AN EXPLORATORY STUDY INTO THE INTRODUCTION OF MATHEMATICAL LITERACY IN SELECTED CAPE PENINSULA HIGH SCHOOLS
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This is an exploratory study to investigate the challenges of implementing the new mathematical literacy curriculum in high schools in the Western Cape. Eight schools from previously disadvantaged areas in the Cape Peninsula of the Western Cape Province of South Africa were studied through class visits, interviews with teachers of mathematical literacy, video taping of lessons and an analysis of students’ results in the June and November examinations in 2006. Initial results of the study show that in these schools, the majority of teachers teaching mathematical literacy have professional qualifications in mathematics. There are also some teachers with other subject specialisations who also teach the subject. Teachers report that learners have a negative attitude to mathematical literacy and are struggling to understand the new subject as can be attested to by the dismal showing in the June examinations.

INTRODUCTION
The South African National Department of Education began to implement a new curriculum in all high schools in 2006 with a specific focus in the Further Education and Training (FET) phase. This new curriculum is a logical progression Curriculum 2005, which was introduced by the new South African government after 1994 as a replacement for apartheid education. The new curriculum, which was introduced in the FET phase in South African schools in 2006, has seen every student doing seven subjects instead of six, with four of these being compulsory subjects. Mathematical literacy would be compulsory for all those students not taking mathematics.

At the beginning of 2006, in response to the proclamation by the Minister of Education in 2005, all schools in the country began to implement this new policy. In anticipation of this new policy implementation, the National Department of Education began, in 2004, to register teachers in an Advanced Certification in Education specializing in mathematical literacy, at Higher Education Institutions throughout the country.

A strategic decision was taken to consider the retraining of teachers who were not qualified mathematics teachers to cope with the large numbers of learners who would be doing mathematical literacy. Many of these teachers would only graduate in 2006 whilst the implementation of the new policy was in progress.
The state realized that it could not formally qualify enough teachers to cope with the huge number of students who would be doing mathematical literacy at the beginning of 2006. Hence, during 2005 and 2006, a number of short courses were conducted in all provinces to train teachers in the implementation of mathematical literacy in Grade 10.

This training focused on training teachers who did not necessarily have mathematics professional qualifications and some of them had undergone a course in mathematical literacy as a qualification through higher education institutions.

This is the context in which this study was undertaken. It is a preliminary study whose aim was to find out how teachers and learners in a few high schools have experienced the teaching and learning of mathematical literacy in 2006. The study also aimed at finding out what content was been taught and learnt at these schools, the contexts within which mathematical literacy was been taught and also to look at learner achievement in the subject in 2006.

RESEARCH QUESTIONS

The study sought to understand teachers’ perceptions about the training they received in particular from the Western Cape Education Department (WCED) and how they applied their training in teaching mathematical literacy in grade 10 classes during the first half of 2006. It sought an understanding of their challenges and their joys in teaching this new subject and the feelings either of inadequacy or achievement in their teaching and in learners’ achievement. It also sought to understand the content of the mathematics taught and the contexts chosen for the subject in class and how learners have achieved in semester assessments. The following are the relevant research questions that were pursued:

- What training did teachers receive on the teaching and learning of mathematical literacy?
- What strategies did schools adopt in teaching mathematical literacy?
- What challenges and experiences have teachers encountered in the teaching of mathematical literacy?
- What was the learners’ academic achievement in mathematical literacy in the first year of implementation?

LITERATURE REVIEW

To pursue an understanding of mathematical literacy, it is perhaps, prudent to start with the notion of literacy from a linguistic perspective. Whilst the Concise Oxford Dictionary defines literacy as “the ability to read and write”, the idea of literacy is very complex and dynamic and is dependent on the development of society. Literacy can be regarded as:
From this definition, one can understand the notion of mathematical literacy as deriving from the need of societies to understand their complexity and the role that mathematics plays in society. Because much of human activity is described mathematically, it has become more important than ever for citizens to be mathematically literate. Understanding this imperative, the South African National Department of Education saw the wisdom of introducing mathematical literacy in all high schools as an alternative to “pure mathematics” - pure mathematics in this case being the non-contextual mathematics.

Mathematical literacy, the new addition to the FET curriculum in South African schools, is viewed by the Programme for International Student Assessment (PISA) as:

…the capacity to identify, understand and engage in mathematics, and to make well-founded judgements about the role that mathematics plays in an individual’s current and future private life, occupational life, social life with peers and relatives, and life as a constructive, concerned and reflective citizen (OECD, 2001:22).

What this definition implies is that society should see mathematics and people’s daily existence as indivisible because mathematics permeates all that they do in their daily lives. To understand what mathematical literacy is, one should start with the notion of literacy, which refers to one’s ability to function in society because one is able to understand the written word. Hence, from this conception, mathematical literacy would refer to an individual’s ability to function in society because the individual understands the language of mathematics, which describes aspects of society and how it creates a participating citizen.

The International Programme Committee for ICMI Study 14 (2002) sees mathematical literacy as belonging to the realm of mathematical applications and mathematical modelling (International Programme Committee for ICMI Study 14, 2002). Applications of mathematics deals with the use of mathematics to solve real life problems, whilst modelling takes a real life problem, and then provides a mathematical model which can then be used to solve this problem and other related problems.

The South African conception of mathematical literacy focuses on applications of mathematics to solve real-life problems in contrast to conceptions that focus on modelling. In emphasising the applications dimension of mathematical literacy, the National Curriculum Statement (NCS) of the South African National Department of Education (NDE) conceptualizes mathematical literacy as being: “…driven by real-life 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 solve problems (NCS, 2003:10)”
The NCS further notes the situations that confront society on a daily basis like financial transactions, hire purchase, mortgage bonds, investments, the ability to read maps and time tables, using medication and so on. It states that a self-managing person must be able to understand these situations and be able to solve problems related to these. The tool to use in understanding and coping with these situations is mathematical literacy (NCS, 2003:9)

Hence mathematical literacy was introduced in the South African education system to facilitate the growth of mathematically literate learners who are able to do mathematics informed by contexts in real life. This will lead to citizens who are mathematically literate.

One would have hoped that students who do mathematical literacy as a subject would not do it as a substitute for mathematics nor regard it as a junior cousin to mathematics.

**THE SAMPLE AND DATA COLLECTION**

At the beginning of September 2006, eight schools in established townships in the Cape Peninsula were approached with the aim of gaining access to observe mathematical literacy classes in session and to interview teachers who were teaching mathematical literacy. All the schools agreed to participate in the study. This happened after permission had been obtained from the Western Cape Education Department (WCED) to conduct the study.

Data for this study was obtained through observation of five classrooms in which mathematical literacy was taught and interviews with teachers who teach mathematical literacy in the eight schools mentioned above. A total of 13 teachers were interviewed. It was not possible to observe classes in all schools because the researcher was only able to reach the schools towards the closing dates for the third term and sometimes schools were involved in revision programmes or end-of-term examinations. The classroom observation was recorded through field notes with two classes observed video taped. The interviews were structured from an interview schedule which contained nine questions ranging from the teachers’ understanding of mathematical literacy, whether they received any training in the teaching the subject, adequacy of the training, the challenges and joys of teaching mathematical literacy, interaction with learners and learner performance in the first semester examinations. The teachers’ responses were audio-taped. The table below shows the profiles of teachers who were interviewed for the study:
As can be gauged from this table, the average teaching experience of these teachers is 13 years with the majority, 62%, being male. Of these teachers the majority, 77%, are qualified mathematics teachers who also teach mathematics as part of their overall teaching responsibilities. The rest are teachers with subject specialization of Xhosa and History.

**DATA ANALYSIS AND FINDINGS**

As indicated above, the interviews held with teachers were audio-taped. Transcripts of the audio-tapes were made and then the responses were analysed to obtain those responses relevant to the research questions. For the classroom observations, observation notes were taken and two lessons were video taped and it is from these notes and videos that findings on classroom teaching of mathematical literacy were obtained. The following findings are derived from teachers’ responses to the research questions.
TRAINING IN MATHEMATICAL LITERACY

With regard to training in the teaching of the new subject, the study has found out that the majority of teachers, 62%, did not receive training in the implementation of mathematical literacy. It is interesting to note that those who did not receive specific training in mathematical literacy are teachers who are qualified in mathematics and are offering mathematics in their schools. These teachers stated that they did not see the need to go for training because as far as they were concerned, they would not encounter any conceptual problems in Mathematical Literacy. Interestingly they seemed to assume that the same methodology of teaching would be employed in the teaching of Mathematical Literacy as is the case in the teaching of mathematics. The rest either attended WCED-organized courses or attended a two-year Advanced Certificate in Education (ACE) course in Mathematical Literacy run by either the University of Cape Town (UCT) or The Cape Peninsula University of Technology (CPUT). These institutions are two of four institutions which won a tender from the WCED to teach the ACE course in Mathematical Literacy to 140 teachers in the Western Cape (Mbekwa, 2006) From the table one can observe that the teachers who attended courses organised by the WCED or the ACE in Mathematical Literacy are not qualified mathematics teachers but are teachers whom the WCED has identified for retraining.

All the teachers interviewed stated that the training they received from the WCED course was not enough. Some indicated that the two weeks set aside for the course was not enough. One teacher put it: “The course was too compressed. For non-maths teachers it was not adequate. Lecturers had advanced assumptions that teachers had understanding of maths concepts”. One teacher stated that many of the teachers attending the course found it difficult: “If teachers could find it so difficult, imagine what it would be like for learners.”

Teaching mathematical literacy at school

Of the five classes observed, one class dealt with measurement, and two classes dealt with functions and two classes dealt with space and shape. The two lessons on functions were similar in the sense that both dealt with the derivation of an algebraic formula from a table of values with a functional relationship. One class, for instance, was given a table showing the relationship between the number of packets of biscuits and the selling price of these packets of biscuits. Students were asked by the teacher to complete the table and then derive from the table the formula that indicates the linear relationship existing between the number of packets of biscuits and the selling price. Students worked in groups on the following table:
<table>
<thead>
<tr>
<th>No of packets (n)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of biscuits (C)</td>
<td>4,50</td>
<td>9,00</td>
<td>13,50</td>
<td>........</td>
<td>22,50</td>
<td>........</td>
</tr>
</tbody>
</table>

Table 2: Showing functional relationship between packets of biscuits and their cost.

Students were then asked a number of questions relating to the nature of the function and also to sketch a graph of the function. The teacher then went around the class to see if students were deriving the correct formula. It is interesting to note that the teacher described the number of packets of biscuits as “conservative numbers” instead of consecutive numbers. This was brought by the researcher to the notice of the teacher after class so that she could rectify this terminological error. The students were able to deduce the relationship between the number of packets and the cost in rand as defined by C=4,5n. I did not get a sense of how the students came to this equation. A question was asked and one student came up with the answer. No student queried how this one student came up with the answer - the answer was simply accepted without interrogation. They also identified the dependent and the independent variables in the table without unpacking the concepts. The teacher did not probe whether learners understood the meaning of the concepts of dependence and independence.

Two schools used computer technology enabling learners to utilise the power of technology to reinforce their learning of mathematical literacy. This implied using computer laboratories with Master Maths programmes with mathematical literacy problems. One could see the enthusiasm and animation of the students while they were doing mathematical literacy etched on their faces. One teacher described this thus: “I have never seen so many kids occupied with mathematics at one time as I saw in this class.” One of these schools, in addition to using computer technology, engaged learners in doing practical research tasks. An example of such a research task involved learners investigating the price of the same model of car from two different car dealers. Learners found out that the prices differed although the car was the same model and year. Learners had to motivate why the marked prices differed and what dealers had to take into consideration when pricing a car. They also had to work out instalments on the different cars given a 10% deposit or on the same priced car if different deposits were paid. They had to look at instalment options for longer term and short term payments. They also had to look at payment on the same car if, for instance, one paid a deposit on the car to a dealer who then arranged bank finance or when the buyer bought the car through a personal loan from a bank and paid the loan from the bank back. Learners then had to make a decision as to the best option of the two.

The two other lessons which were observed through video tape dealt with topics on space and shape. One dealt with the area concept from a tangram activity. Learners were required to find out for instance the ratio of the area of a triangle to the area of a
parallelogram or to the area of a square. The last lesson dealt with calculations related to the theorem of Pythagoras.

**CHALLENGES OF TEACHING MATHEMATICAL LITERACY**

All the teachers interviewed concurred that the greatest challenge to the teaching of mathematical literacy was the lack of understanding of learners and their lack of motivation. Teachers indicated that students do not really want to do mathematical literacy but do it because it is compulsory if they do not do mathematics. As one teacher put it: “*These learners are negative towards mathematical literacy. They do it because they have no choice.*” They also stated that students’ performance in mathematical literacy is not good. According to some of the teachers, what contributes to poor performance is the poor preparation of learners in lower grades. What also contributes to this poor performance is the English language in which Mathematical Literacy problems are couched. Most of the problems are verbal in nature and students find it difficult to make sense of what is required. Teachers have to spend a lot of time translating the language of the problem into Xhosa, their mother tongue. It is only then that students can start developing problem solving strategies.

Two of the teachers interviewed stated that whilst the majority of students struggle with mathematical literacy, one finds one or two students who are very brilliant and obtain distinctions in all tests. In one school, one such student was placed in a mathematical literacy class because he came from another province and registered later than other students after the commencement of the academic year. The teacher of this student was contemplating placing this student in a mathematics class. This thinking is a reflection of the idea that mathematical literacy is a dumping ground for mathematics underperformers and hence this brilliant student is misplaced in a mathematical literacy class.

Amongst other challenges mentioned, one challenge mentioned by teachers who were interviewed refers to the difficulty of finding teachers willing to teach mathematical literacy. They state that this is because mathematics teachers do not want to teach mathematical literacy as they see it as an inferior kind of mathematics. Teaching mathematics at schools is seen as a high status role. Hence the department of education has wisely decided to utilise teachers who have been redirected from other subject streams and re-skilled, to teach the subject. One such teacher, whose specialisation subject is History, was retrained by the department of education and states that she is quite “comfortable to teach mathematical literacy to grade 10 students. I approach Ms…to assist me when I encounter a problem.” This teacher uses the mathematics teacher, that she mentions, as a consultant to overcome mathematical conceptual problems. Most schools pair mathematical literacy teachers with mathematics specialists so that the mathematics specialists perform a mentoring role to the non-mathematics specialists.
STUDENTS’ PERFORMANCE IN EXAMINATIONS

I requested the teachers to supply me with the statistics of mathematical literacy students in their schools and how these students performed in the first semester and final examinations in 2006. Of the eight schools participating in the study, seven provided pass statistics for mathematical literacy for the June and November examinations. The following table represents these figures:

<table>
<thead>
<tr>
<th>Name of school</th>
<th>No. of Candidates</th>
<th>Passes</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>June: 152</td>
<td>21</td>
<td>13,8</td>
</tr>
<tr>
<td></td>
<td>Nov: 163</td>
<td>107</td>
<td>65,6</td>
</tr>
<tr>
<td>B</td>
<td>June: 143</td>
<td>14</td>
<td>9,8</td>
</tr>
<tr>
<td></td>
<td>Nov: 134</td>
<td>100</td>
<td>74,6</td>
</tr>
<tr>
<td>C</td>
<td>June: 358</td>
<td>47</td>
<td>13,1</td>
</tr>
<tr>
<td></td>
<td>Nov: 424</td>
<td>211</td>
<td>49,7</td>
</tr>
<tr>
<td>D</td>
<td>June: 71</td>
<td>4</td>
<td>0,05</td>
</tr>
<tr>
<td></td>
<td>Nov: 77</td>
<td>30</td>
<td>38,9</td>
</tr>
<tr>
<td>E</td>
<td>June: 154</td>
<td>82</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Nov: 156</td>
<td>116</td>
<td>74</td>
</tr>
<tr>
<td>F</td>
<td>June: 215</td>
<td>56</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Nov: 217</td>
<td>185</td>
<td>84,9</td>
</tr>
<tr>
<td>G</td>
<td>June: 79</td>
<td>8</td>
<td>10,1</td>
</tr>
<tr>
<td></td>
<td>Nov: 74</td>
<td>39</td>
<td>52,7</td>
</tr>
</tbody>
</table>

Table 3: Statistics of students taking mathematical literacy and the pass rate per school

The pass rates shown in the table above are represented diagrammatically in the following bar chart:
Figure 1: Bar diagram of student pass rates in the June and November Mathematical Literacy Examinations

REFLECTIONS ON THE FINDINGS

Training in mathematical literacy

In reflecting on the findings of this study, it is instructive to note that these findings are derived from the observation and interaction with a few schools and thus these findings cannot be projected to all high schools in the province or the country as a whole. In this study it can be seen from the teacher profile that the majority of these teachers who teach mathematical literacy are Mathematics teachers. One can thus recommend that the education department should utilise Mathematics teachers in schools to teach mathematical literacy and also to serve as mentors to those teachers who have received a basic training in teaching the subject. It is also interesting to note that almost all the teachers interviewed did not have conceptual problems with Mathematical Literacy. Perhaps it is due to the nature of mathematical literacy being mostly numeric or arithmetic and less algebraic.

The researcher was informed during contact with teachers that courses and workshops on mathematical literacy are continually being conducted by the education department to sharpen teacher skills and to be kept abreast of developments in mathematical literacy.
It is recommended that the department of education should use its data base on its teaching staff to target teachers who passed mathematics as one of their grade 12 subjects for training in the teaching of mathematical literacy.

Teaching mathematical literacy

It was found that in three of the five lessons observed, the lessons focused on context, which conforms to the notion of Mathematical Literacy as dealing with contexts especially as it relates to day to day living. The case of the school, for instance, that gave learners a task to look at pricing practices of a car dealership definitely made the subject more real to its learners. If more schools could subject learners to this kind of activity, it would go a long way in making Mathematical Literacy relevant and promote sense making. It is also recommended that, whenever possible, schools make use of technology and thus achieve one of the critical outcomes of the NCS. Research also shows that computer technology promotes concept formation and improved student attitudes to learning (Baker, Gearhart, & Herrman (1994); Harel (Ed). (1990); Harel & Papert. (1991); Kulik (1994); Sivin-Kachala (1998); Scardamalia & Bereister. (1996); Wenglinsky (1998).

Challenges of teaching Mathematical Literacy

Looking at the challenges of teaching mathematical literacy it is instructive to note the negative attitudes of both the teachers and students towards mathematical literacy. This might arise from the fact that these teachers have not been educated about what mathematical literacy is and what the motivation is for introducing it into the school curriculum. This might go a long way to eliminating the perception of mathematical literacy being a poor cousin to mathematics or a dumping ground for learners who are performing poorly. The issue of code switching to assist the learners in comprehension concurs with recommendations deriving from research in the use of the mother tongue in the teaching and learning especially in mathematics and science. Research shows that using the first language of learners in explicating mathematical concepts helps in conceptual understanding (Allen, 1988; Chapman, 1993; Desai, 2006; Langenhoven, 2006; Nomlomo, 2006; Moschovich, 2007; Setati, 2002; Setati, Adler, Reed & Bapoo, 2002; Setati; 2005). It becomes important therefore for the education department to have teaching and learning support materials translated into the mother tongue of learners. That has not yet happened. It is hoped that teachers will volunteer and be involved in the translation of teaching and learning support materials to assist learners in understanding the subject matter and so facilitate problem solving in mathematical literacy.

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Students’ performance in examinations

Looking at students’ results in the June examinations one can observe the poor performance of students, which confirms the teachers’ observation that students generally do not do well in mathematical literacy. The pass rates range from a minimum of 10.1% to a maximum of 53%, which gives a range of 42.9%. It is quite interesting to note that the November examination results range between 38.9% and 84.9%. The pass rates in June are all below 40% whilst in November only one school has a pass rate below 40%. One observes the increases between the June and November results ranging from a minimum of 11% to a maximum of 64.8%. It seems quite striking that all schools did well in the final examinations whilst in the June examinations they did so badly.

One suspects that there might have been an upward adjustment of marks. What formula was used to adjust the marks and whether this was consistent in all schools in the province one cannot say at this stage. This needs some more probing and probably an expansion of the study to include schools outside of the targeted sample. Only one of these schools has a low difference (11%) between the June and the November results and it is only this school which had a pass rate above 50% in June.

CONCLUSION

This study looked at the challenges of teaching and mathematical literacy at some high schools in the Cape Peninsula. The target group of the study was mathematical literacy teachers who highlighted the fact that learners and mathematics teachers are not motivated to become involved with the subject and learners who initially did not do well in the subject. Results of examinations corroborate the teachers’ observation of a lack of motivation on the part of learners. It is the intention of the researcher to further probe the radical improvement in the performance of learners in the November examinations and also to solicit learners’ opinions on their experience of mathematical literacy.

REFERENCES


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