OBSTACLES TO IMPLEMENTING A NEW CURRICULUM[1]

Kate Bennie and Karen Newstead

MALATI, PO Box 647, Bellville, 7535

The introduction of a new curriculum such as Curriculum 2005 poses a range of challenges to teachers and schools. This paper reports on an attempt by MALATI (Mathematics Learning and Teaching Initiative) to implement the statistics aspect of the Mathematics, Mathematical Literacy and Mathematical Sciences Learning Area, an area of study regarded as a particular challenge for curriculum innovation. Obstacles to the curriculum implementation are identified, including the nature of official curriculum documents, teacher content knowledge, the nature of the topic, differences between teachers' beliefs and the underlying ideology of the proposed curriculum, learner and parental expectations, institutional arrangements, and time restrictions. Attempts to address these factors are also described.

Introduction

The introduction of a new curriculum poses a range of challenges to teachers with regards to the underlying assumptions and goals, the subject demarcations, the content, the teaching approach and the methods of assessment. Curriculum 2005 provides such challenges. South African teachers are currently trying to come to terms with an ideology of outcomes-based education, new learning areas, new content, and the implications of calls for "integration", "contextualisation", "relevance" and "learner-centredness" (Department of Education, 1997). This does not only require that teachers change how and what they teach and assess, but also challenges their underlying belief systems. Furthermore, as noted by Gross, Giacunta and Bernstein (in Snyder, Bolin & Zimwalt, 1992) innovation occurs within a context:

> *Life and death of an innovation are not simply a matter of providing appropriate supports for the innovation and making mutual adjustments as it is being installed. Rather, life and death of an innovation depend on the unique configuration of social, historical, political and ideological factors that make up the school and its social, community context.*

Several factors that can restrict curriculum innovation have been identified in the literature. These relate to both the teacher and the context in which the innovation is taking place. They include issues of time, parental expectations, public examinations, unavailability of required instructional materials, lack of clarity about curriculum reform, teachers' lack of skills and knowledge, and the initial mismatch between the teacher's "residual ideologies" and the principles underlying the curriculum innovation. Other obstacles relate to organisational arrangements such as role overload, rigid scheduling of time, reporting systems, and failure of administration to recognise and understand its role in change (Nolder, 1990; Gross *et al*. as quoted in Snyder *et al*., 1992).

This paper describes an illustration of exactly these obstacles, encountered during an attempt by MALATI to implement the statistics (probability and data handling) aspect of the Mathematics, Mathematical Literacy and Mathematical Sciences Learning Area. These obstacles were encountered in spite of the high motivation of teachers and the fact that they were provided with instructional materials. We also discuss attempts to address the obstacles during the second year of implementation.

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[1] Bennie, K. and Newstead, K. (1999). Obstacles to implementing a new curriculum. In M.J. Smit & A.S. Jordaan (Eds.), **Proceedings of the National Subject Didactics Symposium** (pp. 150-157). Stellenbosch: University of Stellenbosch.

Context

The topic of statistics was selected as a focus of MALATI as it is seldom addressed in South African schools at present and is thus regarded as a particular challenge for curriculum innovation. The Western Cape Interim Syllabus for mathematics requires that learners study elementary data handling in the Foundation Phase and in grade 4 and more formal data handling in grade 9. The extent to which the topic was explored in the past is not known, but observations suggest that at the grade 9 level the topic has been regarded as optional. It also appears that, while some secondary mathematics teachers do have some tertiary experience in statistics, this knowledge is usually in the form of computational techniques and formulae, and there is often little conceptual understanding underlying the use of these techniques.

In Curriculum 2005 statistics is one of the ten Specific Outcomes for Mathematics, Mathematical Literacy and Mathematical Science and is studied in all three phases of general education. Learners are required to collect, organise, display, summarise and critically analyse data. They are also expected to have an understanding of probability and to use methods of counting, neither of which has previously been required of them.

MALATI

MALATI is a curriculum and teacher development project working in project schools in the Western Cape. After undertaking a review of the literature on the teaching and learning of statistics and holding discussions with mathematics educators in the Western Cape and elsewhere, project workers designed materials for the teaching and learning of probability and data handling. These were then trialled in seven (four primary and three secondary) schools.

It should be noted that, in addition to providing schools with learner materials and accompanying teacher notes, MALATI proposes a particular philosophy of teaching and learning. The approach makes use of carefully-selected problems, supported by a learning environment that encourages reflection and social interaction. Teachers do not demonstrate solution methods for problems, but expect students to construct their own strategies, and depend on peer collaboration for error identification and the development of more powerful strategies.

In developing and trialling ideas on curriculum and teacher development, MALATI has had the privilege of working intensively with mathematics departments at a small number of schools. MALATI collaboration with each of the seven project schools was negotiated with teacher and parent bodies. Support for the implementation of the statistics curriculum took the form of an initial workshop with teachers to introduce the materials, daily visits to classrooms by project workers, and ongoing discussions held informally or during "window sessions".[2] The discussions in this paper are based on project workers' observations and written field notes made during the implementation of the MALATI curriculum.

[2] A "window session" is a scheduled period during the school week during which all the mathematics teachers are freed from their teaching duties to meet as a group to discuss and reflect on their work. Discussions centre on issues of content, class culture, assessment etc. MALATI project workers provide support / facilitate the discussion where necessary.

Obstacles Identified

The Nature of the Curriculum Document:

Concern has been expressed about the technical nature of the Curriculum 2005 documents issued to teachers. In some countries documents of this complexity are not actually issued to teachers, but merely serve as a framework for the construction of more accessible documents. Furthermore, Taylor and Vinjevold (1999) point to the difficulty of designing a curriculum framework that achieves a balance between providing specific detail to ensure common learning and to illustrate the "subtle concepts involved in higher order thinking" on the one hand, and providing enough space for teacher interpretation on the other.

While we support these concerns, we would like to point to two other issues. Firstly, we have noted that a number of teachers have not yet received the most basic communications issued to schools regarding Curriculum 2005, let alone the more extensive policy documents. Secondly, we are concerned about the actual construction and accuracy of the document. When designing materials for statistics, we encountered difficulties interpreting Specific Outcome 6 of the official curriculum document (Intermediate Phase Specific Outcomes, 18 May 1997):

- Errors in the construction of the document: In some cases the Performance Indicators of the existing document did not correlate well with the Range Statement concerned, for example, in the case of Assessment Criteria 3, 5 and 6. While it is inevitable that a certain overlap will exist, the lack of clarity may prove confusing for teachers. In addition, the order of the Assessment Criteria could imply that Communication of findings (6) precedes Critical evaluation (7) while this is not necessarily the case.
- Omissions: In the Foundation and Intermediate Phases, we felt that an important component of Range Statement 1.1 ('Identifying situations for data collection') had been omitted, namely a performance indicator which specifies that learners should be able to '*identify relevant variables and ask appropriate questions which can be addressed by the collection and analysis of data'*. We also felt that Assessment Criterion 8 should include the "idea of chance" as an overall concept in addition to "evidence of knowledge of ways of counting".
- Content errors: For example, in Assessment Criterion 2, sampling is given as a method of data collection. In fact it is a process which takes place before the data can be gathered or collected.
- Inappropriate content: In some cases, we felt that the content specified was not appropriate for the given phase, for example the application of statistical tools such as average in the Foundation Phase. Furthermore, as noted below, our trialling experiences have revealed the complexity of learning certain aspects of statistics, and have caused us to reconsider the nature of the Range Statements for this Specific Outcome.

We are concerned that the nature of the curriculum document will confound teachers' attempts to come to grips with a new content area. In attempting to increase the accessibility of this particular Specific Outcome for ourselves and for teachers, we have rewritten the document compensating for the above-mentioned errors and omissions. Furthermore, we have found that the freedom given to teachers and curriculum developers to identify their own Performance Indicators has enabled us to design a statistics curriculum which, based on our reading and experience in schools, we consider as conceptually appropriate for learners. Given the nature of the topic and its relative newness in the school curriculum, it is however questionable whether teachers will be able to do this. It is in this area, therefore, that we believe that materials developers and curriculum development initiatives such as MALATI and the partnership between the Gauteng Education Department and the Gauteng Institute for

Curriculum Development (GICD) have an important role to play in designing and providing frameworks in this regard.

The Nature of the Topic Itself:

The design of MALATI materials is research based – the process takes place after review of the literature and discussion with mathematics educators. Probability is regarded as being a particularly difficult concept to teach for (a) it deals with uncertainty, and (b) the intuitions and experiences that the learner (and teacher) bring to the study of the topic at school can conflict with formal probability (Carpenter, Corbitt, Kepner, Lindquist & Reys, 1981). The point is that, as Ahlgren (quoted in Hawkins & Kapadia, 1992) pointed out in 1989, "It is important to acknowledge that we do not yet know the best (or even a very good) way to teach students probability…".

The trialling of the MALATI probability materials has confirmed claims in the literature as to the complexity of the teaching and learning of this topic (Bennie, 1998). We encountered several examples of learners (and teachers) strongly defending their intuitions, which were in fact in conflict with formal probability. An extensive problem was that of teachers and learners struggling to come to grips with the differences between the everyday and the mathematical use of the language of probability.

In trying to deal with these challenges, we recognised the need to workshop teachers intensively on the content prior to the materials being used in the classroom. In some cases we have had to delay classroom implementation in order to spend more time working with teachers. Furthermore, our experiences have confirmed the importance of recognising rather than ignoring learners' everyday experiences. We encourage teachers to allow for learner discussion that provides opportunities for learners to challenge one another and to revise their earlier ideas. Again, this approach is time-consuming.

Teachers' Content Knowledge:

Related to the challenges provided by the topic of probability is the issue of the content knowledge of teachers, an area of concern in mathematics education in general. Fennema and Franke (1992) note recent research that suggests that teacher content knowledge does influence classroom instruction and the richness of learners' mathematical experiences. This is a cause for concern considering the findings of recent research in South Africa: Summarising the findings of the studies commissioned by the President's Education Initiative (PEI), Taylor and Vinjevold (1999) comment that "one of the most consistent findings of a number of PEI projects pointed to teachers' low levels of conceptual knowledge, their poor grasp of their subjects and the range of errors made in the content and concepts presented in their lessons".

If many teachers are trying to come to grips with the content in the existing syllabi, it is clear that the introduction of new topics is going to place a greater burden on these teachers. Given the complex nature of the topic of probability as noted above, our observations of the difficulties teachers have with both probability and data handling, and the limited extent of training teachers are being given for Curriculum 2005, we are concerned about the implementation of this aspect of the mathematics curriculum.

Our experiences during the first trialling of the MALATI probability materials revealed a frustration amongst both teachers and learners that what was being studied was not "mathematics". While this could be attributed to the underlying beliefs of individuals about

the nature of mathematics or the fact that the content was not previously included in the school syllabus, we feel that teachers' unfamiliarity with the content meant that they were not able to recognise and highlight the mathematics in the topic. For example, a teacher acknowledged that it was only after he had completed a detailed analysis of learner responses to an assessment, that he realised the importance of systematic thinking in our approach to the teaching of probability, and indicated that in future he would emphasise this aspect to a greater extent.

Learners' Pre-Knowledge

The Curriculum 2005 document requires that learners study statistics from grade 1 to grade 9 and the document is designed accordingly for the different phases. When wanting to trial our materials in the senior phase, however, we were faced with learners who had no prior experience of statistics at school. This placed a constraint on the amount and the nature of the work trialled. For example, the grade 9's had to do a number of basic probability activities before the actual mathematics in the problems could be brought out. This led to frustration on the part of learners who viewed the activities as "playing games" and did not view it as "real" mathematics, as well as frustration for teachers at the time being taken up by the topic. This also affected the curriculum development process as it limited the extent to which we could trial the materials and determine the appropriateness of activities for different grades.

Finding the "Time" for Curriculum Development

It has been suggested that if we are going to include a new topic (part of which is recognised as being particularly difficult to teach and learn) in a new curriculum, a certain amount of curriculum development is required. Opportunities for this are difficult to find.

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". We have found that secondary school teachers, who are still teaching according to the interim syllabus, are reluctant to take the time to use the MALATI materials, as they seem to regard other syllabus work as more important. We suspect that this view is influenced by the nature of the final matriculation examination. Even in the primary school where teachers are accustomed to teaching "fractions", "geometry" and "number concept", we find that statistics finds a place only "if there is time". This view of the materials can seriously affect the curriculum development process, for example, MALATI project workers are still struggling after eighteen months to find an opportunity to trial data handling materials in the secondary school. Given the need for research and development in the area of statistics, particularly in the South African context, this lack of opportunity is a cause for concern.

We are finding that, as the implementation date for Curriculum 2005 in different grade levels approaches, so the teachers tend to show more concern about addressing aspects of this curriculum. But we would rather teachers undertook innovations because they recognise or are interested in determining the educational and mathematical value of the innovation. Our challenge, therefore, is to get teachers to reflect on the **mathematical** value of the study of the topic, and not to regard statistics simply as "new content". In fact, during the first year of trialling, teachers did take the time to teach probability and reported finding that there were benefits in the development of learners' systematic thinking, but in the second year of trialling the probability has taken a back seat as teachers try to teach 'core' content such as Algebra and Geometry.

If as teacher developers we are to use the premise that teachers will adopt a practice if they perceive or experience it as valuable, we need to create the conditions in which teachers can test their theories. This is problematic in the case where teachers regard the creation of such conditions as too time consuming given the demands of the existing curriculum. Furthermore, with regard to Curriculum 2005 itself, teaching new content and teaching "old" content in new ways takes time! Teachers can be forced to implement changes, but if they are not given the opportunity to reflect on the innovation and their experiences, they might not be convinced of its value.

Classroom Culture

As noted, much of the work on probability and data handling is suitable for and, in fact, requires co-operative work and discussion amongst learners. For example in the case of probability, learners come to the classroom with varying experiences that are used initially to respond to school probability. These intuitions and experiences need to be unpacked and explored if learners are to develop a meaningful understanding of formal probability – and it is only in a setting in which learners feel safe to discuss their views and to assess the validity of different views that this can take place.

Fennema and Franke (1992) point to recent research suggesting that where the emphasis of the mathematics is placed on problem solving and on the power of learners to do and understand mathematics, learners are engaged in rich mathematical discourse with peers and teachers. This is particularly relevant in the case of probability in which, as noted above, such a discourse is regarded as being necessary for an understanding of the topic. Research in South Africa, however, suggests that the creation of such a discourse community in the classroom is not going to be easy: The work of Reeves and Long, Setati and the Primary Mathematics Project as quoted by Taylor and Vinjevold (1999) indicates that much of the classroom discourse does not proceed beyond the procedural level. It was also observed in a number of PEI studies that, although learners might be seated in groups, little interaction takes place amongst learners.

While acknowledging the role that the introduction of new topics into the curriculum can play in challenging and broadening teachers' views of mathematics, we are concerned by the challenge put to teachers and learners by Curriculum 2005 to explore new topics like probability **as well as** to tackle all the other demands created by curriculum change as discussed in the introduction. This is of particular concern in the light of the limited training being provided for teachers on the implementation of Curriculum 2005. For example, teachers in MALATI project schools used the probability materials during the first weeks of our collaboration with the schools. Consequently the teachers had to come to grips with a new content area as well the accompanying MALATI philosophy, many aspects of which were new to these schools. The topic took a lot longer to study than originally proposed as teachers struggled to deal with the interference of learners' everyday experiences with the school probability being taught. It was also clear to MALATI project workers that learners in these classes were not accustomed to constructive group discussion, to listening to one another and generally to taking responsibility for their own learning. After using the MALATI materials for the first time, one teacher commented that he would have preferred to start with a topic with which he and the learners were more familiar and use this context to establish the required culture of learning in his classroom.

We would question whether the study of more "traditional" content is, in fact, the right context for developing the classroom culture required by Curriculum 2005, but we recognise

this teacher's concern about having to cope with too many demands and innovations early in the period of change. Brombacher's research in the United States indicates that when teachers are challenged to bring about organisational and philosophical changes in their classrooms, the mathematics can be lost (1998).

Acknowledging the urgency for reform in mathematics education as articulated in policy documents as well as the need to introduce new content into the new curriculum, we feel that the issue of teachers' content knowledge needs to be dealt with creatively and sensitively by teacher developers. The challenge is to present new content in a meaningful and non-threatening way. We have attempted to "model" aspects of classroom culture in content workshops and to make these explicit to teachers. Further, we would like to test our conjecture that, **given the provision of appropriate support for teachers**, new content might, in fact, be an appropriate way of introducing other aspects required by a new curriculum. For example, a content area such as probability that requires productive discussion amongst learners, might be a vehicle for challenging teachers to focus on group work in their classes.

In considering the impact of our attempts at curriculum implementation, we need to consider how the culture promoted by MALATI related to the existing culture in the school. Nickson (1992), for example, uses research on classroom culture to suggest that this culture will depend on "the actors" in it. He suggests that the unique culture in a classroom is the product of what the teacher and learners bring to it in terms of knowledge, beliefs and values. Furthermore, all participants do not necessarily share these ideas. This suggests that the existing culture in South African schools is going to have an important influence on the implementation of Curriculum 2005!

The Social Context of Schooling

Schwartz and Cavener (1994) note that "Schools are culture systems of human relationships, traditions, ideas, attitudes and ways of doing things". Our experience in attempting to implement a statistics curriculum has reminded us that mathematics is very much part of this system, for we have not only had to deal with teachers' beliefs about mathematics and mathematics teaching and learning, but also the beliefs of administrators, learners and parents. After a just few weeks of studying probability, secondary school learners began to question whether they were studying mathematics and asked when they would do "real maths with x's and y's". Due in part to the nature of the contexts used to study the topic, learners were experiencing probability as "playing games". Parents who challenged teachers about their children learning about "ice-creams" and "soccer", two contexts used for the study of probability, echoed this concern. Some parents expressed concern about their inability to assist their children with their mathematics. It appears that, in implementing a new approach and introducing new content, MALATI project workers and teachers neglected to negotiate the proposed changes with other role players, in particular the learners. Our experiences in this one learning area suggest the problems that could be encountered with Curriculum 2005 in general.

Taylor and Vinjevold (1999) note the need for systemic change in the implementation of a new curriculum and this has been confirmed by experiences in schools. After eighteen months of collaboration with MALATI, many teachers have embraced the MALATI philosophy of teaching and learning. However, they continue to struggle to create a problem solving approach and an enquiry classroom culture, and to implement new assessment methods. This is partly due to the fact that they are working in settings that can be

unproductive, have unpredictable time schedules and timetables, use traditional methods of assessment and in which colleagues do not follow a similar philosophy. Recognising the limits of working in the field of mathematics only, we have opted for trying to encourage reform from within, that is by encouraging mathematics teachers who are experiencing frustrations and a sense of uneasiness about the systems in which they work, to use their experiences while working with MALATI to motivate for wider changes in their school systems.

Conclusion

At MALATI we are privileged to work intensively with motivated teachers and to focus on particular aspects of the mathematics curriculum. These teachers have also been provided with the necessary instructional materials. In the case of Curriculum 2005 we are not assured of these privileges. Bearing this in mind, our experiences working on one aspect of the learning area Mathematics, Mathematical Literacy and the Mathematical Sciences discussed in this paper illustrate the complexity of curriculum reform. We acknowledge that some of the difficulties noted are related to this specific learning area, but we feel that many of the issues discussed apply to curriculum reform in general. We feel that the obstacles identified are not specific to new content, but also apply to traditional content being taught within a new approach. Taylor and Vinjevold use the results of the PEI studies to conclude that, while there may be support for Curriculum 2005 amongst teachers, "few teachers have been able to translate the very complex logic of Curriculum 2005 and its vaguely stated outcomes into appropriate learning programmes, and to effectively mobilise student-centred learning". In this paper we have attempted to illustrate the range of practical demands placed on teachers and the challenges to their basic beliefs involved in making this "translation".

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