or as part of a bad unit and feel a lack of self-worth and resentment towards the firm.

Such signs were clearly present in both Michael's and Norman's working milieu. The emotional implications of this and the assumed stigma are profound, for if Michael and Norman are embarrassed to identify themselves as mathematical literacy educators and are feeling that their departmental heads and principals recognize little self worth in them in terms of being identified as mathematical literacy teachers, than the required discourse, reflection and change in their instructional practice may never be attained, as to pursue it would imply an acceptance of a label that neither educator wants to wear.

Emotionally the impact of having to teach mathematical literacy given that the teacher is a qualified mathematics educator is an area that requires further exploration. It can be reasoned that Michael and Norman felt threatened because they wondered if the community would continue to respect their apparent status, which they believed they held as a product of teaching mathematics. If this new curriculum had been understood in

terms of its broader purpose not only by Michael and Norman but also by all the major stakeholders, this threat to identity may not have been as prominent as it was.

A deep change as to the value it holds to be entrusted with such a transformative curriculum would be required to ease this tension. It cannot be expected for parents and learners to re-define this when educators like Michael and Norman use labels such as "lesser maths", "I am not sure if it is credible in quality", "it is not real maths", "it is the beginning of maths", "it is a maths only better than nothing", "it is the maths of oranges and bananas", and "it is a subject for the doffies", to express their views on how they understand and respond to the value of this curriculum.

The reality is that deep change is even more difficult to attain on an emotional level. A recommendation would be that in the same way as mathematics educators are fiscally valued so should mathematical literacy educators be. To address this impecunious view of what it currently means to teach mathematical literacy for Norman and Michael incentives and rewards could be considered as a starting point. To understand and appreciate that this curriculum provides for opportunities in terms of empowering learners to become 'numerically self-managing persons, 'contributing workers' and 'participating citizens in a democracy' is deep and difficult as it presents itself as an abstract ideal. However to attach some form of reward to the enabling of this ideal provides an opportunity to addressing the value that such a curriculum may potentially enable especially in a developing country whose workforce in itself is conflicted on the value of what they are teaching.

Odden & Kelley (2002) argue that school-based rewards are a means of providing motivation by introducing clear goals to the whole school which in turn facilitate student achievement. Such goals are necessary at FET High School and East Rand High School as they establish for all at these schools a reason why mathematical literacy is important and not that it was introduced simply because it had to be as a mandate by top-down prescriptions.

Another alternative is to re-consider who should be teaching mathematical literacy. In his discussion of appropriate roles in organizations, Collins (2001) talks about getting the right people into the right seats on the bus. Perhaps the right people for mathematical literacy are not the qualified and experienced mathematics educators who have previously taught higher-grade mathematics but educators that may not need to undergo a change in 'status-identity'. Ross (2004:592) writes:

Many reforms contend that change in teachers' beliefs, habits, and attitudes toward mathematics will improve mathematics education. However, identity in relation to mathematics is constructed over long periods of time, through many experiences. To change an individual's system of knowledge (which amounts to a change in identity) is an intense and personal endeavor (*emphasis added*).

Such change in identity requires fundamental and deep changes, changes that Michael and Norman have indicated they do not want to make for such changes would not only threaten their identity but what they perceive as diminish the status of their identity as mathematics educators. For such change to occur then, the broader mathematical community needs to change their perception of mathematical literacy, for as Allen (2005:5) writes:

Identities are continually recreated, unplanned, and automatic. The social face is on loan from society, for it is through society's recognition that one's identity is reinforced. It is society that determines what we do and who we are, the role that we play and the masks we wear. Identity is construed, maintained, and transformed through social interaction. The social structures in which we live provide the background of experience against which all of life is lived.

Apart from the pedagogical knowledge and threat to status of teacher identity several other themes emerged with regards to the role of teacher understanding of curriculum and its subsequent enactment. These themes are identified and discussed below.

8.5 Instructional Material

Both educators in this study were found to use the textbook as the predominant form of reference in their instructional practice. The choice of textbook was not predetermined but as a result of sample copies sent to the schools by various publishers. Although both the textbook that Norman and Michael were using was significantly different to mathematics textbooks of the past the classroom observations revealed that both these educators used the parts of these textbooks that explained the use of mathematics formulas and rules. They made conscious decisions to strip questions and topics from the contexts in which they were embedded and predominantly delivered the algorithmic content to the learners.

Although the curriculum recommendations made it explicit that the instructional pedagogy should deliver the learning outcomes through the use and exploration of relevant contexts neither educator delivered the curriculum in this way. And when Norman did dress up the content with context this was done at such a superficial level that at times it simply included the use of pictures. For Michael, context was something he knew he had to deliver but would only do so when he felt that his learners had grasped the basic mathematical concepts. This pedagogical approach of both Michael and Norman was to a significant degree based on their beliefs and understanding that mathematical algorithms should dominate mathematics instruction, including that of mathematical literacy.

In their assessment practice that was distinctly separate from their actual teaching, Norman and Michael further used textbooks to set their assessment tasks. These summative assessment exercises were slightly more aligned to the curriculum intentions as they were mostly taken 'word for word' from textbooks that the learners did not possess. The deeper engagement of context that materialized here was not indicative of their understanding of the curriculum document but rather that of the textbook authors. As such to interpret that the assessment somehow reflected an appreciation of what was in point of fact required by the curriculum would be a misinterpretation for it only

reflected that the educators chose to utilize material that was readily available rather than to set their own assessment tasks. If their comprehension of the curriculum is to change, Michael and Norman must "become more assessment literate" as this provides access to opportunities for better understanding and instruction (Hargreaves, A. & Fullan, M, 1998).

Davis and Krajcik (2005) in a synopsis of literature on the use of textbooks describe how teachers use such reference materials:

Teachers' use of and learning from text-based curriculum materials depend not only on the characteristics of the curriculum material but also on the type of teaching activity in which the teacher is engaged, the teacher's persistence or lack of persistence in reading materials over time, what the teacher chooses to read or ignore, the teacher's own knowledge and beliefs (e.g., about content, learners, learning, teaching, and curriculum materials), how those beliefs are aligned with the goals of the curriculum, and the teacher's disposition toward reflective practice ...These factors interact in a complex and dynamic relationship as teachers interpret the curriculum materials and shape the enacted curriculum...

Norman and Michael's continual use of the textbook and what they chose to ignore and what to teach was mostly based on pedagogical content knowledge that was sparingly connected to the Mathematical Literacy curriculum. This knowledge that is required to teach the content (Shulman, 1986) was lacking in both these educator's instructional practice. And if as Davis and Krajcik (2005) argue that promoting teacher learning is even more complex than promoting student learning the task to 're-educate' Michael and Norman in terms of their understanding and beliefs on what the nature of mathematical literacy entails takes on a monumental requirement. For not only do these educators require training in what the curriculum necessitates in terms of pedagogy but also a change in what they believe the teaching and learning of mathematics to be. This change in the core assumptions and beliefs with regard to both teaching and learning requires as Coburn (1993:4) explains a deep change:

By 'deep change' I mean change that goes beyond the surface structures or procedures (such as changes in materials, classroom organisations, or the addition of specific activities) to alter teacher's beliefs, norms of social interaction and pedagogical principles as enacted in the curriculum.

The research findings concur with this viewpoint, as the textbooks that Michael and Norman were using were notably dissimilar to those of the past and yet neither educator had a deep awareness of this or how to best utilize these. A change would necessitate instruction that deals not only with the required pedagogical process but also instruction on understanding the nature of mathematical literacy.

This nature is conspicuously in deviance to the nature of past mathematics curricula and as such demands a reflective understanding of the disparity between numeracy and mathematical literacy. The way that Norman and Michael delivered the curriculum was more in line with what could be anticipated in the conveyance of a curriculum for numeracy. Their focus and emphasis of mathematical algorithms and formulae evidences this. To acquire the knowledge on the disparity in concepts is difficult, as it requires 'deep learning' not of content but of a concept that is patently new in the South African secondary school mathematics curriculum.

8.6 Educational Backgrounds

Michael was far better qualified in mathematics than Norman. He held a BSc degree and had done Mathematics III. Norman was less qualified in that he had done a teachers primary school diploma, which he had then changed to a high school diploma in one year. According to Shulman (1985), to be a teacher calls for far-reaching and highly organized bodies of knowledge. Elbaz (1983) holds the same view when he identifies teachers' knowledge as the single factor which appears to have the furthestmost influence to carry forward teacher understanding of the teachers' role. Such bodies of knowledge, the evidence of this study showed, were not simply a consequence of teacher qualification as the 'higher' qualification of Michael did not significantly enhance his understanding of the Mathematical Literacy curriculum. This is an important revelation

of this study for before the implementation of mathematical literacy it was widely debated as to who was going to teach this curriculum. From these two educators it seems that even though a qualification in mathematics is required the level of that qualification is not considerable in better enactment of the curriculum in the actual classroom.

It could be argued that the qualification in a way is a hindrance in that the two qualified teachers did not believe that they should be teaching mathematical literacy. It would however be inattentive to express that this implies that this curriculum can be taught by anybody. Michael felt that schools committed 'treason' when they used educators to teach mathematical literacy that were not well qualified, but did contradict him when he expressed that this should not include himself. Norman also held that the teaching of mathematical literacy required mathematically qualified educators but once more did not include him.

Literature is replete with evidence on how the low levels of mathematical subject knowledge impact on learners' outcomes (Darling- Hammond, 1997; Weiss, 1994). What this study furthers is that the converse is not always implied. That is, if teachers subject knowledge is of an acceptable level it does not necessarily hold that such teachers can deliver mathematical literacy as intended. This is of substance, for as already mentioned, before the actual implementation of this new curriculum, debate was rife as to who should be teaching mathematical literacy. The contention that it does not of necessity need to be mathematics educators may prove to be significant if this curriculum is to be taught as proposed. It would be perhaps easier to educate teachers in another discipline than to 're-teach' educators in the discipline of mathematics. The former requires training, the later requires abandonment of old beliefs and practices as it requires changing a culture, which as Sergiovanni (1998:577) observes:

[Changing a culture] requires that people, both individually and collectively move from something familiar and important into an empty space. And then once they are in this empty space, to build new set of norms, a new cultural order to fill it up. Deep change, in other words, requires the reconstructing of existing individual and collective mindscapes of practice.

As such, the former presents itself, simply put, as a lesser 'painful' alternative. Furthermore it also does not compete with draining the few mathematics educators that are well qualified and experienced from the Mathematics classrooms. The shortage of which is not uniquely South African but widespread even in developed countries³³. In developing countries this lack of well-qualified teachers is even greater generating a dire domino effect on learner outcomes.

8.7 Learner Expectations

Mathematical Literacy as a mandatory alternative to mathematics presupposes that all learners can and should do some form of mathematics. As an equity reform it further allows all learners access to mathematics. However the broader philosophy of this curriculum is more about accessing mathematics as this is how the curriculum envisages the attainment of the three main purposes, namely to provide and develop skills in learners that are required by 'numerically self-managing persons, contributing workers and democratic participants'.

This standard was however not been realized in either Norman nor Michael's classroom as they believed that the majority of learners doing Mathematical Literacy did not have the mathematical pre-knowledge required by the Grade 10 Mathematical Literacy curriculum. In Michael's classroom the majority of learners taking the subject either failed mathematics in Grade Nine or were placed in the class as new students with a history of very low attainment in mathematics. For Norman the scenario was very much alike. The learners in his Mathematical Literacy class either failed Grade Nine Mathematics on the year aggregate or failed the end of year examination. As such both these educators were influenced not only in the level of knowledge and skills they chose to deliver to these learners but also in their expectations of learner outcomes.

³³ In England: "the shortage of suitable teachers continues to be perceived as a major problem in terms of delivering the secondary mathematics curriculum" p4-2002/3 *Annual Report on Curriculum and Assessment (Mathematics)* published in March 2003 the QCA.

Norman referred to his learners as 'doffies' and the evidence from the classroom observations indicated that this perception of his learners' ability undoubtedly impacted on the implementation of the new curriculum. His lessons did not support higher order skills and his continuous focus on basic mathematics concepts precluded learner engagement in new ways of learning and thinking. He also admitted to often having to re-teach sections of work as he found that the learners were not coping with the material. In his opinion the reading was causing much of the problem, however the observed lessons revealed that the actual mathematical content was what the learners were struggling with.

The responses from the learners themselves also further evidenced this as they indicated that they struggled with mathematics concepts and formula. What is more is that Norman referred to the mathematics in the Mathematical Literacy curriculum as the "maths of oranges and bananas". An intimation of how he perceived the curriculum that he was teaching. This value judgment further enforced in Norman a perception of how weak his learners actually were, for if they were unable to muddle through a curriculum that he considered very easy and trivial it stigmatized his learners ability, when not acquiring the outcomes, even further.

What becomes noteworthy is that his perceptions of his learner abilities negatively affected the implementation of this new curriculum. Having claimed that his expectations of his mathematical literacy learners were high but realistic he exhibited behavior that was noticeably indicative of having very low expectations of his learners. His lack of expectation in terms of homework done and eliciting learners' response was evident throughout the six-week observation period.

In terms of equity reform and 'mathematics for all' his acuity as to who could and could not do mathematics was clearly expressed in his following retort: "not all pupils can do mathematics, but at least mathematical literacy is something". What exactly this 'something' was was never explained any further, but the impression given was that it was basic numeracy. His beliefs on what the learners in his classroom could achieve were clearly embedded in his learners' previous history of mathematics achievement.

Similarly, Michael had no higher expectations of the learners in his mathematical literacy class. His lessons and assessment practice did not extend them beyond what he also referred to as the 'basics'. This emphasis on basic numerical and calculator skills hindered him from affording his learners material and knowledge that was either empowering or enriching in terms of experiencing mathematics in contexts relevant to everyday lives.

His emphasis on building the basics and focusing on questions, which he believed to be of manageable ability, did not take into account individual needs or wants. His awareness that some of the learners in his class 'feared mathematics' also did not prevent him from making comments about his learner's abilities and he further reinforced this, even though it seems to have been on a subconscious level, in his instructional practice. His altercation with one of his learners when that learner indicated that he had found the homework difficult can be assumed to have caused embarrassment and humiliation to his learner when he uttered the following:

It is not difficult; you just cannot do it. If your friend can also not do it then maybe he should also be in this class. Hands up, if you also found it difficult.

You see, maybe you and you friend should be in a special class of your own.

This substantiates his perception of how he viewed not only that learner's ability but also any learner doing the subject of Mathematical Literacy. The implication being that Michael held that learners taking core Mathematics as a subject were more intelligent and able than those doing Mathematical Literacy.

Both Norman and Michael's views were such that seemed to indicate a predetermined expectation of their learners that predestined them from ever achieving the high knowledge and skills that the curriculum purported to afford. These low expectations of learner outcomes for Norman and Michael were such, as both these educators did not intrinsically believe that the mathematical literacy curriculum was an opportunity to alter learners' outcomes with regards to any 'real' form of mathematics. They were both clearly

under the impression that the low levels of numeracy with which their learners came into Grade Ten implied that they would have low levels of mathematical literacy. Although it can not be disputed that these numeracy levels clearly played a role in the learners ability to comprehend lesson content it can be argued that they were obstacles of immense extent for the reason that the lessons' prominence was one of hierarchical dominance of content. As such the challenge becomes the educators in creating a learning environment that engages their learners' past mathematical histories while at the same time developing and furthering their mathematical literacy skills. Donovan, Bransford and Pellegrino (1999) explain this as follows:

Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp new concepts and information taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classrooms.

The deep change required for understanding new concepts includes lessons that are not of traditional instruction as well as a change in their beliefs and understanding of the difference between the concepts of mathematics, numeracy and mathematical literacy. These changes are so edifying that it is incomprehensible to assume that reading a curriculum policy and attending a single teacher-training workshop by these two teachers can achieve this type of change. Such meaningful and deep change requires extensive strategies that are continuous to both develop and sustain this need. This required delivery is possible but only once all stakeholders believe that it is worth investing in. The central tenet underlying this charge is a clear vision of what the value of mathematical literacy is by both the workplace and the Higher Education Sector, and not only the curriculum which states (DoE, 2003):

It sets up high expectations of what all South African learners can achieve. Social justice requires the empowerment of those sections of the population previously disempowered by the lack of knowledge and skills. The National Curriculum Statement specifies the minimum standards of knowledge and skills to be achieved at each grade and sets high, achievable standards in all subjects (3).

An education system does not exist to simply serve a market, important as that may be for economic growth and material prosperity. Its primary purpose must be to enrich the individual and, by extension, the broader society (5).

Why neither educator believed that this was possible allows for the interpretation to be made that these educators had not undergone any significant change let alone a deep change as to what the nature of this reform calls for, in terms of challenging their assumptions on who can and can not be taught mathematical literacy. Until educators believe that this curriculum allows for and makes provision in terms of the required pedagogy and content for high levels of knowledge and skills the implementation of this curriculum will not take place 'in the spirit' and with the moral purpose with which it was intended.

Michael Fullan (2006:19) in his report on *Effective District Wide Strategies to Raise Student Achievement in Literacy and Numeracy* states:

The districts held an educational vision that extended beyond narrow attainment measures to a belief in the moral purpose of education, which included an expectation-and indeed assertion-that all students can learn and that all teachers can teach students to learn given sufficient support and time. The districts developed and promoted high expectations and positive attitudes for student learning and achievement.

This 'expectation-and indeed assertion-that all students can learn' was clearly not visible in either of their practices. However they both held that they were able to teach mathematical literacy and never questioned whether what they were doing could in any way be done differently. To change such behavior and perception requires not incremental change but a deep change, as it is completely discontinuous from the past.

Quinn (1996:3) observes:

[Deep change] requires new ways of thinking and behaving. It is change that is major in scope, discontinuous with the past and generally irreversible. The deep change effort distorts existing patterns of action and involves taking risks. Deep change means surrendering control.

This view of deep change holds for the dismantling of the status quo. It requires the deconstruction of views and beliefs and an abandonment of the past and a start from the very beginning. In so doing, it requires discipline, courage and motivation, which is at the core of changing ourselves (*ibid*). In so doing it also necessitates recognition that this is required. Recognition that neither Michael nor Norman displayed in their instructional practice.

Michael stated that all learners "cannot do maths" but that "everyone could do mathematical literacy if taught properly". Having later on admitted that his learners were not coping with mathematical literacy the inference would be that he was not teaching them 'properly'. Yet, Michael did not see his learner outcomes as a reflection of his own instructional ability but rather as a result of his learners' past history with mathematics.

And, if it was not for the externally set Grade Twelve examination that presented itself as an ominous cloud for both Michael and Norman their instructional practice would support learner outcomes to an even lesser extent, as it was this pending examination that forced them to aspire to teach the curriculum content in its entirety.

Michael like Norman did however believe that mathematical literacy could provide for high levels of skills and knowledge, but not to the learners that were taking the subject. The two teachers did not hold themselves accountable for their learners' results.

There are deep consequences for this lack of accountability for the fate of this reform curriculum in that if Michael and Norman do not change their perceptions on who can and cannot do mathematical literacy and change their views on learner attainment and who is accountable for this, this new curriculum will not be effectively implemented in their classrooms. The purpose of introducing this curriculum then, which includes, empowering the workforce with skills that are demanded by the 'Information Age' and the serving of the "market place" (DoE, 2003:5) may never emerge.

Many arguments have been made that there is no empirical evidence that curriculum reform improves the economy of a country in either developed or developing countries (Psacharopoulos, 1986; Camoy & Samoff, 1990), but such arguments do not consider that many countries where the levels of numeracy and mathematical literacy are considerably low if not unacceptably so occur in countries with low economies. As such it would be fair to state that a reform seeking to empower the workforce of such developing countries if implemented as intended, given the limitation that the curriculum design and content is of value, may go some way in altering the micro-level economy, even on a personal level, for such countries, South Africa included.

What all this points to, is staff development that mandates teacher accountability in terms of pursuing a deep change of what they believe students can and cannot learn. In *Effective District Wide Strategies to Raise Student Achievement in Literacy and Numeracy* Fullan (2006: 18) observed the following, "A lack of focus on student achievement was widely understood as being unacceptable, and there was low tolerance for excuses about poor performance". Such levels in Michaels and Normans classrooms were not only acceptable in terms of justifying learner outcomes but were also used as excuses for not engaging these learners with the required level of knowledge and skills that the curriculum afforded. As such, strong strategies are necessitated that address how teachers should cultivate already held beliefs and understanding to suit those that are new and requisite for the learners of the Mathematical Literacy curriculum.

Teacher training programs must address the purpose of change by providing empirical evidence not only of the failure of the 'old' but also of 'successes' of similar curricula as that of the 'new'. Intervention strategies that support struggling mathematics learners are also further required and educators need to be trained in terms of 'best practice' teaching and learning strategies, if the attempt is to reach and affect the majority of South African learners. At the same time this staff development must account for and provide solutions for the complexities associated with teaching in contexts that are impoverished in terms of resources and human capacity.

8.8 Resources

The resources available to Norman in terms of materials to teach with were less than those of Michael's in that Michael had more computer technology available to him than Norman did. Norman had three textbooks and a scientific calculator. Michael had similar resources but also access and skills to use the computer laboratory, which he chose not to do. For Michael, it was pointless to integrate his instructional practice with computer technology as he felt that if his learners were struggling with the use of the scientific calculator how would they be able to cope with other technology. This perception of Michael's not only limited the learning opportunities of his learners but also the curriculum intentions as designed. Norman spoke of needing access to the Internet in order to acquire material that he could use in his practice and saw this as a major and restricting obstacle to his teaching of mathematical literacy. Michael did have free and readily available access to the Internet but other than the exemplar paper that he had downloaded from the Thutong website he made no other use of the Internet in terms of acquiring resources.

The Teacher Guide for Mathematical Literacy lists the resources needed to teach this curriculum to include the following: textbook(s), advertisements from the media that refer to percentage and interest rates, articles and advertisements from the media that are supported by graphs and tables, sales brochures offering different payment methods, nutritional panels from food packages, municipal utility account statements, municipal tariff tables, banking brochures, recipe books, tournament logs and results, timetables for trains and other transport systems, national and regional maps, basic calculators, rulers and measuring tapes, measuring jugs, scales, pairs of scissors and compasses, stopwatches and clocks, graph paper, protractors, glue and string, elastic bands and paper clips (DoE:2006). This comprehensive list includes many resources that could readily be available to both Norman and Michael despite the contexts in which they found themselves working in. Yet the only two that dominated their practice was primarily the textbook and secondary the scientific calculator. It can be inferred from their behavior in the lessons and from their replies to the questions in the interviews and questionnaires

that this use was not limited because they did not have access to most of these other resources but because they did not value their use as a requirement in the teaching of the new curriculum.

Furthermore, four official documents were available for Mathematical Literacy at the time of the study, namely the Mathematical Literacy Subject Statement (DoE, 2003), the Subject Assessment Guidelines: Mathematical Literacy (DoE, 2005), the Learning Programme Guidelines: Mathematical Literacy (DoE, 2005), and the Teacher Guide: Mathematical Literacy (DoE, 2006). Of these documents Norman was only in possession of the Subject Statement and Michael of the Assessment Guidelines and Subject Statement, all of which had been handed to these educators by their respective heads of department. The use of these documents by both these educators was limited to acquiring the content that had to be taught in terms of drawing up weekly schedules and year plans. Neither educator engaged with the official documents in any other way. Even the understanding of Chapter Three in the Subject Statement that deals with the learning outcomes and assessment standards required was limited in acquiring the broader area of what was to be taught.

I have argued that a strong theory of action, in terms of teacher development strategies, needs to accompany this new curriculum. However due to the teacher's thin and disconnected interaction with official documentation, if this was to be embedded in such documents, it can be assumed that it either would go unread, or if it were read it would be interpreted on a superficial and personal level, in the same way as the purpose and possibilities were by the two teachers.

The workshop that both educators had attended had also not provided training and learning that had significantly altered the instructional practice for either Michael or Norman. Having analyzed the material handed out at the workshops it was evident that these programs had provided for some level of explaining teaching mathematics in context and a relative amount of scaffolding that was required for the necessary change in instructional practice. Why had Michael and Norman not incorporated what was

delivered in these workshops can be based on three revelations. Firstly the workshop did not elucidate the purpose of the reform nor did it make mention of the crisis in mathematical literacy in South Africa and as such did not make it explicit as to why Mathematical Literacy, the subject, had been introduced. Secondly, there was no distinction made between numeracy and mathematical literacy and as such the focus was on numbers with the use of context acting as a 'dress up' for the mathematical content. Thirdly, its early delivery was too soon in the implementation process of mathematical literacy and the educators did not have enough experience to be able to reflectively engage with what was been taught.

Teacher training not only needs to provide for deep learning but also needs to provide this at a time when educators are most receptive. What is more is that those responsible for such training need to have ownership of the curriculum and a collective commitment towards what they intend to explicate. To foster a collective commitment implies that both those responsible for training and those responsible for learning believe in the possibilities and value of the new curriculum and hence the reform, both of which were profoundly found to be lacking at the time of the study.

One major contributing factor was that the higher education sector was uncertain as to how to value this new curriculum and most tertiary institutions were hesitating to provide information as to which doors Mathematical Literacy opened or closed. The only certainty was that learners taking Mathematical Literacy as a subject and attained forty percent and above would obtain a university entrance. This was fervently pursued by most of the learners in both Michaels and Norman's classroom.

One of the learners in Norman's class stated that he was doing Mathematical Literacy for by doing the section on Mathematical Finance he would be able to study further as a Chartered Accountant. Neither the learner nor Norman was aware that this door, Mathematical Literacy did close. Such confusion results when all stakeholders have not collectively bought into the value and possibilities of a new reform. It begs the question

then as to how the government can allow for the introduction of a new reform before all the groundwork necessary for understanding the reforms value have been established.

In addition, because deep learning is a necessity for deep change it takes time and thus cannot be acquired by simply reading official documentation. So to provide these educators with all the documents they did not have in their possession will not be of consequence unless teachers are provided with opportunities to reflect upon and discuss the curriculum as it unfolds in their classrooms. Such opportunities can only be afforded by programs that are continuous and not 'once off' if change is to be sustained particularly at the onset of a new reform. Once momentum is gained and the instructional practice of educators has significantly changed, then and only then can it perhaps be relied upon that these educators will similarly train those entering the mathematical literacy profession.

The learning resources for the two educators of the study also differed in that Norman's learners did not have textbooks and Michaels did. It was observed however that the possession of these textbooks or lack thereof did not markedly contribute to a different lesson delivery in terms of work covered or homework set. This is not to say that the conditions in Norman's classroom were not more difficult but that having textbooks did not markedly impact on the implementation pathway of the curriculum in Michael's classroom. The fact that the learners in Norman's classroom did not have textbooks did constrain Norman's lessons in that his learners spend a lot of time copying exercises and questions from the textbook rather than using the time to engage with their teacher in the requirements of the days lesson. However, despite this and the other shortage of resources that the learners had, this study revealed no evidence that would support that if the learners and educators had more resources their instructional practice would be any different.

What is worthy of mention is that such evidence does go towards showing that in developing countries the delivery of textbooks to the classroom will not magically resolve the problems of educating economically disadvantaged learners. This is not to say that textbooks are not necessary with respect to 'opportunity-to-learn' Tate (2004). It only

suggests that even of graver necessity is a teacher workforce that can use these textbooks and other obtainable resources in a manner that will most benefit the learners.

This requires 'deep learning' which is not only about working smarter and harder but also accruing resources that enable one to go deeper and further (Fullan, 2005b). Resources that, as mentioned, both Michael and Norman could acquire a lot of if they knew not only to look for them, as they both claimed that they should find articles in the newspaper that were topical but had not done to date, but rather to look for them because they believed that it would benefit both the teaching and learning of mathematical literacy. Such a mind shift would require collaboration with peers and stakeholders and some semblance of a reflective practice, both of which were also found to be scarcely pursued by both the teachers in this study.

8.9 Collaboration & Reflection

In Norman's school there were four mathematics educators of which he and one other were given the duty to teach the Mathematical Literacy curriculum. His head of department was not one of them, and the five departmental meetings observed which were held once a week did not provide any evidence of discourse or reflection on how these two educators were implementing this new curriculum. The focus of the meetings was mostly planning and other than discussion on what section was to be taught next and for how long, the discussions at these meetings did in no way provide for any in-service training.

Norman claimed that discussion was not required as he knew what he had to teach. This was loosely based on his assumption that because he believed that he had a mastery of the mathematical content requisite by the curriculum he was implementing this new curriculum successfully. He explicitly stated this when he said that at looking at the exemplar paper that a colleague of his from another school had given him, the work that he had covered to date, he had done so correctly. If the learners were unable to do this work it was not a reflection of his teaching but rather of his learners' ability.

Other than the planning mentioned there was also no deliberation between Norman and his colleague at FET High School that was also teaching the subject on what mathematical literacy entailed, or how it was unfolding in his classroom. The principal of the school was additionally also uninvolved in what was happening in the delivery of this new curriculum. His only connection with Norman was that of assisting with disciplinary matters if the learners were found to either misbehave or show disrespect.

At the cluster meetings that Norman attended, a similar pattern was described by Norman. He mentioned that discussions did not include the mathematical literacy curriculum and were mostly focused on sharing ideas and information with regards to the core Mathematics curriculum. Once again, the main reason why Norman did not attempt to discuss mathematical literacy was because he believed that what he was doing was sufficient and correct. His beliefs were in turn based on the understanding he had of the mathematical content that he had to deliver.

For Michael collaboration and reflection was also not part of his mathematical literacy instructional practice. At East Rand High School there were five mathematics educators and Michael was the only one teaching mathematical literacy. His head of department also held weekly meetings that also failed to provide a forum of discussion on how the implementation of mathematical literacy was taking place in his classroom. He solely barred the responsibility of this new curriculum at his school, not only because he was the only teacher teaching mathematical literacy but also because he chose not to engage with discussion on this new curriculum. His behavior can also be explained with regards to his understanding of the mathematical content that he taught, which he explicitly believed he had a mastery of.

At the one cluster meeting attended by Michael, during the observation period of this study, there was also no dialogue on the mathematical literacy curriculum in terms of content, pedagogy or purpose, and the only mention of the subject was that they should not worry too much about how the learners were doing as all the educators present at the meeting were clearly under the impression that no learner would fail Mathematical

Literacy in Grade Twelve, which was two and a half years away. This rumor was rife and the educators were under the impression that this was so because the Department of Education had got the level of the curriculum wrong. Michael agreed that the standard of the curriculum was too difficult for the learner's taking the subject and expressed that the Education Department may have realized this, and would not fail the learners taking Mathematical Literacy for several years while they sorted this problem out. For Michael, this rumor did not seem to consciously influence his practice in any way as he claimed that he would have to see it in writing to believe it.

For Norman, who had also heard this rumor, the impact was significantly different, as it seemed to put him at ease with the way his learners were achieving. He claimed that this was also true of the other educators in his cluster that had told each other not to worry about how their learners were experiencing the curriculum, as they would all pass this in their Grade Twelve year.

Having inquired into this rumor I found that departmental officials even though hesitant to admit that this rumor was true were as hesitant to deny it. They referred me to policy documents that indicated the required pass aggregate for Mathematical Literacy. One mathematical stakeholder that is highly regarded in educational circles and consults for the Minister of Education on mathematical matters admitted that this was a discussion that was busy taking place.

It is uncertain that in the absence of this rumor more discussion and reflection would be taking place in Norman and Michael's cluster. But it is certain that this perception prevented Norman, at least, from worrying about his students' struggle with the mathematical literacy curriculum.

What is more is that in less than nine months both Michael and Norman believed that they had successfully implemented the Mathematical Literacy curriculum. For both of them their main reference point was the exemplar paper that they had in their possession. This seemed to vindicate for them what they had been doing, a finding that was confusing

as the exemplar paper was by no means similar to either of their instructional practices. And yet, Michael and Norman were confident in that they were teaching mathematical literacy 'correctly'. The use of 'correctly' is important for not only was it used by both educators to describe what they were doing but also to emphasize that for these two educators it was either right or wrong.

This viewpoint hindered reflection on their instructional practice and in the absence of a collaborative network indicated that this concentration of detachment of understanding can only but remain at this surface level for as Fullan & Hargreaves (1991) observe, there is a ceiling effect to how much we can learn if we keep to ourselves. Dialogue arbitrates collective sense. By critically exploring and examining other educators' instruction and reasoning and partaking in the solution findings of incongruity, educators learn to monitor and change their thinking.

Michael and Norman's belief that what they already knew more than sufficed in delivering the curriculum also further prevented them from holding themselves accountable for the learner outcomes. As such any change that may still be needed in terms of holding learning as a function of teaching, will not take place unless it is supported, understood and driven by professional learning communities.

Professional Learning Communities allow for teachers to develop as a result of continuous interaction, shared understanding and commitment to achieve high level outcomes for all students Newmann (1998). These should also include those in a position of leadership. Fullan (2005a: 30) explains for the difference that this makes:

What does make a difference is recapturing the process of developing professional learning communities in the school. Recapturing involves going from a situation of limited attention to assessment and pedagogy to a situation in which teachers and others routinely focus on these matters and make associated improvements. Structures can block or facilitate this process, but the development of a professional community must become the key driver of improvement. When this happens, deeper changes in both culture and structure can be accomplished.

Leadership is important as it allows for sanctions and rewards and thus accountability. Hay Management Consultants (2000) compared two hundred highly effectual principals, with two hundred senior executives in business. The five domains of leadership identified were: teamwork and developing others; drive and confidence; vision and accountability; influencing tactics and politics; and conceptual and analytical thinking styles (Fullan, 2002). Ferrini-Mundy & Johnson (1997) further claim that available evidence suggests that significant change in how teachers teach mathematics can occur with strong administrative support and an intense and sustained program of professional development focused on curriculum, mathematics content and pedagogical issues. Fullan, Campbell & Glaze (2006) support this assertion with their findings that show that within schools, principals with deep knowledge and understanding of successful literacy and numeracy practices were important for ensuring such approaches were applied in classrooms. The leadership at Michael's and Norman's schools did not exhibit any of these domains with significant depth as regarded the introduction of the Mathematical Literacy curriculum, which in term impacted on how these teachers functioned-as solitary change agents.

As it is unlikely that schools will appoint mathematical literacy educators as leaders for the time being, there is a need to develop not only the educators teaching mathematical literacy but their heads of departments and principals. This ideal is recommended to take place simultaneously with implementation Fullan (2003), however as it has not yet been realized a concerted effort is required to both pursue and introduce it. This pronouncement is sizeable for there was no indication during the time of the study that any of the workshops were designed to include anyone else other than the educators who had been assigned the task of teaching mathematical literacy for the very first time. The selection or omission of which this study revealed led to conflict not only as a result of a lack of support but also of professional competitiveness that also significantly impacted on the evidenced feeling of a threat to the teachers 'status- identity'.

This study adds to this scholarly text, in that in South Africa and perhaps other developing countries with low levels of mathematical literacy, pedagogy and assessment may be important for mathematical literacy but they will not be effectively transacted

upon unless the curriculum purpose in terms of transformation is spelt out and engaged with as an opportunity to establish a culture and ethos of higher learner expectations, not only by mathematical literacy teachers but also by those in positions of leadership.

Jointly these findings have implications for mathematical literacy reform, and are discussed below.

8.10 Implications for Mathematical Literacy Reform

The thin and disconnected understandings of the Mathematical Literacy curriculum of the two educators in the two case studies echoes an expansive literature (Hill *et al*, 2004; Sherin, 2002; Shulman & Grossman, 1988; Mwakapenda, 2002) that recognizes the complexity of bridging the gap between curriculum as intended and curriculum as implemented in the context of actual classrooms. Added to this, the introduction of this new curriculum implores a linear link between curriculum and practice as it provides an implicit theory of change without providing a theory of action. The transformation required in moving between and beyond teaching mathematics to mathematical literacy indicates by all accounts that a deep change is necessitated not only for educators delivering this curriculum but also for all stakeholders of the broader mathematics community. The evidence provided through an explorative design urges that action strategies must provide the implied change theory with support that enables the changes required.

Norman and Michael had a surface level understanding of the curriculum because in the absence of strong teacher development strategies they were not empowered with a deep engagement of the curriculum. Rather than internalizing and understanding the changes needed, they implemented the curriculum thinking that they had made the necessary changes when in effect these were far removed from the curriculum design.

Strategies required were evidenced in the following fields; personal transformation needed in terms of understanding the concept and nature of mathematical literacy as a

subject, a consideration and reflection on the impact of beliefs on who can and can not do mathematics, requisite pedagogy of teaching mathematics in context, thought and planning as to who is to teach mathematical literacy, lack of leadership in terms of collaboration and reflective practice, valuing of the curriculum by all stakeholders, and valuing mathematical literacy educators as a deflative process to the threat of 'status-identity'.

The propositions that were positioned to accompany the research questions were further evidenced as follows:

Proposition One:

Michael and Norman did not have a deep understanding of the purpose and possibilities contained in the Mathematical Literacy curriculum. Their level of understanding was thin and disconnected to the curriculum intentions.

Underlying this finding was the lack of interaction with the curriculum document as a result of such interaction been viewed as an acknowledgement of not understanding a 'lesser subject'. A deeper engagement with the curriculum would have further exacerbated the threat to the 'status-identity' that these teachers were experiencing when being identified as mathematical literacy educators.

Proposition Two:

Michael and Norman implemented the Mathematical Literacy curriculum using beliefs, pedagogy, and understanding that were already entrenched in their mathematics practice. They proceeded to implement the curriculum in a way synonymous to numeracy or the old standard grade mathematics curriculum. The change of using context only dressed up the content and did not align itself with the required and stipulated pedagogy.

Underlying this finding was the prejudice shown in favour of mathematics formulae and algorithms as an acknowledgement of the superiority of numbers over context. This prejudice, further prevented threats to the 'status-identity' of these teachers as mathematics educators.

Proposition Three:

Both teachers of this study implemented Mathematical Literacy at their schools because they were told to do so. Neither educator had embraced the 'spirit' nor the purposes of the reform nor wanted to be regarded as the mathematical literacy teacher.

Underlying this finding was the little value that the curriculum held for both these teachers. Not as an explicit judgment of the curriculum content *per se*, but rather as a reflection of popular public opinion.

8.11 Concluding Remarks

Norman and Michael were unable to make the changes required because policy and planning did not provide sufficient strategies or support for these educators. Analyzing Norman's and Michael's understanding of the curriculum through the conceptual framework of deep change, this study extended the evidence base in developing countries on the difficulty of pursuing a transformative reform in mathematics in the absence of a strong theory of action by providing the following insights:

Firstly, a mathematics curriculum distinctly different from curricula of the past was diktat on educators without due consideration on how substantial the required change would be in terms of understanding the purpose and possibilities of this new curriculum. A purpose that in transforming mathematical literacy levels in South Africa presupposes some or other level of social justice. As such it obliges a collective moral purpose and a belief that all pupils can be taught to become mathematically literate. Such deep understanding was

distinctly absent not only in the schools that made up the two case studies but also in the snap-shot survey that involved over fifty educators.

Secondly, there was an assumption that educators understood the concept of mathematical literacy that by its very own nature is distinctly dissimilar from that of mathematics or numeracy which can be considered as the only previously taught and learnt mathematics, by educators in South Africa. This assumption of being able to comprehend a new concept by simply reading a curriculum document fails to consider the broad literature that shows that if meaning is left up to the teacher to be acquired a 'great variability' in understanding will occur (Hill, 2001;Spillane & Zeuli, 1999,Drake, 2002).

Thirdly, there were no provisions made for strategies to empower educators to deal with and assist learners with a past history of low attainment in mathematics. Such strategies are imperative for as seen in Michael and Norman's classrooms, the learners doing mathematical literacy had a history of low mathematics success. Taking into account the impoverished mathematics educator workforce many of these learning difficulties they had acquired can be contributed to poor learning. To address these gaps learning policy has to make explicit what the required pre-knowledge of mathematical literacy learners should be and provide stratagems to educators and opportunities to learners to bridge the gap for knowledge required when beginning mathematical literacy in Grade Ten.

What is more is that a change in beliefs has to be pursued in the educator work force on who can and cannot do mathematical literacy. It is imperative that educators begin to hold themselves accountable for the learning of their students.

A fourth insight gleaned from this study was that there was an absence of collaboration and reflection on how mathematical literacy was been implemented. This was not only as a result of Michael and Norman believing that they already had implemented the curriculum successfully but also as a result of the absence of involvement and interest of the leadership structures directly above them. The head of departments and principals of

these schools did not involve themselves with the implementation of this new curriculum and any discourse at the departmental meetings and cluster meetings tended to focus on planning and complaining about how difficult the learners were finding this curriculum, rather than exploring and discussing issues of pedagogy and best practice. Mathematical Literacy learning communities were distinctly absent.

Lastly, a surprising but major and overriding insight that emerged from this study was that this curriculum reform threatened teacher identity, not in terms of ability and 'intensification' of work, but in terms of a threat to status of teacher identity. The two mathematical literacy educators did not want to be identified as such as they felt that this diminished their value in terms of how they were perceived as educators by the broader community. This, significantly and negatively impacted in their engagement with any form of discourse that would illuminate and lessen the emerging problematic findings mentioned above.

8.12 Implications for Future Studies

This study explored and explained the implementation of mathematical literacy in its first year of introduction. The two educators responsible for this at two urban high schools in South Africa did not change deeply as was required by this reform. Having posed the caveat earlier on that perhaps it was too soon to expect deep change I challenge that this will not take place in these educators future as they both believed that this change posed a major threat to their mathematics teacher 'status- identity'.

As a result they did not reflect on their practice, and in the absence of informed and collaborative leadership in terms of head of departments, principals, professional learning communities, and also in the face of a lack of any future training of any of these stakeholders on the value of mathematical literacy, it can but only but be assumed that their instructional practice will remain largely unaltered in future. This line of reasoning points to the following suggestions for future studies:

- Research is required on the attributes of teachers more likely to embrace a mathematical literacy curriculum. Is it easier to train teachers that are not qualified in mathematics to understand the nature and pedagogy required by this new curriculum, or is it reasonable to assume that qualified mathematics educators and the larger community will gain a deep understanding of the value of this reform so that these educators do not perceive a threat to their the professional status identities? The question of interest in, or performance by, qualified or not mathematically qualified educators could be a topic of research.
- What intervention strategies are best suited for learners with a history of low mathematical attainment in continuing successfully with mathematical literacy?
- Does a deep understanding and appreciation of the purpose and 'spirit' of a curriculum enable a deeper understanding and delivery of that curriculum?
- What strategies are best suited to train teachers into using pedagogical content knowledge that is best suited to teach mathematics in context?
- What would motivate qualified educators to want to teach mathematical literacy in the first place?
- A need exists to document the impact that mathematical literacy has on the self worth of learners taking mathematical literacy.

8.13 The Emerging Significance of this Research

The principal contribution of this study lies in the fact that it has demonstrated that the implementation of mathematical literacy is undermined by the threat that qualified educators experience in relation to their identities as mathematics teachers. What is presented in the literature on the construction of teacher identity as a consequence of teacher subjectivities is not only largely absent in the literature on educational change (Carson, 2005), but also has few accompanying insights as to how a threat to the 'status-identity' affects and changes the lives of teachers in developing countries. This research extends the knowledge base on educational change into a new discipline and provides an insight that goes beyond the confines of the "institutionalized text" (Pinar et al., 1995) of the Mathematical Literacy curriculum.

I found that some of the problems been experienced by educators were such that teachers did not even have an awareness that these were so (required pedagogy of teaching mathematics in context). Others (history of learner ability) allowed teachers defenses with which to justify low learner outcomes and delivery of instructional material that did not support higher order knowledge and skills. Collectively, these issues were not been dealt with mainly for two reasons.

Firstly, the purpose of this new curriculum had not been understood in any considerable depth and consequently mathematics teachers were not significantly valuing the curriculum. And secondly, because the value of mathematical literacy was considered lesser than that of mathematics, qualified mathematics teachers teaching mathematical literacy were feeling a threat against their 'status-identity'. As an addition to the existing scholarship that thinly accounts for the importance of how teacher's personal and national histories engage with new equity circumstances to effect the desired change (Carson, 2005), I found that changes in subject disciplines also affect teacher identities.

A mathematics teacher attempting to add up the Mathematical Literacy curriculum not only has to come to terms with a new and variable concept of mathematics but also to

make sense of what it means to be assigned the status of a mathematical literacy educator. To understand the concept of 'mathematical literacy' requires understanding not only on a deep level of the nature of mathematics but also of its transformative purpose and possibilities. It requires a deep understanding of the sudden shift from content, to context and content as a process, and a similar understanding of the motives behind the purpose and how the two interact within the new curriculum.

The struggle experienced by teachers in comprehending this interaction has connected teacher understanding of reform to understanding teacher 'status-identity'. Keeping in mind that South Africa is one of the first developing countries to mandate mathematical literacy in secondary schools as a discipline, this study extends the knowledge base on curriculum implementation into new contexts. For as Shulman & Sherin (2004:136) state, "if reform policy must be 'learning policy' (Cohen & Hill, 2001), then it must also be domain specific". These findings have revealed insights, some known and some as yet uncharted into the recurrent quandary of why it is so difficult to deeply change instructional practice.