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Implications of Differences and Similarities of Mathematics and Mathematical Literacy

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ABSTRACT The differences and similarities between the learning areas Mathematics and Mathematical Literacy have been debated. Nine years after the introduction of Mathematical Literacy in South Africa, this debate is still raging. This paper reports on an analysis of teachers' views on mathematics (M) and Mathematical Literacy (ML) tasks, in some selected schools in Gauteng, South Africa. In this paper, four (M) and four (ML) teachers from four schools, with contrasting backgrounds, were asked to state their views and experiences of M and ML tasks. The findings revealed that no clear distinctions were made between M and ML tasks as seen by teachers who participated in the study. Those tasks, which were part of mathematics, were deemed to emanate from ML papers. Similarly, tasks that were taken from ML papers were viewed as M tasks. Therefore, the researchers recommend that, in order to minimise confusion, ML teachers should be adequately trained in the content of Mathematical Literacy in the way Mathematical Literacy differs from Mathematics.

INTRODUCTION

The call for all learners to do mathematically oriented subjects has gained momentum in the past few years in the South African context. Mathematical Literacy has been introduced in 2006 in the Further Education and Training (FET) band in South Africa as a subject that runs parallel to Mathematics in the FET band (Grades 10-12). Thus, in South African schools, learners from Grades 10 to 12 take either Mathematics or Mathematical Literacy. These are two separate learning areas from the exit band of the South African secondary education system. Since Mathematics and Mathematical Literacy are separate learning areas, the possibility exists that, by the time learners reach Grade 11, they would have acquired different levels and a different nature of knowledge and problem-solving skills.

However, Mathematics (M) teachers are assigned to teach either one or both of these learning areas in spite of the fact that they have not officially been trained in Mathematical Literacy (Machaba 2014, 2016a, 2016b; Machaba and Mwakapenda 2016c). The teaching method that teachers use to teach Mathematics and Mathematical Literacy is a function of their experience and perceptions of the two learning areas. It is also a reflection of how they have been inducted into the discourses of Mathematics and Mathematical Literacy (Mbonani and Bansilal 2014; Machaba 2016a, 2016b; Machaba and Mwakapenda 2016c). Due to their exposure to Mathematics, one would expect M teachers to perceive M-orientated tasks in terms of M. Similarly, ML teachers' exposure to ML should lead them to perceive ML-related tasks in ML ways.

Four M and four ML teachers from four schools, coming from contrasting backgrounds, were interviewed. The interview focused on their educational background in Mathematics and Mathematical Literacy and their views on and experiences of the teaching of Mathematics and Mathematical Literacy. All M and ML teachers, except one M teacher from School 1(MTS1), had been trained officially to teach Mathematics but not Mathematical Literacy.

Due to their exposure to Mathematics, Mathematics teachers would have mathematics as their dominant orientation. This means that Mathematics teachers would more easily recognise tasks with a mathematical orientation as mathematics tasks. Similarly, the researchers hypothesise that Mathematical Literacy teachers would have Mathematical Literacy as their dominant orientation, that is, they would easily recognise tasks that have a Mathematical Literacy orientation as ML tasks. However, M and ML teachers would interpret tasks with no clear orientation (that is, containing a flavour of both Mathematics and Mathematical Literacy) in multiple different ways. Tasks with a dominant M orientation would have a strong M boundary and those with a dominant ML orientation would have a strong ML boundary. In the research from which this paper reports, ML teachers demonstrated multiple orientations to Mathematical Literacy because they were not fully inducted into ML discourse. Research revealed that no clear distinctions were made between M and ML tasks as viewed by teachers. The result that M and ML teachers perceived all the tasks in a similar way is interesting. The similarity of teachers' responses can be attributed to ML teachers not knowing the difference between M and ML underlying theories. In this paper, the researchers therefore recommend that there should be adequate training for ML teachers in the content of Mathematical Literacy and in the way Mathematical Literacy differs from Mathematics.

To develop the argument, the paper drew from Parker (2006) and Graven and Venkat's (2007) analyses of the Curriculum and Assessment Policy Statement (CAPS) for Mathematics and Mathematical Literacy. The researchers have identified similarities and differences between Mathematics and Mathematical Literacy based on Bernstein's (1996, 2000) constructs (especially classification and framing) and Graven and Venkat's conceptual framework for a spectrum of pedagogic agendas. The reason the researchers looked into the two curricula was that teachers' official pedagogical identity is embedded in them. Bernstein's constructs of classification and framing, which are related to recognition and realisation rules, respectively, were further used to describe and explain teachers' orientations in Mathematics and Mathematical Literacy.

Mathematics

Mathematics has been defined within the Curriculum and Assessment Policy Statement (CAPS) of the FET phase in the following terms:

Mathematics is a language that makes use of symbols and notations for describing numerical, geometrical and graphical relation ships. It is a human activity that involves observing, representing and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to developmental processes that enhance logical and critical thinking, accuracy and problem solving that will contribute in decision-making. Mathematical problem solving enables us to understand the world (physical, social, and economic) around us, and most of all, to teach us to think creatively (DBE 2011: 8).

It is evident from the above definition, as analysed by Parker (2006) and Graven and Venkat (2007), that the mathematics curriculum is a hybrid curriculum, integrating content and context, but being more skewed towards content. The fact that Mathematics is 'about problems in the physical and social world' (DoE 2011: 9) suggests that mathematics appeals to the everyday context and to the context of mathematics itself. A strong mathematical agenda is clear, and 'rigorous logical reasoning' and 'theories of abstract relations' are emphasised (DoE 2001: 9). The context of learning Mathematics lies 'in the context of Mathematics itself' (DoE 2001: 9). Mathematics is viewed as a practice, which constitutes skills or practices such as problem solving, observing patterns and generalising as well as representations of mathematics numerically and symbolically. It is a discipline developed through both 'language and symbols' (DoE 2011: 9). This emphasises the issue of the language of Mathematics. In her analysis of the Mathematics curriculum, Parker (2006) found that 91.3 percent of the assessment standards indicate intra-disciplinary integration (the integration between algebra and geometry as two branches of Mathematics). This implies that Mathematics is a content-oriented subject. Although everyday context is included in Mathematics, the incorporation of everyday context into Mathematics was intended to make the learning of Mathematics easier for the learner (Adler et al. 2000; Graven and Venkat 2007). According to Bernstein (2000), the fact that Mathematics is a content-oriented subject makes it to be strongly classified and framed, which results in its recognition and realisation rules being clearer.

Bernstein (1996: 59) refers to 'classification' as follows:

[It is] the nature of differentiation between contents. Where classification is strong, contents are well insulated from each other by strong boundaries. Where classification is weak, there is a reduced insulation between contents, for the boundaries between contents are weak and blurred.

Framing refers to the 'form of the context in which knowledge is transmitted and received and refers to the specific pedagogical relationship between the teacher and the taught' (Bernstein 1982: 59). The concepts of classification and framing, according to Bernstein, yield to concepts of recognition and realisation rules. Recognition rules, according to Bernstein (2000: 50), are criteria (special relationships) for distinguishing the speciality of a thing, a practice, a specialisation or a context, that is, what makes it what it is. Recognition rules are principles for recognising the 'legitimate text', that is, the voice to be acquired, and these rules are determined by the classification principle at work (relations between different knowledge discourses and practices). Realisation rules are the 'means for creating and producing the special relationship internal to what is recognised as the "legitimate text", that is, the means for reproducing/creating the speciality in practice' (Bernstein 2000: 50).

According to Bernstein (2000), this implies that the mathematics context can easily be recognised due to its strong classification of a knowledge structure, unique identity, unique voice and internal rules. The acquirer (the learner or the teacher) is able to recognise mathematics pedagogical text (for example, textbooks) in the classroom. It means that teachers or learners are able to identify themselves in the context of Mathematics. They can recognise 'the speciality of the context they are in' (Bernstein 1996: 31). However, it may not necessarily happen in the case of Mathematical Literacy.

Mathematical Literacy

The Curriculum and Assessment Policy Statement (2011: 10) defines Mathematical Literacy as follows:

[A] subject that develops competencies that allow learners to make sense of, participate in and contribute to the twenty-first century world – a world characterised by numbers of different ways. Such competencies include the ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events and use and apply technology.

It is claimed from the definition that 'mathematical language, conventions, algorithms, theorems and practices can be learnt first and then be applied to life-related problems and everyday situations' (Graven and Venkat 2007: 70). In contrast, the Department of Education (2003a) indicates that the approach, which needs to be adopted in developing Mathematical Literacy, is to engage with context rather than to apply mathematical concepts already learnt.

It is clear from the definition of Mathematical Literacy that the curriculum of Mathematical Literacy has mixed messages. Graven and Venkat (2007) observe that during the implementation of this curriculum, there is a spectrum of agendas, which resulted from the different interpretations of the curriculum. It seems that teachers do not know which agenda to pursue: content oriented, context oriented or a balance between content and context, which is intended to develop in learners the habits of a mathematically literate person. The spectrum of agendas results in the recognition rule of Mathematical Literacy being blurred. The acquirer(teacher or learner)may become confused or face difficulty in recognising the context as that of Mathematical Literacy. For example, the learner or the teacher may be inclined to recognise context as being that of Geography or of Mathematics. One of the aspects that blurs recognition of the ML context is the recontextualisation of ML knowledge from other disciplines, for example from Mathematics and Geography. Bernstein (1996) therefore cites that, if recognition rules are blurred, the realisation rule becomes contradicted in the recontextualisation of knowledge, and the meaning is not clear.

Graven and Venkat's (2007) conceptual framework for a spectrum of pedagogical agendas is discussed below.

Description of Agendas in ML curriculum

Agenda 1: Context Driven

According to Graven and Venkat (2007), in this agenda, context in the form of scenario-based tasks is explored in order to deepen an understanding of that context. The purpose of mathematics in this agenda is to strengthen the understanding of the context. According to Sethole (2004), engagement with the context can make mathematics invisible, that is, move it to the background or lost in everyday context.

Agenda 2: Content and Context Driven

The ML teachers' guide posits a dialectical relationship between content and context (DoE 2006), which explains a way in which the content of mathematics and learners' everyday context could simultaneously work together without compromising each other. The challenge for teachers is to use situations or contexts to reveal the underlying mathematics while simultaneously using mathematics to make sense of the situations or context, and in doing so, developing the habits or attributes of a mathematically literate person in students (DoE 2003a: 4).

Graven and Venkat (2007) argue that this agenda should become a focus in Mathematical Literacy, as this agenda strikes a balance between the context and the content and emphasises the dialectical relationship between content and context. In her paper on developing Mathematical Literacy through project work, Vithal (2006) argues that a specific pedagogy, such as project work, can support the development of Mathematical Literacy from a critical perspective. Vithal (2006: 41) states the following in this regard:

A particular challenge in the teaching and learning of contextualised mathematics is that the teacher has to ensure that neither learners understanding of the mathematics or that of the context gets compromised.

Venkat (2007: 76) supports this statement as follows:

Tweaking the flow of questions and activities can allow for a productive integration of mathematical and literacy orientated agendas, with each agenda working to bolster rather than distract from the other in the teaching Mathematical Literacy.

Venkat (2007) demonstrates that the Mathematics and Mathematical Literacy agendas are not incompatible. She argues that there is a need for improved awareness of different ways of thinking about the agendas that underly M and ML teaching and learning. The evidence presented in her research suggests that the implementation of Mathematical Literacy in South Africa may provide fertile ground for locating a mathematical agenda within the broader notions of sense making and interpreting the world that constitutes the notions of Mathematical Literacy.

The dialectical relationship between content and context, as emphasised in the ML teachers' guide, is not clearly demonstrated in the Curriculum Statement for Mathematical Literacy. However, ML teachers are expected to know the core agenda that defines Mathematical Literacy. Hence, the researchers argue that, for teachers to know this core agenda, they need to be fully inducted into the ML discourse. It should not be taken for granted that if teachers teach mathematics, they would automatically be able to recognise the speciality of the ML context and be able to produce the legitimate text in practice.

Agenda 3: Mainly Content Driven

Mathematical Literacy has been criticised as having too much traditional M content, which detracts from the literacy agenda (Association of Mathematics Education for South Africa [AMESA] 2003; Christiansen 2007). In the analysis of the National Curriculum Statement (NCS) for Mathematical Literacy, AMESA (2003) discovered that various aspects of the curriculum document were skewed more towards the content than towards the context. In support, Christiansen (2007) says that seven of the 18 assessment standards are strictly ordered by mathematics. She argues that the curriculum for ML is driven less by everyday application than what is implied in its stated purpose.

Agenda 4: Content Driven

According to Graven and Venkat (2007), this agenda is based on word problems, but to a lesser extent compared to agenda 3. Graven and Venkat (2007: 70) note that the application of mathematics to word problems that link to the real world in various ways is provided in the hope that it will support logical reasoning about problems in the physical and social world. This agenda is also driving mathematics. In mathematics, according to Sethole (2004), the context of word problems is used as a bait to access the learning of mathematics.

From the above descriptions of the various agendas, it is clear that ML agendas differ strongly from M agendas in the FET phase. It is clear that there are differences and similarities between M and ML agendas, as discussed above. Mathematics is content oriented. Although there is context in mathematics, the context should service understanding of the content. With regard to Mathematical Literacy, a curriculum analysis and literature (Graven and Venkat 2007) agree that a spectrum of agendas is underpinning the ML curriculum. For M and ML teachers to be successful in teaching these subjects, they need to know these agendas, and should be able to identify them in scenarios and tasks with which they interact. In South Africa, debates about mathematics, specifically, and Mathematical Literacy, generally, have centred on achievement issues rather than issues linked to examining the nature of disciplines and discipline-specific orientations.

The researchers pose the following questions:

- To what extent would Mathematics teachers readily view tasks, which have a mathematical orientation, as mathematics tasks?
- To what extent would Mathematical Literacy teachers more readily view tasks, which have a Mathematical Literacy orientation, as Mathematical Literacy tasks?
- How would Mathematics teachers view tasks that have Mathematical Literacy as their dominant orientation, and vice versa?

These key questions are explored in the broader study and are based on teachers' perspectives of the subjects they are teaching. In order to respond to these questions, M and ML teachers were provided with a combination of M and ML tasks (Fig. 1) to see how they would interpret them. The four tasks below were taken from previous national question papers of both learning areas. The first three tasks were taken from Grade 12 national mathematics question paper 1 of 2009, while the fourth task was taken from a grade 12 national Mathematical Literacy question paper 2 of 2008 a previous year. The researchers decided to have one task in Mathematical Literacy (task 4) because it had two sub-questions.

METHODOLOGY

Study Design and Tasks

Four tasks have been administered as an activity as described below. All four tasks had aspects of Mathematics and Mathematical Literacy embedded in them. The tasks were selected on the basis that learners of both Mathematics and Mathematical Literacy would be able to solve the problems.

The four tasks presented to learners were as follows (Fig. 1):

The research involved four secondary schools with teachers from contrasting backgrounds in Gauteng, South Africa. The research was conducted by adopting a qualitative, multiple case-study approach. The four schools were located at socially divergent sites: Two former model C schools, which served middle to upper well-resourced schools, where parents typically were high-income professionals, were selected. The other two schools selected were public township schools serving children from predominantly poor backgrounds, that is, less affluent schools offering both Mathematics and Mathematical Literacy, where parents were typically low-income earners. Four M teachers (MTS1, MTS2, MTS3 and MTS4) from four schools and four ML teachers (MLTS1, MLTS2, MLTS3 and MLTS4) were interviewed to obtain their views of the four tasks.

In the next section, findings on Mathematics and Mathematical Literacy are discussed in terms of teachers' general background, followed by their experiences and their views of M and ML tasks.

RESULTS

Mathematics Teachers' Qualifications

When MTS1, MTS2, MTS3 and MTS4 were asked about their qualifications and whether they had studied Mathematics and Mathematical Literacy, they responded as follows:

I did BSc honours in mathematics education at University A[1]. I also have a Secondary Teachers Diploma (STD) majoring in Mathematics and Physical Science from the college, and I did a Bachelor of Technologiae (B. Tech) at University B, majoring in Mathematics IV and Chemistry, Yes, I did Maths Lit when I was doing BSc Hons in mathematics education at A (MTS1).

I have a B.Ed hons in Science and mathematics teaching, and I have only studied Mathematics at tertiary level and learned Mathematical Literacy while teaching. I have also attended Gauteng Department of Education

1. Solve for x

3x+ — =4

2. Calculate the value of 1234567893 x 1234567894 – 1234567895 x 1234567892

3. A sequence of squares, each having side 1, is drawn as shown below. The first square is shaded, and the length of the side of each shaded square is half the length of the side of the shaded square in the previous diagram.

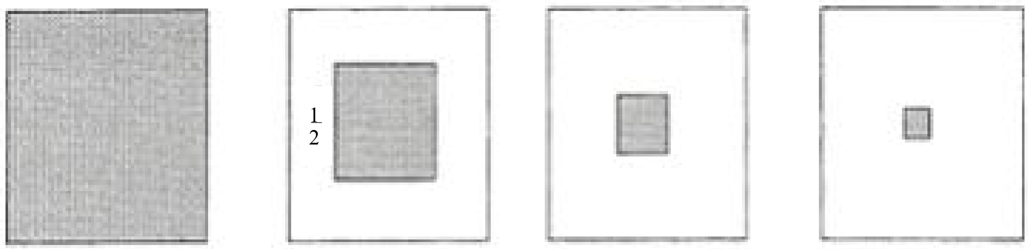
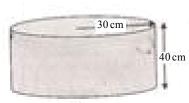


DIAGRAM 1 **DIAGRAM 2** **DIAGRAM 3** **DIAGRAM 4**

3.1 Determine the area of the unshaded region in diagram 3.

3.2 What is the sum of the areas of the unshaded regions on the first seven squares?

4. Thandi washes her dishes by hand three times daily in two identical basins. She uses one basin for washing the dishes and the other for rinsing the dishes. Each basin has a radius of 30 cm and a depth of 40 cm, as shown in the diagram below.



BASIN

Thandi is considering buying a dishwasher that she will use to wash the dishes daily.

4.1 Calculate the volume of one cylindrical basin in cm^3.

4.2 Thandi fills each basin to half its capacity whenever she washes or rinses the dishes. Calculate how much water (in litres) she will use daily to wash and rinse the dishes by hand (250 cm^2=0.025 ε)

4.3 A manufacturer of a dishwasher claims that its dishwasher uses **nine times** less water in comparison to washing the same number of dishes by hand.How much water would this dishwasher use to wash Thandi's dishes daily? Is the claim of the manufacturer realistic? Justify your answer by giving a reason(s).

Fig. 1. Tasks

Source: Tasks are from National Senior Certificate Mathematics and Mathematical Literacy question papers for 2009 and 2008

(GDE) workshops on Mathematical Literacy (MTS2).

I have a BSc in Mathematics and Post-Graduate Certificate in Education (PGCE). As for Mathematical Literacy, I did not do it at all (MTS3).

I have a BEdHons in mathematics education, but did not do Mathematical Literacy (MTS4).

Table 1: Comments by M teachers to task 1 to 4

Teacher	*Task 1*		*Task 2*		*Task 3*		*Task 4*	
	M	ML	M	ML	M	ML	M	ML
MTS 1	√	√	√	√	√	√	√	√
MTS 2	√	X	X	√	√	√	X	√
MTS 3	√	X	√	X	√	√	"	√
MTS 4	√	X	√	√	√	√	X	√

'√' indicates that teachers viewed task as M or ML and 'X' as neither.

Most of the M and ML teachers specialised in Mathematics, but not in Mathematical Literacy. For example, the teachers from MTS1 had a BSc Honours in Mathematics Education; from MTS2 had a BEd Honours in Mathematics Teaching, from MTS3 had a BSc in Mathematics and from MTS4 had a BEd Honours in Mathematics education. However, none of them had qualifications in Mathematical Literacy. For example, MTS2 had 'only studied Mathematics at tertiary level and learned Mathematical Literacy while teaching it'. She only 'attended Gauteng Department of Education (GDE) workshops on Mathematical Literacy'. It was assumed that if one had studied Mathematics at tertiary level, one would be able to teach Mathematical Literacy because some of these teachers were also teaching Mathematics. It might further be assumed that mathematics is essentially the same as Mathematical Literacy. This could lead to a perception that one does not need to specialise in Mathematical Literacy. Teachers who were not trained in Mathematical Literacy were unable to differentiate between Mathematics and Mathematical Literacy. Table 1 indicates the overall categorisation of tasks by M teachers.

Table 2 shows the sub-total of number of M teachers who labelled a task as an M or ML only, or both M and ML.

Table 2: Sub-totals of the comments by M teachers to task 1 to 4

	M only	*ML only*	*Both M & ML*
Task 1	3	0	1
Task 2	1	1	2
Task 3	0	0	4
Task 4	0	2	2

MTS1, as indicated in Table 1, was the only teacher who viewed all tasks as being related to both Mathematics and Mathematical Literacy. Other teachers had different views on tasks 2 to 4. This indicated that the distinctions between the M and ML tasks were not clear to them. It is clear from Table 3 that all four M teachers labelled task 1 as an M task. However, three of the four teachers indicated that task 2 was both an M and an ML task. This was also confirmed by the performance of both M and ML learners in the research from which this paper emerged. In task 2, both teachers and learners failed to recognise that the task was about the concept of pattern. Both teachers and learners thought this task could be solved by using a calculator. In the case of Task 3, it is evident from the tables that all the teachers indicated that this was an M and ML task. In the case of task 4, two of the four M teachers indicated that this task was both an M and an ML task. The M teachers were asked to indicate strategies they thought learners could use when solving the tasks. The comments below indicate some of teachers' views on M and ML tasks.

Mathematics Teachers' Comments on Task 1

When asked to comment on task 1, MTS1 stated, 'A maths question is more of content and ML more of context. In ML, the context is in the form of scenarios.' It is clear from this statement that MTS1 viewed M questions as being content oriented and ML questions as being driven by context. MTS1 regarded task 1 as 'more of [a] maths question than the ML question because learners can use more of algebra'. For MTS1, a maths question is more about content than context; an ML question is in 'the form of scenarios which are in learners' everyday experiences'. In other words, for MTS1, mathematics is content and algebra oriented, while Mathematical Literacy is context and scenario based. When asked to comment on task 1, MTS2 stated, 'Solve for x is an M question because you have a variable to be solved/substituted –

you don't have [a] real-life situation. It is an abstract question.'

MTS2 regarded task 1 as an M question because it is a *'solve for x question'*. According to MTS2, the fact that this question had a variable meant that it was an M question. It was also an abstract question because it did not depict a real-life situation. According to MTS2, everyday context is regarded as the only feature or attribute of an ML question. If a question is connected to learners' everyday context, according to this teacher, it is not suitable as an M question. This is because, according to MTS2, an M question 'doesn't have [a] real-life situation. It is an abstract question'. Similarly, when asked to comment on task 1, MTS3 commented, 'This is basically a[n] M question not a[n] ML question, because [of] solve for x^1. MTS3 also viewed task 1 as an M question, not an ML question. This is because it was a solve for x^1 question.

Mathematics Teachers' Comments on Task 2

When asked to comment on task 2, MTS1 stated, 'Task 2 is more of arithmetic. I think [it] is an M question by the look of things, but it can also be a[n] ML question'. MTS1 regarded task 2 as both an M and ML question, because it was more arithmetic than context oriented, and could also be solved algebraically by letting the number 1234567893 be x. MTS2 stated, 'I think this can be a[n] ML question because you work with numbers.' This would suggest that, according to MTS2, ML is about working with numbers. It also suggests that mathematics, according to MTS2, is not about working with numbers. According to MTS3, 'This is an M question', while MTS4 said 'Question 2 is both a[n] M and [an] ML question because in M [it] is [a] basic operation and in ML [as well]'.

The above comments show that MTS1, MTS2 and MTS4 regarded task 2 as both an M and ML question, whereas MTS3 considered task 2 an M question only.

Mathematics Teachers' Comments on Task 3

When asked to comment on task 3, MTS1, MTS2, MTS3 and MTS4 stated the following:

It is also an M and ML question, because of the scenario given, so ML learners can use mathematical skills to solve the scenario given. It is also an M question because a learner can use algebra to solve the scenario given (MTS1).

It can be both [an] M and ML question, because M learners can use number pattern[s] to solve the problem and ML learners can use a formula of an A=Length x Breadth (MTS2).

...it is an M and ML question (MTS3).

It is a[n] M and ML question. For M learners, [a] square ... is [decreasing and increasing exponential (MTS4).

All four teachers viewed task 3 as both an M and an ML task. MTS2 in particular noted that it had concepts of pattern and area. The fact that it had the concept of area made it appropriate for ML learners. In addition, the fact that it had aspects of pattern made it suitable for M learners. This suggests that the concept of pattern is for mathematics learners, while that of area is for Mathematical Literacy learners. As a result, MTS2 concluded that M learners would use a pattern strategy, while ML learners would use the formula for area, that is, A= Length x Breadth.

Mathematics Teachers' Comments on Task 4

When asked to comment on task 4, MTS1 stated, 'I think this question is for both M and ML learners, because it consists of content and context'. MTS1 explained that this task qualified as both M and ML because it had elements of content and context. MTS2 said, 'This is a[n] ML question because it is based on [a] real-life situation, and it is about area and volume'. When asked why it was not an M question, the teacher responded as follows: 'I don't think we can have such a question in M – it is so easy'. MTS2 argued that task 4 was an ML question because it was based on a real-life context, and it contained the concepts of area and volume. This teacher further posited that the task was too easy to be an M task. However, MTS3 said, 'I think [it] is for both M and ML learners – this is about learners' everyday life experiences. So, ML learners [will] be able to do it.' MTS3 concurred with MTS1 that the task qualified as both M and ML.

Mathematical Literacy Teachers' Qualifications

When ML teachers were asked to state their qualifications, they said the following:

Table 3: Summary of comments by ML teachers on task 1 to 4

Teacher	*Task 1*		*Task 2*		*Task 3*		*Task 4*	
	M	ML	M	ML	M	ML	M	ML
MLTS1	√	X	√	√	√	√	X	√
MLTS2	√	X	√	√	√	√	X	√
MLTS3	√	X	√	√	√	√	√	√
MLTS4	√	X	√	√	√	√	√	√

Table 4 shows the sub-total of number of ML teachers who labelled a task as an M or ML only, or as both M and ML.

MLTS1: BSc in Statistics and Psychology; Higher Diploma in Education (HDE), majoring in Mathematics and Guidance.
MLTS2: Diploma in Life Sciences and Mathematics.
MLTS3: BEd in Mathematics.
MLTS4: BSc with Psychology, Advance Certificate in Education (ACE) degree in Mathematics majoring in Mathematics and Science Education, Post Graduate Certificate in Education (PGCE) specialising in Mathematics and History, and honours degree in Educational Management and Leadership.

It is evident from the above that none of the four teachers had studied Mathematical Literacy at tertiary level. Moreover, the four teachers were not trained officially in Mathematical Literacy. Some teachers, such as MLTS2, only attended a Gauteng Department of Education workshop on Mathematical Literacy. MLTS2 was not fully qualified in Mathematics. LTS2 alluded to the fact that, because she did not specialise in Mathematics but in Life Sciences, she was not confident in teaching Mathematics but she could teach Mathematical Literacy. This could imply that any teacher can teach Mathematical Literacy. Table 3 presents a categorisation of the four tasks by ML teachers.

Table 4 does not differ greatly from what the M teachers indicated in Table 2. It is clear from

Table 4: Summary of comments by ML teachers on task 1 to 4

	M only	*ML only*	*Both M & ML*
Task 1	4	0	0
Task 2	0	1	3
Task 3	0	1	3
Task 4	0	2	2

Table 4 that all ML teachers recognised task 1 as an M task, but that they labelled tasks 2, 3 and 4 in the same way as the M teachers did. Table 5 shows the grand totals of both M and ML teachers who labelled a task as an M or ML only, or as both M and ML.

Looking at Table 5, task 3 appears to have attracted multiple interpretations from the most number of teachers across the Mathematics and Mathematical Literacy groups. Four (4) Mathematics teachers and three (3) Mathematical Literacy teachers viewed task 3 as both an M and an ML task. This task was selected from a previous national Mathematics question paper. Similarly, task 2 was selected from a previous national Mathematics question paper. However, five of the eight teachers viewed the task as relating to both Mathematics and Mathematical Literacy task.

Table 5: Summary of M and ML teachers' comments on task 1 to 4

	M only	*ML only*	*Both M & ML*
Task 1	7 (3+4)	0	1 (1+0)
Task 2	0	2 (1+1)	5 (2+3)
Task 3	0	1 (0+1)	7 (4+3)
Task 4	0	4 (2+2)	4 (2+2)

Mathematical Literacy Teachers' Comments on Task 1

When asked to comment on task 1, MLTS2 and MLTS4 said the following:

This is absolutely [an] M question, because it [is] solving for x (MLTS2).

[It] is M because of the unknown variable x (MLTS4).

As indicated in the above comments, MLTS2 and MLTS4 viewed task 1 as an M task. For MLTS2, task 1 was an M task 'because it is a solve for *x* task. This implies that, according to MLTS2, a task requiring learners to solve for would not be an ML task. MLTS3 viewed task 1 as not being an ML task because 'it is a quadratic equation'. For MLTS4, task 1 could not be an ML task because of the 'unknown variable.' This also suggests, according to MLTS4, that ML tasks do not need to involve an 'unknown variable '.

Mathematical Literacy Teachers' Comments on Task 2

When asked to comment on task 2, MLTS1 and MLTS4 responded as follows:

I think anyone can do it, *both M and ML learners* (MLTS1).

OK, both; *they should* be *able to do it because it is a basic operation* (MLTS4).

As indicated above, MLTS1 and MLTS4 regarded task 2 as both an M and an ML task.

Mathematical Literacy Teachers' Comments on Task 3

When asked to comment on task 3, MLTS1 and MLTS3 responded as follows:

I think both M and ML learners can try to do it, *so it falls in both M and ML* (MLTS1).

I think ML learners might have a problem with this one, even though it looks like it can be both [an] M and ML question (MLTS3).

According to MLTS1 and MLTS3, task 3 was both an M and an ML task. For MLTS3, most learners would use 'M knowledge from primary school'. MLTS4 viewed this task as a practical task. She recalled doing a similar task with learners. MLTS3 said, 'Task 3 is related to activities that involve cutting and measuring, which are done with ML learners'. However, MLTS4 argued that, if the task were to be given as it appeared in task 3, ML learners 'would be scared out of their mind'. This means that MLTS4 possibly viewed this task as being for M learners only.

Mathematical Literacy Teachers' Comments on Task 4

When asked to comment on task 4, MLTS1 said, 'This one is for ML; normally they are given formulae to apply in this kind of problem'. MLTS2 also commented, 'This is a[n] ML task', and observed that 'learners are supposed to use a formula; you cannot give these learners this kind of question without giving them [a] formula' because 'learners have to substitute [for], radius and diameter'.

However, MLTS3 observed that task 4 'can be [an] M [task] in Grade 9 but [an] ML [task] in Grade 11'. This teacher stated that Grade 11 Mathematics learners would not be 'tested in this way'. Viewing task 4 as a Grade 9 M task but not a Grade 11 M task ties in with the notion that Mathematical Literacy is basic Mathematics, as suggested in some of the comments made by the M teachers. MLTS3 commented further:

Generally, for maths learners this question is simple. You see, in maths, learners know hard maths, but sometimes they will surprise you if they are unable to do the simple problem.

Again, the comments above confirm the idea that Mathematics and Mathematical Literacy need to be taught differently. Learners in Mathematics are given formulae to apply, but in Mathematical Literacy, they develop ideas that underpin the concept.

As in the analysis of the M teachers' data, 'solve for (task 1) was labelled an M question by MLTS1. However, this teacher did not deny the fact that there was a solve for x problem in Mathematical Literacy, but argued that 'solve for x is used in everyday contexts such as finding a breakeven point. Furthermore, the teacher posited that 'solve for x' in Mathematical Literacy is more advantageous than solve for x in Mathematics because in Mathematics, learners do not have an idea of where they are heading when they solve for x. In Mathematical Literacy, however, learners can make sense of it when they relate it to their everyday context.

DISCUSSION

It is clear from the teachers' descriptions of M and ML tasks that the evaluative rules (recognition and realisation rules) of Mathematics seem to be clear. It is clear that the teachers regard Mathematics as an 'abstract, content-driven discipline'. Although the curriculum and literature refer to context in Mathematics, the context is viewed as a vehicle through which M content can be accessed. However, it was not clear from the teachers *x*' responses whether they viewed the relationship between content and context in the same way as suggested by the curriculum and literature. Some of the teachers indicated that Mathematics comprises context and content, but they did not seem to make explicit relationship between the two (content and context). For example, MTS1 stated, 'there is content and context in Mathematics but Mathematics is more of content'. As much as MTS1 acknowledged that there are content and context in M, the use of context in Mathematics is not explicitly stated. It can therefore be assumed that policymakers believe that teachers themselves should be required to make this relationship explicit. The researchers therefore argue that it should not be taken for granted that teachers will know what is clearly prescribed in the curriculum. The curriculum needs to be clear about the use of context in Mathematics and teachers need to be familiarised, through official training, with the relationship between content and learners' everyday context in Mathematics.

The researchers have noticed from the analysis of M and ML teachers' responses that the recognition and realisation rules appear to be understood clearly based on the teachers' description of mathematics as a content-oriented subject. It is clear that mathematics is driven by the third agenda, namely the content-oriented agenda (Graven and Venkat 2007; Machaba 2016c).

By contrast, understanding of ML evaluative rules seems to be elusive. All the agendas appear to have been implied in the comments given by the M and ML teachers. However, it is not clear from respondents' comments on which agendas Mathematical Literacy should ideally be based. All eight teachers appeared to be uncertain about what officially counted as legitimate knowledge in Mathematical Literacy. Venkat (2007) notes that in the early stages of the process of implementing Mathematical Literacy, it would not be surprising that there were mixed messages, which are defined by the agendas referred to above. However, mixed messages in Mathematical Literacy are still prevalent eleven years after Mathematical Literacy had been introduced in South Africa in 2006. Drawing on the work of Harley and Parker (1999), Graven and Venkat (2007) note that a shift away from strongly classified collection codes towards more integrated codes could create ambiguity, which means that the recognition rules are elusive in the case of Mathematical Literacy. They argue that this ambiguity means that these rules need to be negotiated in the ML classroom.

The existence of these mixed messages can be attributed to teachers' different interpretations of the curriculum policy and to the policy itself being not clear in terms of what officially counts as legitimate Mathematical Literacy knowledge. Hence, the researchers argue that inadequate teacher training in Mathematical Literacy is the cause of teachers not knowing what counts as legitimate text for Mathematical Literacy. Venkat (2007) and Bansilal and Debba (2012) confirm that ML teachers are expected to implement a curriculum that does not have well-established aims and purposes. This is evidenced by the wide spectrum of responses from teachers in Mathematical Literacy and the mixed messages referred to earlier.

The issue of mixed messages associated with Mathematical Literacy suggests that the pedagogical identity (Bernstein 2000) is not clear. The vague pedagogical identity of Mathematical Literacy is owing to the recontexualisation (Bernstein 1996, 2000) of its structure of knowledge from other disciplines, skills and attitudes. Mathematical literacy is therefore viewed as a generic and a weakly classified subject. Its identity is not well established, and insulation is blurred by the organisation of a knowledge structure that is integrated with that of other subjects and disciplines. In other words, Mathematical Literacy knowledge is organised through the consensus of interests from other pedagogical discourses.

As indicated, task 3 appears to have attracted multiple interpretations from the most number of teachers involved in the study. Four (4) Mathematics teachers and three (3) Mathematical Literacy teachers viewed task 3 as both relating to Mathematics and Mathematical Literacy. However, this task was selected from a previous national mathematics question paper. Similarly, task 2 was selected from a previous national mathematics question paper.

It is significant that five (5) of the eight (8) teachers viewed the task as both a Mathematics and Mathematical Literacy task. The way in which teachers viewed tasks 2 and 3 appears to be consistent with the orientations of the tasks themselves. Both tasks have Mathematics and Mathematical Literacy orientation both in their form and in the way they need to be engaged with in order to obtain the correct solutions. However, for tasks like 1 and 4, whose dominant orientations are either mathematics only or mathematical literacy only, the identity of mathematics appears to be stronger and more visible than that of mathematical literacy. Seven (7) teachers viewed task 1 as being about mathematics only, while four (4) teachers viewed task 4 as being about mathematical literacy only. This suggests that when a task is a mathematics task, teachers do not seem to struggle to see it as being explicitly about mathematics. However, when it is a mathematical literacy task, fewer teachers appear to see it as explicitly about mathematical literacy. This distinction, although only tentative and arising from a study involving a small number of teachers, suggests that it is less possible for mathematical literacy to stand alone, that is, to have an exclusive identity. The chances are greater that a mathematical literacy task will have many other aspects (especially mathematics) attached to and embedded in it. What gives mathematical literacy an identity currently cannot be divorced from mathematics (Machaba and Mwakapenda 2016).

CONCLUSION

This paper focused on a selected group of teachers' views on and experiences of Mathematics and Mathematical Literacy and tasks linked to these learning areas in the South African curriculum. Conceptual frameworks for a spectrum of pedagogical agendas were used to analyse the Curriculum and Assessment Policy Statement (CAPS) for Mathematics and Mathematical Literacy and to discuss teachers' views on tasks linked to Mathematics and Mathematical Literacy.

The data analysis, the curriculum perspective and the literature reviewed suggest that Mathematics is an 'abstract, content-oriented' subject. Although the curriculum and literature speak about context, the context is viewed as a vehicle through which to access mathematical content. However, it was not clear from the teachers' responses that they viewed the relationship between content and context in the way suggested by the curriculum and literature. Some of the teachers indicated that mathematics comprises context and content, but they did not seem to make explicit the relationship between the two. This uncertainty appears to have arisen from the assumption that teachers themselves should be able to see a clear relationship between context and content. However, it is unrealistic to expect of teachers to do this since it might be beyond their knowledge of what is prescribed in the curriculum. The curriculum needs to show clear uses of context in Mathematics.

For Mathematical Literacy, it is clear from the data analysis that the curriculum and literature are not in unison. Both data and literature seem to suggest that there are mixed messages – refer to the spectrum of agendas in terms of which Mathematical Literacy is described. Agenda 2, the balance between content and context, is viewed as the ideal agenda explaining mathematical literacy. The issue of balance between content and context is not stated clearly in the Curriculum and Assessment Policy Statement (CAPS) for Mathematical Literacy and in teachers' responses in the analysis. Teachers are expected to find that balance when teaching and interpreting the policy. It is clear from the above discussion that the policy itself may be the cause of confusion among teachers. It is unrealistic to expect of teachers to find the balance, if that balance is not clearly articulated in the policy perspective. The researchers therefore argue that ML teachers should be fully inducted through official training into the discourse of Mathematical Literacy.

The Curriculum and Assessment Policy Statement (CAPS) for Mathematics and Mathematical Literacy should be structured clearly in terms of their appropriate agendas, particularly with regard to the use of content and everyday context. Teachers appear to lack a deep knowledge and understanding of relationships between content and everyday context in the two subjects. Such a limited understanding of relationships appears to have shaped the ways in which teachers view tasks presented to them. Issues of balance and orientation are critical to the teaching of Mathematics and Mathematical Literacy. Mathematics and Mathematical Literacy teachers responded similarly, in spite of their supposed dominant orientations, because all the teachers' orientations had mathematics as their foundational frame and because they view Mathematics and Mathematical Literacy as inseparable, as both have mathematics as their originating frame.

RECOMMENDATIONS

It is recommended that, in order to minimise confusion, ML teachers should be trained adequately and appropriately to establish the content of Mathematical Literacy and the way in which it differs from Mathematics. The Curriculum and Assessment Policy Statement (CAPS) for Mathematics and Mathematical Literacy should be structured clearly in terms of the respective agendas of the two learning areas, particularly with regard to the use of content and everyday context.

NOTE

1 Names of institutions in pseudonyms to preserve anonymity

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