"I DON'T HAVE TIME TO TEACH FOR UNDERSTANDING": REFLECTING ON A TIME-CONSUMING PROCESS OF CHANGE

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Many teachers feel that the process of teaching for understanding, for example by using problem-solving and social interaction as vehicles for learning, is too time-consuming, especially in the higher primary and secondary grades. Higher primary school teachers experience pressure from the school community and wider community, as well as from themselves, to 'cover' the existing syllabus and prepare the learners for secondary school. Research conducted on children's mathematical performance before and after MALATI's first year of intervention in schools shows that significant conceptual change occurred as a result of a problem-centred approach in which learners were expected to discuss and argue about their solutions. The whole syllabus was not 'covered' but this does not appear to have seriously affected the learners' performance.

Background

That a problem-centred approach takes too much time to realistically implement is a commonly heard complaint amongst teachers (e.g. Cooney, 1985). Teachers and parents are concerned that it can take a whole lesson, and sometimes more than one lesson, for learners to solve a single problem using their own, sometimes long-winded strategies ('Verbaas', 14 November 1991) and to discuss their strategies in groups. Even if teachers are aware of the wealth of integrated mathematics that can emerge during such discussion and from the problem-solving process itself, they still find themselves constantly looking at their watches and worrying about how they are going to 'cover' the syllabus. The implication of this concern is that the teachers believe that the learners are not learning the mathematics they should learn as preparation for the next grade.

The following are extracts from interviews with Grade 7 MALATI project school teachers in November 1998.

> Interviewer: ...When we observed that lesson last week, you said that you were doing this activity because you wanted to put something in the exam. Do you want to comment on that?
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> Teacher A: The reason for that is that we felt there were certain sections that we hadn't covered.
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> Interviewer: Yes.

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Teacher A: And we're sort of pushing for time...So in our work load, in our, what we've actually covered this year, we started to look back and sort of panic, because there's a lot of sections that we haven't actually done. Not all the pupils are going on to [a MALATI project school], they'll be going to different schools, and there're all sorts of other problems that will crop up. OK, so…

Interviewer: So you decided you needed to examine this…

Teacher A: So we decided we needed to examine this.

Interviewer: And in order to examine it, you needed to do…

Teacher A: To do, to cover the work.

Teacher B: ... what I can say is that my own teaching has been affected [by MALATI] and my own...I have realised where... what I have been doing wrong, because I once taught mathematics before, and I have realised what I have kind of been doing wrong, but ... my... my main problem at the moment is the time... the time that is... that you have to take so as to get to the actual thing and I am sure it's based on my past experience, past mathematics, because I always know that this is leading me to there, but it takes me time so as to get there, and yet I am rushing there, and that is, at the moment, my major problem which maybe, as time goes on, I will kind of overcome.

Carter and Richards (1999) refer to the "universal issue/dilemma" of time, and "the teachers' belief that if they do not spend their time 'covering' the 'curriculum' they will be damaging the students". They describe a process similar to MALATI's teacher development strategy in which "teachers do come to believe that exploring, inquiring, discussing, trying things out for yourself, and asking students to explain their ideas are important, but they also find these activities all take a lot of time and they cannot 'cover' the number of topics they are used to covering". According to Carter and Richards (1999), this results in a conflict between teachers' commitment to learner exploration and "their felt need to cover material". The danger is that this conflict can become overwhelming and defeat teachers' attempts to explore new practices.

This paper illustrates that while learners do indeed learn what teachers teach, content which is not directly taught can also be learned, while content which is superficially taught, is not

necessarily learned. The concern of teachers about the extent of the syllabus which needs to be covered in order to prepare the learners for the next grade, while understandable, may in fact be unfounded.

MALATI: A time-consuming process of change

The MALATI project has identified certain 'problem' areas in the curriculum and has developed materials and teaching approaches in these areas based on careful review of the existing literature and research in local schools. During the first year of implementation in 1998, teachers were provided with learner and teacher materials, participated in workshops and received intensive classroom support from MALATI project workers. Even in Grades 6 and 7, in content areas such as fractions, the basic concepts were retaught from the beginning before the official interim core syllabus could be reached, as our research had identified serious limiting constructions which learners already had in these areas (for example Newstead & Murray, 1998). New content areas, such as probability and spatial skills, were also taught and, as no pre-knowledge could be assumed in these areas, these concepts were also taught 'from scratch'. In other words, concepts that might be considered appropriate for Grade 5 and 6 had to be taught in Grade 7 as well. However, MALATI was not concerned about covering these concepts in a particular grade, as Curriculum 2005 is formulated in terms of phases: What is not covered in one grade, can be covered in the next grade as long as the necessary concepts are learned by the end of the phase.

In addition to the time constraints placed on the teachers arising from the teaching of new content and the reteaching of previously-covered content, several of MALATI's underlying philosophical beliefs and material design principles were also experienced by the teachers as time-consuming:

- Problem-solving is used as a vehicle for learning. The introduction of terminology, notation, rules and procedures is delayed until the basic concepts have been grasped. For example, learners are given the opportunity to make sense of operations with fractions in a problem context before being expected to make sense of them out of context.
- The materials repeatedly pose problems with similar structures to provide students with repeated opportunities to make sense of particular structures. For example, fractions and spatial skills were taught continuously throughout the year, once or twice a week, rather than in a concentrated 'block' of time.

- A supporting classroom culture is required in which learning takes place via problem solving and discussion and challenging of ideas, and in which errors and misconceptions are identified and resolved through interaction and reflection. Teachers do not demonstrate solution strategies, but expect students to construct and share their own strategies and thus to gradually develop more powerful strategies. Such strategies also emerge in the whole-class discussion facilitated by the teacher. This originates from our theoretical orientation based on the view that students construct their own mathematical knowledge irrespective of how they are taught. Cobb, Yackel and Wood (1992) state: "… we contend that students must necessarily construct their mathematical ways of knowing in any instructional setting whatsoever, including that of direct instruction," and "The central issue is not whether students are constructing, but the *quality and nature* of these constructions" (p. 28, my italics).
- A philosophy is incorporated in which difficulties with important concepts are diagnosed and addressed by diversifying the class into temporary, sometimes homogeneous groups. Consolidation is then provided for the learners who are struggling with the basic concepts, before these learners are reassessed and the heterogeneous groups are re-established. Although time-consuming, this diversification is considered essential for the further effective functioning of the heterogeneous groups as well as exposure to further, more advanced mathematics.

As a result of these changes in content and in classroom culture, several areas of the interim core syllabus were not covered in Grades 6 and 7 in 1998, and teachers were understandably concerned about this.

Methodology

As part of a larger impact study, tests were compiled including items representing the entire existing interim core curriculum as well as the MALATI intended curriculum for Grades 6 and 7. These tests were administered to all Grade 6 and 7 learners in two of the participating primary project schools. Both schools are near Cape Town, one in a coloured area and the other in a black township. The performance of the Grade 6 and 7 learners in these two schools in November 1997 (before the MALATI intervention) was compared to that of the Grade 6 and 7 learners in these same schools in November 1998. The latter learners had then been exposed to one year of the MALATI materials and approach.

The tests were coded by project staff according to a coding schedule based on initial analysis of the most common categories of response for each item. Pairs of project staff cross-checked approximately 10% of each other's tests in order to ensure reliability of coding. Data was entered and analysed using the SPSS program. For the purposes of determining whether significantly more (or less) learners had achieved success on each item in 1998 than in 1997, categories were collapsed into three new categories: 'correct', 'incorrect/omitted' and (where appropriate) 'partly correct'. Crosstabulations and chi-squared tests were used to determine the significance of any changes in the distribution of learners from 1997 to 1998.

Results

Although there was some variation between the two schools (and almost certainly between individual teachers as well), the *trend* in the two schools was similar and the results are thus reported together, unless otherwise specified.

The table below shows the results of the tests after one year of intervention. For each grade, the number of items is given on which there was a significant increase in success ($p<0,05$); no significant change ($p>0,05$); and a significant decrease in the number of successful responses ($p<0,05$). An indication is also given of whether or not the various content categories were covered by the MALATI/school partnership curriculum during the year. 'Not M' indicates that teachers did indeed teach this content, although materials were not provided by MALATI.

Content	Covered ?	Grade 6			Grade 7		
		Pos. change	No change	Neg. change	Pos. change	No change	Neg. change
COMMON FRACTIONS							
General concept	Yes				1	1	0
Part of whole	Yes	5	1	0	2	4	0
Of collection of objects	Yes	1	1	0	1	1	0
On number line	No	6	0	0	1	2	0
As ratio	No	1	0	0			
Of collection (comparison)	Yes	0	1	0			
Of different wholes (comparison)	No	0	1	0			
Operations, in context	Yes				1	1	0
Operations, no context	No	2	0	1	0	3	2

Content	Covered ?	Grade 6			Grade 7		
		Pos. change	No change	Neg. change	Pos. change	No change	Neg. change
DECIMAL FRACTIONS							
Rounding off	No	0	0	1	0	1	0
Place value	No	0	1	0			
Number line	No	1	1	0			
Operations, no context	No	0	2	2	0	7	0
GEOMETRY							
Spatial	Yes	1	0	0	1	1	0
Spatial, area, volume, perimeter	No	1	1	0	2	0	0
Area, volume, perimeter	No	3	2	0	0	5	0
Line symmetry	Yes	2	0	0	0	0	1
Rotational symmetry	No	1	0	0			
Angles	Not M.	0	2	0	2	0	0
Polygons	No	1	2	0	0	1	1
Parallel lines	No				0	2	4
ALGEBRA							
Pre-algebra	No	1	1	0			
Pattern recognition	No	0	4	0	0	3	0
Equations	No				0	4	0
Order of operations	Yes				4	7	1
OTHER							
Percentages	Not M.				1	1	1
Problem solving	Yes	0	3	1	0	3	0
Whole number rounding-off	No	0	0	2			
Operations, no context	No	3	0	1			
Number sense	No	0	3	0	0	1	0
Units	No	0	1	0	0	2	0
Bar graph	No						
Ratio	No				1	3	0
Negative numbers	Not M.				2	5	0

Table 1: Results after one year of intervention

Content areas partly covered by MALATI[1]

In the area of common fractions, there was a significant improvement (at least $p<0,05$) on nearly all of the items in both Grade 6 and 7. This included a significant improvement on some items concerning number lines and context-free operations with fractions, neither of which were directly taught in 1998. On items assessing specific aspects of common fractions not

[1] MALATI has also designed and trialled materials on probability and data handling, but this was not yet envisaged when the tests were designed.

covered by the existing materials, for example the comparison of fractions where the whole is not specified as the same, there was no significant change and this is being taken into account by including such concepts during the revision of materials. The only item to show a significant decrease in performance in Grade 6 was the context-free item concerning division of fractions, not taught in 1998. Similarly, the items concerning addition of mixed numbers and multiplication of fractions out of context, showed a significant decrease in performance in Grade 7 but this was not taught during 1998.

Similarly, in the area of spatial skills, there was a significant improvement on the items which we believed we 'covered'[2]. As regards other aspects of the geometry curriculum which we did not 'cover', there was either no significant change (such as area and volume) or a significant decrease in the number of correct responses (such as the definition of parallel lines, polygons and symmetry). Angles were taught briefly at both schools, but without MALATI materials. Only at one school was there a significant change on items concerning angles, negative in the case of Grade 6 and positive in the case of Grade 7.

Grade 6 and 7 learners were exposed to a calculator-based introduction to order of operations as part of the introductory algebra approach. Such items were included in the Grade 7 test, but unfortunately not in the Grade 6 test. There was a significant improvement on some of these items, especially at one school where more intensive teacher support was provided. Despite the fact that other aspects of algebra, such as pattern recognition and solving equations, have not yet been covered, there was no significant change in the Grade 7 learners' performance on these items.

Content areas not covered but supported by MALATI

The MALATI materials were never intended to constitute the entire year's work in Grade 6 and Grade 7. Rather, we used these materials as vehicles to introduce the project teachers to our teaching approach and philosophy, and provided support and advice where necessary as regards other aspects of the curriculum. For example, in one school, the Grade 7 teachers taught negative numbers after nearly a year of reflection and support within the context of the

[2] When the tests were designed, the extent of the underlying spatial skills which would need to be developed before other aspects of geometry could be addressed, was not anticipated. Thus only a small number of general spatial skills items were included. The assessment of such skills also does not lend itself to written, timed, individual work.

project. Approaches to teaching integers were discussed very briefly with them, and minimal classroom support was supplied to one of the two teachers. Their approach had changed significantly enough to ensure a significant improvement in their Grade 7 learners' performance on most (five) of the items regarding negative numbers. From a teacher development perspective, we find this very exciting.

Content areas not covered owing to time constraints

There were several curriculum areas that the MALATI project teachers did not cover at all during the year, such as context-free operations with fractions, decimals, ratio and certain aspects of algebra, namely pattern recognition and solving equations (in Grade 7). There was no significant change in Grade 6 and 7 learners' performance on many of the items in these content areas.

There were some items on which pupils performed significantly worse after a year of intervention. These were areas which were not taught by MALATI teachers, but in contrast to basic *concepts* such as fractions, we consider most of these to be social knowledge which can be 'taught' in a reasonably short space of time. Examples of these are the definition of parallel lines and rounding off whole numbers. There was also a significant decrease in the performance on some of the decimals items in Grade 6. This was not covered at all in 1998, as we consider a basic grounding in common fractions and equivalence to be a prerequisite for understanding decimal fractions.

Discussion

The disadvantage of an evaluation test such as the one used in this research is that it has to be designed and administered *before* intervention can take place. Inadequacies of the test have become more and more evident as we have developed and implemented our materials and approach. Several MALATI content areas were underrepresented in the test, and we are thus not able to assess our impact in these areas. In addition, during the process of development that the MALATI project workers have themselves undergone, they have reconceptualised much of the content and the resulting material does not always coincide with that which we envisaged when designing the evaluation instrument.

Given the limitations of the evaluation instrument, it is still clear that during the first year of MALATI's intervention in schools, learners acquired certain basic and fundamental concepts which were lacking in the 1997 cohort of learners. There was a significant improvement in most of the items representing the fractions, geometry and algebra content which was taught in 1998. On a small number of items, however, there was no significant improvement although we believed the materials had covered the concepts sufficiently. This has implications for our curriculum development process – these 'gaps' in learners' understanding are being taken into account during the revision of the materials.

It is also significant that learners' understandings improved in some content areas which were in fact not taught. Integrated and transferable knowledge is indeed an important aim of Curriculum 2005, and the success of the intervention is thus more general than in specific strands of content. Project teachers have changed their approaches and learners have improved their thinking skills across the syllabus.

The fact that there was no significant decrease in performance in many of the content areas which were not taught at all in 1998, has implications for the teachers in terms of reflecting on the effectiveness on their previous teaching approaches, and for the project in terms of ethical considerations: By neglecting these content areas, no serious damage was done to these learners in preparing them for the secondary school! For this reason, we prefer to adopt Carter and Richards' (1999) definition of 'covering the syllabus' in a problem-centred approach as "deep engagement with a much smaller set of fundamental themes". We have evidence that when teachers come to better analyse their learners' understanding of such fundamental content areas, they realise that the learners are learning the essential content despite the time problem and become less concerned about 'covering' the traditional syllabus (Bennie, Olivier & Linchevski, 1999).

In conclusion, during the first year of implementation, MALATI project teachers took the time to adjust to a new teaching approach and to teach new content as well as traditional content in new ways. The data presented in this paper shows that they can be assured that the pupils' performance on many of the items representing neglected areas of the interim core syllabus was not negatively affected, in comparison to performance in 1997. Teachers' fears of the consequences of not 'covering' the traditional syllabus were therefore unfounded. The next cohort of learners arriving in Grade 6 and 7 in these schools will all have been exposed to this approach and content for a year and there is now an opportunity to build on their basic concepts and 'cover' the rest of the curriculum in a conceptual way before the end of the phase.

References

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