Mathematical Literacy: A new literacy or a new mathematics?

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Why a special issue?

Mathematical Literacy is a 'hot' topic at present in most countries, whether it is referred to by that name, or in some cases as Numeracy, or Quantitative Literacy, or Matheracy, or as some part of Ethnomathematics, or related to Mathematics in Society. Questions continue to be asked about what is meant by mathematics in any concept of Mathematical Literacy and the use of the very word 'Literacy' in its association with Mathematics has been challenged. Its importance, however, lies in changing our perspective on mathematics teaching, away from the elitism so often associated with much mathematics education, and towards a more equitable, accessible and genuinely educational ideal. As South Africa begins to implement a new Mathematical Literacy curriculum this year for all learners from grades 10-12 who do not take the subject 'Mathematics', there is much discussion about what exactly is mathematical literacy and issues about how it can be realised have emerged.

The editors of this Special Issue sought interesting and provocative papers on different aspects of Mathematical Literacy, in order to create an issue which will reflect some current thinking and practices, as well as promising innovative approaches. At this time there is a great need to share the variety of experiences, concerns and aspirations related to this topic, and we welcomed the opportunity to demonstrate that variety, and to contribute to the current debates.

Any development in mathematics education raises questions about the curriculum, for the teachers and their teaching, and for the learners and their learning. Mathematical Literacy is no exception. For example, there are new curricular issues about the range of contents and contexts to be addressed, the necessary changes in assessment practices, the extent of curricular control by any textbooks or materials used, how it is being featured in teacher education and training programmes, and the ways in which Mathematical Literacy links with other subjects in the school curriculum.

Teachers need to see practical examples of relevant classroom activities, with discussions of how these new practices differ from the old, and how they can avoid losing what was good and effective in what they previously did. What new materials are, or would be, helpful for teachers teaching Mathematical Literacy? What are the teaching implications of striving for "a more equitable, accessible and genuinely educational ideal" in the classroom? What new language issues will arise? What pre-service and in-service need does this new ideal demand, and how should these be met?

Also what are the implications for the learners? How can they be empowered to bring their unique perspectives from home and from their community and society into any mathematical classroom activity? We learn from other countries' experiences that this particular development not only makes greater demands on the teachers, it also demands more from the students. By engaging them more in their own learning, they need to accept a greater share of responsibility for what they learn and for how they learn.

There are a number of different forces that have led to a strong concern with the quality of the mathematical knowledge, skills, values and attitudes of learners in the last few decades. That is, not only a concern with those expected to continue in further studies and the professions related to mathematics, science, technology and economics but the mathematical competence of *the general school population.* These questions often revolve around how mathematically literate learners are and its importance for how they will enact their citizenry in a rapidly advancing scientific and technological world once they leave schooling. The imperatives driving this concern could be grouped into three broad categories. The first may be referred to as *contextual forces*, for instance, how this concern has emerged and is taken up in different countries, by the state in

mathematics curriculum policy, or by mathematics teacher organisations, and in research agendas. The second category may be derived from the *theoretical shifts and emergence of new perspectives* such as the developments in issues of gender in mathematics education, ethomathematics, realistic mathematics or critical mathematics education which include social, cultural, political, historical and economic analyses for how and why children learn mathematics the way they do. A third category may be characterised as the broad range of *innovative practices and pedagogies* being developed and enacted to address the claimed inadequate teaching and learning of mathematics – from small scale interventions to radical changes in practices. These analytical categories are, however, interlinked.

Mathematical Literacy and the South African context

The focus on mathematical literacy in the South African context needs to be understood both historically in how access to mathematics was denied to the vast majority of black people, as well as with reference to the current imperatives for general scientific, technological and economic development (Vithal & Volmink, 2005). The huge backlog of deliberate underdevelopment that post apartheid South Africa inherited in 1994, in both human (qualified mathematics teachers) and physical resources (classrooms, materials, etc.) over several decades is proving very difficult to redress in education in the current context of a globalising world in a country with high levels of poverty and unemployment. Although some strides have been made, still one fifth of secondary schools in the country do not offer mathematics beyond grade 10. Of the approximately half a million learners who write the high status and high stakes grade 12 end of schooling national matric examination that determines entry into further education and work opportunities, some 40% of learners do not take mathematics (CDE, 2004).

Not surprisingly learners have not been performing very well in these national exams and also in various national and international mathematical tests at lower levels of the schooling system. The focus and significance given to mathematics achievement nationally and in the media has been driven by South Africa's repeated extremely poor performance on a number of international studies such as in the Third International Mathematics and Science Study (Howie 1997, 2001) and other national evaluations and assessments (see CDE, 2004). Heads of educational institutions, government officials, and politicians often refer to these in public.

Since 1994 South Africa has had three waves of curriculum reforms for the grades 0 to 9 curriculum and is in the process of implementing a new curriculum for grades 10-12 as of 2006. In both these curricula, mathematical literacy features as a competence to be acquired by all learners. An important change in the new curriculum for the grade 10-12 band is that all learners will have to take *mathematics* or *mathematical literacy* as a subject from grades 10 to 12. That is, for the first time all students who leave the schooling system from the end of 2008 will have taken some mathematics up to the end of schooling in grade 12. This has meant a major and substantial intervention to reskill and upgrade teachers to be able to deliver the new mathematical literacy curriculum. From the outset the new curriculum has had to engage challenges about what exactly is mathematical literacy and how does it differ from mathematics.

The notion of mathematical literacy has differed in name and conception in different countries in curriculum policies and in research. For example the term *numeracy* is used in the UK (Brown, 2003) while *qualitative literacy* appears in the USA (Steen, 2001). In the South African curriculum Mathematical Literacy is defined as follows:

> *Mathematical Literacy provides learners with an awareness and understanding of the role that mathematics plays in the modern world. Mathematical literacy is a subject driven by life-related applications of mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems*. (DOE, 2003: 9)

This definition needs to be read and understood against the broader principles underpinning the South African national curriculum statements which include: "social transformation, outcomes-based education, high knowledge and high skills, integration and applied competence, progression, articulation and portability; human rights, inclusivity, environmental and social justice; valuing indigenous knowledge systems; and credibility, quality and efficiency" (DOE, 2003: 1). The national curriculum explicitly takes as its point of departure the constitution of South Africa, the values of which are infused also in the

mathematics curricula. This can be observed in the critical and developmental outcomes which are interpreted specifically for mathematical literacy as intending "to enable learners to:

- *Use mathematical process skills to identify, pose and solve problems creatively and critically*
- *Work collaboratively in teams or groups to enhance mathematical understanding*
- *Organise, interpret and manage authentic activities in substantial mathematical ways that demonstrate responsibility and sensitivity to personal and broader societal concerns*
- *Collect, analyse and organise quantitative data to evaluate and critique conclusions*
- *Communicate appropriately by using descriptions in words, graphs, symbols, tables and diagrams*
- *Use mathematical literacy in a critical and effective manner to ensure that science and technology are applied responsibly to the environment and to the health of others*
- *Demonstrate that a knowledge of mathematics assists in understanding the interrelatedness of systems and how they affect each other*
- *Be prepared to use a variety of individual and co-operative strategies in learning mathematics*
- *Engage responsibly with quantitative arguments relating to local, national and global issues*
- *Be sensitive to the aesthetic value of mathematics*
- *Explore the importance of mathematical literacy for career opportunities*
- *Realise that mathematical literacy contributes to entrepreneurial success*" (DOE, 2003: 10)

These critical and developmental outcomes are expected to be achieved through four Learning Outcomes: *number and operations in context* – the ability to use knowledge of numbers and their relationships to investigate a range of different contexts which include financial aspects of personal, business and national issues; *functional relationships* and the ability to solve problems in real and simulated contexts; *space, shape and measurement* including handling instruments, estimating and calculating physical quantities and working with two and three dimensional shapes and objects; *data handling* and the ability to apply knowledge of statistics and probability to communicate, justify, predict and critically interrogate findings and draw conclusions.

Many of the intentions in the critical, developmental and learning outcomes may be found in the broad emerging international literature that explores multiple dimensions of mathematics education both as a field of practice and as a field of study. In exploring not only the mathematical aspects of mathematical literacy but also its social, cultural, political, psychological, economic, historical and societal dimensions, has led to different interpretations being made of mathematical literacy and produced a range of pedagogies.

The papers in this special issue capture some of this variety of concerns and foci. No doubt much research and many more analyses will follow in the wake of the implementation of this new Mathematical Literacy curriculum in South Africa.

Iben Maj Christiansen sets the scene with a critical analysis of the whole issue of Mathematical Literacy as a school subject and questions the possibilities for achieving the educational ideals often promised in such curricula.

In Hamsa Venkatakrishnan and Mellony Graven's paper in which Mathematical Literacy in two different contexts of South Africa and England are presented, we read of interesting and contrasting approaches to the same problem. In particular we gain a deeper understanding of the policy-practice imperatives that these curricula are having to negotiate where such concerns are being debated at a national level.

Drawing on their experience of materials development, Lynn Bowie and Vera Frith focus attention on the importance of distinguishing between Mathematics and Mathematical Literacy and address the issue of the role of technology in Mathematical Literacy as well as the need for a proper understanding of the contexts used to teach Mathematical Literacy.

The issue of context which is central to any conception of Mathematical Literacy is taken further by Renuka Vithal in exploring a specific pedagogy, that of project work for developing mathematical literacy. She discusses a range of practice and conceptual tools to show how a mathematical literacy from a critical perspective may be realised by teachers in a South African classroom but also some of the tensions this produces.

Bruce Brown and Marc Schäfer retain the focus on teacher education by raising issues arising

in the training of Mathematical Literacy teachers, using an approach based on mathematical modelling. They point to the challenges of preparing teachers who do not having the requisite mathematical skills and knowledge choosing to become mathematical literacy teachers.

The paper of Vera Frith and Robert Prince reports on the use of a research task in a Mathematical Literacy teacher education course. A curriculum component on data handling was structured around this research task which required the teachers on the course to put mathematical literacy into a practice context.

In Cyril Julie's paper he explores various myths, inclusions and exclusions, in relation to Mathematical Literacy. In concluding this Special Issue, his paper does not seek closure, rather he opens up further issues which will need to be investigated before the teaching of Mathematical Literacy can be said to have achieved its goals.

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> Mathematics is a logical method ... Mathematical propositions express no thoughts. In life it is never a mathematical proposition which we need, but we use mathematical propositions only in order to infer from propositions which do not belong to mathematics to others which equally do not belong to mathematics.
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> **– *Ludwig Wittgenstein***