DISPELLING THE MYTHS OF MATHEMATICAL LITERACY

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In this paper I aim to dispel certain criticisms of the school subject Mathematical Literacy that are circulating in both the public and schooling sectors. In doing so I argue that components of these criticisms are based in various misconceptions or 'myths' about the intention of the subject and learner performance in the subject. In particular, I focus on four prevailing myths: (i) the myth that Mathematical Literacy is legitimised according to mathematical knowledge and structures; (ii) the myth that higher pass rates point to Mathematical Literacy being an easier qualification than Core Mathematics; (iii) the myth that we would be better off without Mathematical Literacy; and (iv) the myth that Mathematical Literacy restricts future career and study opportunity. I conclude by suggesting that Mathematical Literacy has become the 'scapegoat' for declining enrolment in Core Mathematics and that, as an alternative, to retain learners in Core Mathematics more attention should instead be focused on improving the quality of teaching and learning in this subject.

INTRODUCTION

At present there is a tremendous amount of negative publicity surrounding the subject Mathematical Literacy, with some arguing vehemently that the subject should not be part of the qualifications framework (see, for example, Jansen, 2012). At the core of many of these criticisms is a two-fold concern. Firstly, the fact that Mathematical Literacy is (supposedly!) an easier qualification to Mathematics is contributing to the exodus of increasing numbers of learners from Core Mathematics to Mathematical Literacy. Secondly, there is concern over the quality of the Mathematical Literacy qualification and the fact that participation in the subject does not afford access to various avenues of tertiary study or career choice. It is this negative criticism that has contributed to the Minister of Education's decision to institute a ministerial panel to investigate, amongst other things, "the currency of Mathematics and Mathematical Literacy and whether this is the best option for the South African schooling system in terms of preparing learners for the workplace and for higher education studies." (DBE 2012a). Unfortunately, in the midst of this increasing criticism (and in some ways inherent in the criticisms) are various misunderstandings and misconceptions about the intention of the subject Mathematical Literacy, about the currency of the subject, and about the reality of learner performance in the subject. The intention of this article is to identify, clarify and debunk these misconceptions.

MYTH #1: MATHEMATICAL LITERACY IS LEGITIMISED ACCORDING TO MATHEMATICAL KNOWLEDGE AND PRACTICES

The first myth that is circulating is that the basis of legitimate knowledge and practice in Mathematical Literacy is to be found in *mathematical* knowledge, structures and practices. It is this myth that makes it possible for some people to criticize

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Mathematical Literacy on the basis that the 'mathematical' content is so simple and which reinforces the perspective that Mathematical Literacy contents – for example, involving basic calculations with percentages, ratios, rates, and so on − are easier than Core Mathematics contents − which deal with significantly more complex abstract mathematical concepts. It is on this basis that Mathematical Literacy is called (not affectionately) 'Diet Maths', 'Maths Lite', or 'Mango Maths'[2]. It is also on the basis of this misconception of the intention of Mathematical Literacy and of the basis of legitimate knowledge and participation in the subject that the Independent Examinations Board (IEB) have been able to convince Umalusi of the feasibility of a project currently being trialled in IEB schools where learners who are enrolled for Core Mathematics in Grade 12 are able to register to write both the Core Mathematics and Mathematical Literacy national examination papers, and then choose which result (and, hence, which subject) is to be reflected on their National Senior Certificate[3] (IEB, February 2013). This initiative is grounded in a belief that engagement with the abstract mathematical contents of Core Mathematics will more than adequately prepare learners for the demands of the Mathematical Literacy examination papers, since, as suggested by Anne Oberholzer (the CEO of the IEB), "Reality: Mathematical Literacy (which is little more than arithmetic) is to

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[2] To clarify, *South African Airways* (SAA) is the national airline carrier, while *Mango* airlines is the low-cost (second rate?) partner to SAA.

[3] Although not clearly stated in the IEB Circular 18/2013 in which the details of this project are outlined, discussion with IEB representatives has revealed that the project is only intended for learners who are at risk of either failing Core Mathematics in Grade 12 or at risk of not achieving 50% for the subject – which will mean that they may not qualify for entrance to tertiary study. These representatives have provided assurance that if a learner writes both examination papers and achieves more than 50% in the Core Mathematics examinations, then it is the Core Mathematics result that will stand and not the Mathematical Literacy result (irrespective of whether the Mathematical Literacy is higher). Only in instances where the Core Mathematics result is below 50% will the Mathematical Literacy mark be considered. The underlying intention, then, is to encourage learners to remain enrolled in Core Mathematics for as long as possible and to utilise Mathematical Literacy as a "life-line" (IEB, February 2013) in instances where remaining on Core Mathematics may disadvantage further study options.
Although there is not enough scope in this paper to problematise this project and the intentions stated therein in a detailed way, it is vital to point out that this project presents a problematic situation for several reasons: (i) it devalues Mathematical Literacy by suggesting that participation in the subject is not essential and that participation in Core Mathematics is adequate preparation for the contents of Mathematical Literacy; (ii) is dismisses the intention of the CAPS process for Mathematical Literacy which deliberately initiated a shift in the subject away from the legitimisation of knowledge and practices according to mathematical structures and inappropriately brings Mathematical Literacy and Core Mathematics back into the same mathematical frame of reference; (iii) it dismisses the positive learning experience afforded by the Mathematical Literacy qualification in favour of a fixation on pass rates; and (iv) it undermines and invalidates the intention of the School Based Assessment (SBA) system since for learners who write both examination papers and then choose the Mathematical Literacy results, their SBA marks achieved in Core Mathematics will be ignored completely.

Mathematics what spelling is to writing." (2012: slide 14).

All of these perspectives are underpinned by the misconception that knowledge, practice and participation in Mathematical Literacy are legitimised according to mathematical contents and structures. While this may certainly have been true for certain components of the NCS curriculum (DoE 2003), and while this may be true for current examination papers in the subject (see, for example, DBE 2012b, 2012c), this perspective is contrary to the intention and philosophy of the CAPS curriculum document for the subject.

The CAPS curriculum document for Mathematical Literacy (DBE 2011) makes a deliberate and explicit attempt to move Mathematical Literacy outside of a predominantly mathematical frame of reference and to argue that knowledge in the subject is not only to be legitimised on the basis of mathematical structures, contents and principles. This is exemplified by statements in the CAPS document that claim that the learning of mathematical knowledge and the development of mathematical skills are not the primary intention in the subject (see, for example, (DBE 2011: 9-11)). Rather, the primary intention is for learners to develop appropriate knowledge, skills and capacity to make sense of a variety of real-world problem situations through consideration of both mathematical techniques and solutions as well as non-mathematical influences and considerations which affect how people function in those environments on a regular basis. Paraphrasing Bansilal (2013) (who draws on the work of Anna Sfard (2001, 2007)), Mathematical Literacy involves interplay and negotiation between two different discourses and/or domains, one of which is mathematical (or conceptual) and the other contextual. Mathematical Literacy is *not* about developing a 'Mathematical Gaze' (Dowling 1998) on the world; it *is* about developing a deeper understanding of how and why people operate in particular ways (sometimes mathematical and sometimes not) when engaging in real-world problem situations. In this sense the CAPS conception of Mathematical Literacy reflects a goal for a life-preparedness orientation (Venkat 2010) rather than a mathematical-preparedness orientation.

As a result, the contents of the CAPS document move extensively beyond the predominantly basic mathematical skills and contents that were prescribed in the Core Assessment Standards in the SAG document (DoE 2008) for the NCS curriculum, with an increased emphasis on sense making of contextual situations and problems encountered in such situations, including problems and solutions paths that do not demand or make use of mathematically driven techniques or knowledge base. This means that there is every opportunity for examiners in the CAPS examination process to focus more on assessing contextual knowledge and applications of mathematics (based on extensively described and prescribed contexts listed in the CAPS document) rather than exclusively or predominantly on mathematical concepts embedded in those contexts. A plethora of evidence suggests that sole engagement with mathematical principles is unlikely to prepare learners to understand the intricacies and working of, for example, pension schemes, inflation related

considerations (e.g. how to use inflation figures to inform salary negotiations in a strike situation), and so on. It is a misinformed and mythical perspective to conceive that this can possibly be the case. And it is this misinformed perspective that continues to constitute Mathematical Literacy as a sub-set of Core Mathematics rather than as a uniquely independent domain of practice.

MYTH #2: THE HIGHER PASS RATE IN MATHEMATICAL LITERACY INDICATES THAT MATHEMATICAL LITERACY IS AN EASIER QUALIFICATION THAN CORE MATHEMATICS

AND/OR …

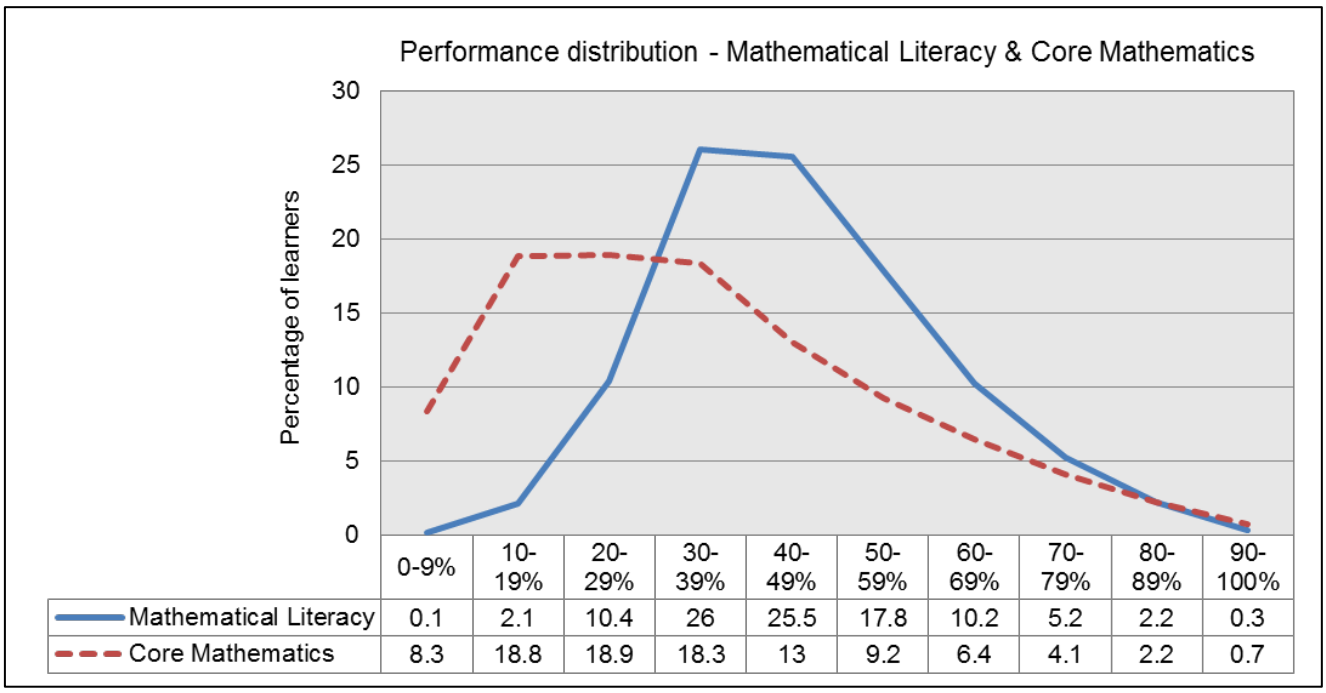
BY OPTING FOR MATHEMATICAL LITERACY LEARNERS STAND A HIGHER CHANGE OF GAINING POINTS FOR ENTRANCE INTO UNIVERSITY

A prevailing opinion is that Mathematical Literacy is an easy subject, as evidenced by the exceptionally high pass rate of 87,4% in 2012 (DBE, 2012d, p. 151); and that it is certainly easier than Core Mathematics which has a lower pass rate of 54% (DBE, 2012d, p. 120). This opinion is sometimes accompanied by statements which suggest that: (1) learners are almost guaranteed to pass Mathematical Literacy; (2) learners who enrol in Mathematical Literacy instead of Core Mathematics stand a better chance of scoring the points needed for entrance into tertiary study because Mathematical Literacy is the easier subject. As a consequence, discussion with teachers has revealed that certain teachers and/or principals actively encourage learners to enrol in Mathematical Literacy rather than Core Mathematics because it boosts the pass rates for the school, and also because it supposedly enhances opportunity for entrance to tertiary study. However, closer analysis of learner performance in Mathematical Literacy examinations will reveal this to be a significant misconception of the reality of learners' experiences in the subject.

Figure 1 shows the performance distribution curves for Mathematical Literacy and Core Mathematics in the 2012 National Examination papers[4]. For purposes of this discussion it is important to notice two main issues. Firstly, the statistics indicate that Mathematical Literacy is indeed easier to pass than Core Mathematics, as evidenced by the high bulge of Mathematical Literacy learners achieving between 30-49% in the subject. However, there is a significant decrease in the number of learners achieving more than 40% in the subject. This draws attention to the second point, which is that the numbers of learners achieving 70% or more in Mathematical Literacy (7,7%) is almost identical to those in Core Mathematics (7%). In other words, learners in both Core Mathematics and Mathematical Literacy struggle equally to achieve high results. And this flies in the face of common opinion that the easier qualification of Mathematical Literacy provides increased opportunity for

[4] This graph was constructed using data on the Mathematical Literacy and Core Mathematics examination papers drawn from (DBE, 2012d, p. 151 & 120).

achieving the points necessary for entrance into tertiary study. In fact, if one considers that at several universities the minimum entrance requirements for entrance into certain faculties is a mark of 70% on Mathematical Literacy or 50% on Core Mathematics, then a higher percentage of the Core Mathematics learners would meet this minimum requirement than the Mathematical Literacy learners.



	0-9%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	70-79%	80-89%	90-100%
Mathematical Literacy	0.1	2.1	10.4	26	25.5	17.8	10.2	5.2	2.2	0.3
Core Mathematics	8.3	18.8	18.9	18.3	13	9.2	6.4	4.1	2.2	0.7

Figure 1: Distribution curves of learner performance in the 2012 Mathematical Literacy and Core Mathematics national examinations

The trend in the Mathematical Literacy results – namely, the extremely high pass rate but low numbers of high achievers – can easily be explained by reference to the structure of the examination papers for the subject. There are two examination papers in Mathematical Literacy that are differentiated according to cognitive demand[5] – Paper 1 is a 'skills paper' that only assesses questions at Levels 1 (60% of the paper) and 2 (40% of the paper) of the assessment taxonomy. Paper 2, by comparison, is an 'applications paper' that assesses questions primarily at Levels 3 (40% of the paper) and 4 (40% of the paper) of the assessment taxonomy, and with only a small number of questions at Level 2 (20%). Paper 2 does not contain any questions that reflect Level 1 of the taxonomy. The result is that Paper 1 is a tremendously easy paper, with learners effectively only needing to get all of the Level 1 questions correct to pass the

[5] Mathematical Literacy is the only subject in the schooling qualification framework that comprises examination papers that are differentiated according to cognitive demand. Most other subjects that comprise two examination papers differentiate the papers according to content; or, in the case of certain practical subjects (e.g. Drama or CAT) according to practical and theory components.

subject[6]. Paper 2, on the other, is a considerably more difficult paper, influenced not only by the dominance of questions at the two highest levels of the taxonomy, but also by the fact that the level of accessibility of the questions is significantly reduced due to the limited scaffolding provided (due to the removal of all Level 1 and most Level 2 questions)[7 & 8]. This distinction between the two papers is evidenced by the significant difference in average mark for the Paper 1 and Paper 2 examinations papers: approximately 60% for Paper 1 and approximately 40% for Paper 2 (DBE 2012d: 152, 159)[9 & 10]. In essence, then, the differentiation of the examination papers

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[6] The pass mark for the subject is 30%. Hence, to pass the learners simply need to complete all of the Level 1 questions in Paper 1 correctly since these questions constitute 60% of the paper (or 30% of the final marks when both papers are combined).

[7] Conversations with teachers have revealed that due to the complexity and general inaccessibility of the questions in Paper 2 for many learners, some learners – after writing the Paper 1 examination paper – do not bother to arrive to write the Paper 2 examination paper, presumably because they believe they will fail the paper; and that some teachers do not even prepare their learners for Paper 2 and only focus on preparation for Paper 1 – since reasonable performance in Paper 1 is enough to guarantee a pass in the subject.

[8] Alongside the issue of limited scaffolding, there are also a host of other factors which impact on learner poor performance in Paper 2, including language and context. A focus on problem solving in contextualized situations inherently requires interpretation of contextual information, which in turn requires interpretation of context-specific language. For learners for whom English is a second language, this process adds significantly to the complexity of each activity. Furthermore, misinterpretation of the contextual information can impede on learners' ability to successfully engage with the demands of the questions based on the context, even if those questions draw on mathematical knowledge. From this observation we can start to question whether a learners' inability to answer a question successfully is related to a misunderstanding of a concept or rather due an inability to adequately interpret contextualized information.
As regards context, the familiarity or unfamiliarity of a context with respect to a learners' lived experience of the context can also affect their ability to successfully engage with the context. For example, a learner whose parents engage them with travel maps during holiday trips is at a distinct advantage to a learner who travels exclusively in public transport and whose only exposure to map work is restricted to limited engagement in a classroom environment. Both of these issues require further research.

[9] In the absence of raw mark data to work with, I have determined these average marks by averaging the average mark for each question in each examination paper. Clearly this method of working out an average of an average will not provide an accurate answer − the raw marks are needed for this purpose. However, for purposes of the discussion in this paragraph, I believe that this method does provide a reasonable (although not entirely accurate) estimation of the average performance in each paper.

[10] Notice that the average mark for the Mathematical Literacy Paper 2 examination is almost identical (actually slightly lower) to the average mark for the Core Mathematics Paper 1 examination paper* (DBE, 2012d, pp. 120-159). This suggests that if the results of the basic skills Paper 1 are ignored and the results of the application Paper 2 are taken as an indication of learner competence, then it becomes possible to propose that the learners are finding Mathematical Literacy contents as challenging as those in Core Mathematics.

according to cognitive demand has facilitated a situation where it is easy to achieve a pass but difficult to do well in the subject – as reflected in the trend of the graph showing learner performance in the 2012 Mathematical Literacy examinations.

In sum, analysis of learner performance in the Mathematical Literacy examination papers suggests that although the pass rate in the subject is very high, the number of learners that are able to achieve marks that would provide access to entrance in to tertiary study is very low and is no different to the trends in Core Mathematics. These trends confirm that the opinion that it is easier to do better in Mathematical Literacy than in Core Mathematics – and, hence, that enrolment in Mathematical Literacy more easily accords access to the credits required for entrance to tertiary study − is nothing more than a myth.

MYTH #3: WE WOULD BE BETTER OFF WITHOUT MATHEMATICAL LITERACY S A SUBJECT

Accompanying criticisms of Mathematical Literacy echoed a sentiment that doing away with the subject would help to retain learners in the Core Mathematics domain. This sentiment is sometimes qualified by the belief that the previous system of a differentiated mathematics curriculum – comprising Higher Grade (HG) and Standard Grade (SG) Mathematics – was a better system since Standard Grade afforded access to more areas of work and study than does Mathematical Literacy. What is necessary here is to dispel this sentiment as a misrepresentation of past reality.

Within the pre-2006 system of a differentiated mathematics curriculum, approximately only 60% of the Grade 12 learners opted for Mathematics (either HG or SG), with the other 40% choosing to do a non-scientific course (e.g. Woodwork or Typing). Of the 60% doing Mathematics, only 10% opted for HG and the remaining 50% for SG. Table 1 shows the numbers of learners enrolled in HG and SG mathematics in the pre-2006 differentiated curriculum system, together with the percentage of learners who passed in each stream[11].

What is interesting to note are the low percentages of both the HG and SG candidates passing, generally between 30% and 40% of the candidates[12]. A quick calculation reveals the following percentages of passes for all learners enrolled in some form of

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*(Note: the incorrect graph is supplied in the DBE diagnostic report on the learner performance in the Core Mathematics *Paper 2* examination paper (see DBE, 2012d, p. 132). As such, an indication of the average mark for Paper 2 is not included here.)

[11] All statistics drawn from (DoE, 2001). Note that I have deliberately chosen to illustrate mark related data for an earlier time period rather than for a period directly prior to 2006 to demonstrate that even during this immediate post-Apartheid period the situation was not an improved situation. However, by 2005 there had been an improvement in performance, with the HG pass rate at approximately 60% and SG pass rate at approximately 41%. See (DoE, 2006) for more data.

[12] Except for in 2000 when the percentage of HG candidates passing increases substantially; but the SG passes remained low.

mathematics: 1997 → 35,5%; 1998 → 31,8%; 1999 → 32,7%; and 2000 → 33,8%.

Table 1: HG and SG passes 1998 - 2000

1 000's of candidates	1998			1999			2000		
	Wrote	Pass	% Pass	Wrote	Pass	% Pass	Wrote	Pass	% Pass
HG	60.3	20.3	33.7%	60.3	20.3	33.7%	60.3	20.3	33.7%
SG	219.4	68.6	31.3%	219.4	68.6	31.3%	219.4	68.6	31.3%

What is significant in these figures is that they are lower than the current pass rates in Core Mathematics. Furthermore, whereas within the current system all learners do some form of mathematics, in this previous differentiated curriculum approximately 40% of learners completed school with no formal mathematics qualification. It was for this 40% of the learners that Mathematical Literacy was introduced to ensure that all learners – even those who could not cope with the demands of scientific mathematics – would leave the schooling system with some degree of mathematically based training[13]. As such, to suggest that we were better off in the previous system and that we would be better off without Mathematical Literacy is a misrepresentation of the reality of learner performance in the past and a misreading of the needs of the current learner population.

MYTH #4: LEARNERS MUST 'STICK IT OUT' IN CORE MATHEMATICS FOR AS LONG AS POSSIBLE BECAUSE CHANGING TO MATHEMATICAL LITERACY WILL CLOSE DOORS

Another prevailing opinion within some quarters is that learners must be encouraged to 'stick it out' on Core Mathematics for as long as possible because changing to Mathematical Literacy is accompanied by restriction in terms of future career and study opportunity. There are two issues that must be addressed in this regard.

Firstly, and as has already been established, Mathematical Literacy was never intended to provide the same opportunities as Core Mathematics and was never intended to provide access to career or study options that require a degree of understanding of scientific mathematics principles. Rather, it was intended to provide an alternative study opportunity for learners who were not able to cope with the demands of the scientific mathematics curriculum. For these learners, many of whom

[13] It is somewhat ironic that Mathematical Literacy was introduced as a subject within the schooling system to provide an alternative qualification for those learners who were not able to cope with the demands of a scientific mathematics curriculum. In other words, an alternative subject was created so that learners would not have to work with scientific mathematical principles. And, yet, now that same subject is being criticised because the mathematics is not difficult or scientific enough; and when the learners who are 'weaker' at mathematics achieve well in this alternative subject the subject is then criticised for being too easy. Perhaps what these critics want is for these 'weaker' learners to be placed in a course that consists of an equivalently difficult mathematics curriculum and then see them all fail again?

struggle to pass Core Mathematics, the doors to career and study opportunities that require scientific mathematics have long since closed. Mathematical Literacy does not close doors; it is the learners' inabilities to engage with the demands of the scientific mathematics curriculum that restricts future career and study options. In this sense, we should be applauding the existence of Mathematical Literacy since it is this subject offering which provides the alternative option that enables learners who cannot engage with scientific mathematics to still participate successfully within the schooling system.

Secondly, what this opinion dismisses is the tremendously positive learning experience of learners who engage in the full 3-year Mathematical Literacy qualification. A conversation with many Mathematical Literacy teachers will reveal the tremendous relief that some learners experience at no longer having to struggle with scientific mathematics concepts and at now being able to engage with and understand the contents of the subject, despite the (sometimes) presence of mathematical structures. This relief is often accompanied by a growth in the confidence of the learner in their own ability, which in turn contributes to their further successful engagement with the contents of the subject. Furthermore, and as observed by Venkat & Graven (2008: 34), for some learners engagement in the subject provides grounding for more effective and empowered participation in daily-life practices. Encouraging learners to 'stick it out' at all costs overlooks the anxiety and anguish that many learners experience while often unsuccessfully attempting to engage with scientific mathematics contents and the impact that this anxiety can have on their self-confidence and performance in other subject. The 'stick it out' at all costs mentality is not necessarily in the best interests of the child.

CONCLUSION

We are facing a serious issue at the moment with respect to increasing numbers of learners moving from Core Mathematics and enrolling in Mathematical Literacy. This is not a situation that can be allowed to continue: we need to retain learners in Core Mathematics and to put systems in place that support those learners so that they can successfully engage with the contents of this scientific domain. But by the same token, Mathematical Literacy serves a significant purpose and provides a form of qualification that previously was not available to large numbers of learners. And if Mathematical Literacy were to be removed from the schooling system, then what would happen to the many learners who are engaged in the subject? Would they be expected to return to Core Mathematics (where many of them were failing previously)? The critics remain ominously silent on the answers to these questions.

Mathematical Literacy needs to be recognized for what it is – *not* scientific mathematics; and, as such, it does not afford the same study and career options as this type of mathematics. However, just because it is not mathematics does not mean that it is not complex for the learners who engage with its contents, nor that it does not provide a valuable learning experience for its participants, nor that it does not

facilitate access to worthwhile future opportunities. In seeking to find solutions to the issue of decreasing numbers in Core Mathematics, critics need to look beyond Mathematical Literacy and to begin to focus attention in a more pointed way on why so many learners are struggling, failing and so frequently so negative about Core Mathematics: after all, if learners were able to cope with the demands of Core Mathematics then there would be no need for them to opt for Mathematical Literacy and the status of Core Mathematics would remain unchallenged. In the absence of answers and successful strategies for dealing with decreasing enrolment numbers due to poor performance in Core Mathematics, Mathematical Literacy, it would seem, has become the new scapegoat.

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