

***HOW TEACHERS USE INSTRUCTIONAL MATERIALS IN TEACHING JUNIOR
PRIMARY MATHEMATICS, WITH SPECIFIC REFERENCE TO THE MATHS
CENTRE FOR PRIMARY TEACHERS***

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DECLARATION OF ORIGINALITY

I, Thulisile Cheryl Dlamini, declare that this research report "HOW TEACHERS USE INSTRUCTIONAL MATERIALS IN TEACHING JUNIOR PRIMARY MATHEMATICS, WITH SPECIFIC REFERENCE TO MATHS CENTRE FOR PRIMARY TEACHERS" is my own work and that all sources I have used or quoted have been indicated and acknowledged by means of complete references.

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DURBAN

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ABSTRACT

This is an empirical study of how teachers in the Maths Centre for Primary Teachers project use instructional materials in teaching mathematics in junior primary schools. The key question of the study is whether teachers use instructional materials in ways that promote quality education. Instead of being guided by the "school effectiveness" paradigm, one which is based on a production function model, this study adopts an approach used in "quality education" research which argues that it is not simply the availability of instructional materials, but the effective use of instructional materials that determines quality instruction, and in turn quality education. Huberman's model of a teacher as an independent artisan describes the role of a teacher I envision as one that is likely to bring about improvements in the quality of instruction. The approach adopted in Huberman's model emphasises teacher-centred methods. (Teacher-centred does not mean "not child-centred", but simply focuses on what role the teacher needs to play).

In this study it was found that, with regards to certain aspects, teachers used instructional materials in ways that were appropriate and contributing to improvements in the quality of education. Teachers valued MCPT materials for their power to illustrate and teach mathematical concepts. Teachers applied methodologies that were informed by a constructivist theory of learning, within a classroom environment conducive for this. However, teachers hardly prepared and used their own materials, and they presented MCPT materials in ways that deprived them of opportunities for teacher development in curriculum management. It is argued, therefore, that there is need for advanced training of teachers on the use of instructional materials - training that enables teachers to use materials in ways that fit in with their design of classroom curriculum.

Introduction

The purpose of this study is to examine how teachers in junior primary schools use instructional materials in teaching mathematics, with special reference to the Maths Centre for Primary Teachers (MCPT). The crucial question about the use of instructional materials is whether it improves the quality of instruction, and that of mathematics in particular, which would in turn, contribute to improvements in the quality of education.

The post-Apartheid ministry of education is faced with a formidable and onerous task of normalising an otherwise very chaotic situation in the South African education system. The severe national financial constraints, the glaring lack of a culture of learning and teaching, the low matric passrates and the crisis over millions of unemployable school leavers has compelled the government and policy researchers to closely examine issues of "school effectiveness" and "education quality" (Adams, 1993).

The "school effectiveness" research studies effects of a set of inputs, such as classrooms, laboratories, libraries, qualifications of teachers, textbooks, on student performance. This is based on a production function model, which assumes that a lack of a single or a set of these inputs leads to poor student performance (Jansen, 1994). Researchers of "school effectiveness" identify the availability of textbooks or instructional materials in the classroom as necessary inputs needed to make schools effective (Heyneman and Jamison, 1978). An important contribution made by these researchers is their conclusion that the availability of textbooks is associated with student achievement. Research conducted in the "school

effectiveness" paradigm is therefore concerned with availability and the numbers of textbooks available to students.

In South Africa, under the Apartheid government, the question of the availability of textbooks was a political issue. In many black areas plagued by poverty, textbooks were the primary source of any meaningful learning. Therefore politicians and teachers were primarily concerned with the free supply of textbooks and the timely arrival of such books, and not so much the content. In other developing countries, especially in Zimbabwe, the focus has also been less on content, and more on the development of low-cost materials (Commonwealth Secretariat, 1991). In the Falkland Islands there has been a lot of talk about how best to adapt instructional materials produced in first world countries (Commonwealth Secretariat, 1991).

However, some researchers have now begun to shift their focus from issues of "effectiveness" to issues of school "efficiency" and education "quality". Researchers of "education quality" argue that the presence of these inputs does not necessarily improve education quality. What needs to be understood is: "how certain classroom factors (inputs) interact in real contexts" (Jansen, 1994, original emphasis). Policy researchers are increasingly pointing out the need to get a glimpse of the "insider perspectives" (Jansen, 1994), and to closely examine school based and even classroom inputs and their utilisation by teachers and pupils (Fuller, 1985; Chetty, 1992).

Researchers of "quality education" believe that it is how the instructional materials are utilised that will make a difference to the learning of pupils (Montero-Sieburth, 1989;

Commonwealth Secretariat, 1991). Indeed, the delivery of textbooks in the classrooms does not necessarily raise student achievement. Many can attest to the fact that in some African schools, teachers rarely use textbooks but keep piles of them in their cupboards for fear of them getting lost. Even where they are used, it cannot be assumed that their utilisation brings about a change in the classroom practice, which could result in quality instruction. There is, however, evidence from the World Bank research that the provision of textbooks, amongst other strategies, does contribute to quality improvement (Verspoor, n.d.).

Very little research has been carried out in South Africa which begins to address issues of utilisation of inputs. Even though the National Education Co-ordinating Committee (NECC) - a powerful umbrella organisation for the education resistance movement during the 1980's - and schools demanded that the Department of Education and Training (DET) supply textbooks (City Press, May 7 1991) little is known about how teachers use these textbooks. Several non-governmental organisations (eg. Science Education Project - SEP; Open Learning Systems Education Trust - OLSET; Independent Teacher Enrichment Centre - ITEC; and Maths Centre for Primary teachers - MCPT) in the country are increasingly producing innovative instructional materials. While these organisations are evaluated, very little is done to qualitatively evaluate implementation and teacher interaction with their innovative materials in the classrooms.

For years matric student performance in mathematics in African schools in South Africa has been poor. While low performance could be attributed to a lack of qualified teachers and textbooks, little is known about the methods teachers use in teaching mathematics, and even less is known about how they use instructional materials in teaching mathematics.

The Departments of Education send lists of prescribed books to schools for subject teachers to select books they want to use in their classrooms and request teachers to send requisitions to the departments. This method is not only prescriptive and excludes teachers from giving input on the selection of textbooks, but it discourages teachers from trying out a variety of instructional materials in their classrooms. Thousands of books continue to be sent to schools, but they have been subject to a lot of criticism. According to Macrae (1994), these books are: firstly, authoritarian; secondly, written by non-reputable authors; and thirdly, lack humanity - they do not contain African names.

Two main problems arise out of research conducted in the area of instructional materials. Firstly, it concentrates on the use of textbooks to the exclusion of other instructional materials such as manipulative materials. Martha Montero-Sieburth (1989) describes instructional materials as comprising of two categories: textbooks, which are the most basic of all learning materials, and other materials which include word cards, worksheets, notebooks, fact sheets, various forms of audiovisual materials, homemade materials from the environment, and programmed materials.

In South Africa, especially in African rural, farm and township schools, there is not much of a tradition of using manipulative materials in the teaching of mathematics. However, there is an increasing interest in that regard as many non-governmental organisations, such as Maths Centre for Primary Teachers - MCPT, Co-operative Organisation for the Upgrading of Numeracy Training - COUNT, Change Agent for Primary Mathematics Education - CAPME and Rhodes University Mathematics Education Programme - RUMEP, which work mainly with disadvantaged schools, develop or encourage the development of materials for

effective instruction of mathematics. As this work continues and grows in the country there are some pertinent questions about the way teachers use instructional materials (textbooks and manipulatives) that need to be answered.

Secondly, very little classroom-based research has been documented about how teachers use textbooks or any materials for that matter. I am aware of one such study conducted by Jeanne Moulton (1994). Moulton, believing that it is not sufficient just to know whether pupils have textbooks or not, has recently conducted a literature review of what research says about teachers' use of textbooks in their instruction. Moulton asserts that many researchers and evaluators are often interested in the content and format of the books: whether they have any ethnic and gender biases, and whether the language is appropriate for the level of children. Usually they ignore how teachers help pupils learn from the textbooks.

Two important findings were made in Moulton's study. Firstly, teachers in developed countries tend to "over use" textbooks, compared to teachers in developing countries who appear to "under use" them. Secondly, teachers' practices with regard to the use of textbooks vary considerably. Based on these findings Moulton suggests that there is a need for more in-depth studies to investigate teachers' different practices, and what these tell us about the quality of instruction.

Quality education researchers examine the effectiveness of teaching and learning - the classroom processes, the quality of academic activities and tasks, the time spent on engaging students in learning - as indicators of quality (McGinn, 1989; Montero-Sieburth, 1989). For some researchers the crucial question is whether the use of instructional materials does make

a difference in the lives of learners (Atkin, 1994).

Some of the pertinent questions this study aims at addressing are: do instructional materials bring about a change in the teaching styles of teachers; do they bring about a change in the way learners learn the mathematics subject; do they create and maintain interest in the learners; are instructional materials tools for teacher development; do they contribute to raising teachers' level of confidence; and what support do teachers need in order to enhance the effectiveness of materials?

The primary audience for this study can be divided into three groupings: the teaching fraternity, policy researchers, and mathematics non-governmental organisations. Each of these need to be informed about the methods that have the greatest impact on teaching and learning practices for better results to be realised in our education system.

Background to the Study

The MCPT is a non-governmental organisation which provides INSET training to junior primary mathematics teachers in Soweto. For the past ten years the MCPT has been working in collaborative action research with local teachers to develop effective alternative educational practice. MCPT believes in classroom practice which is informed by constructivist methodologies, such as activity-based teaching, promotion of independent and creative thinking, problem solving, and constructive challenge and debate in the classroom.

During their ongoing workshops the MCPT collaborated with teachers to develop alternative instructional materials. The instructional materials consisted of booklets and an equipment kit containing manipulative materials such as number cards, counters, shapes and many others. The mathematics booklets were produced, and they were to be used in accompaniment with the equipment kit.

The development of MCPT instructional materials was partly an attempt to address some of the concerns the MCPT had with regard to the development of educational materials. Firstly, the MCPT felt that the curriculum policy issues in South Africa had for years been an exclusive domain of the "elite experts (such as government agencies or universities)" (MCPT, 1994) who research, develop, evaluate and disseminate these curricula to schools for teachers to implement unquestioningly. MCPT felt that such a process disempowered teachers and actually mitigated against the implementation of change. Secondly, they thought that top-down structures often functioned in ways that created power for the dominant group while antagonising the others. Thirdly but important, was the fact that top down structures centred around the interests of the universities, and little attention was paid to the needs of the learners and the contexts within which they were situated.

The second set of concerns MCPT wanted to address had to do with the last point above. MCPT's goal therefore was to produce instructional materials which would:

- (i) be pedagogically effective;
- (ii) increase learners' mathematical understanding through a variety of games and activities;
- iii) be low cost and easy to reproduce;

- (iv) develop "language-in-action strategies for facilitating second language speakers to develop facility in both English and formal mathematics terms" (MCPT, 1994); and
- (v) test the efficacy of an investigative model.

The MCPT instructional materials were implemented in about fifty classrooms in Soweto during 1994. The MCPT had developed a phased model to support teachers in effecting change in their classrooms. Initially, schools approached the MCPT for assistance. Aims and methodology were discussed, and modelled in classrooms. A collaborative relationship was negotiated. MCPT facilitators then worked with all interested teachers (most commonly the entire junior primary staff) to find ways to implement and sustain change. The intervention took the form of in-depth classroom support. These were usually four hourly sessions a week lasting about three weeks, depending on teachers' needs. The initiative and responsibility for change was gradually shifted from the MCPT staff to teachers. The classroom work was further supported by weekly workshops for all participant teachers.

The MCPT teachers were at different levels of their implementation of the MCPT materials because they joined the MCPT programme at different times. Some teachers were involved with the MCPT during MCPT's initial stages of work when the enquiry-driven methodology of teaching was introduced to teachers. Other teachers had recently joined the MCPT when there were already instructional materials developed.

At the time of the evaluation (October, 1994) most schools which used MCPT materials were using them independent of facilitators. Facilitators and authors of the MCPT booklets paid

these teachers periodic visits in order to sustain motivation and provide assistance where difficulties were experienced.

In order to make informed decisions about further development, printing and dissemination of the materials, the MCPT contracted the Improving Education Quality (IEQ) Project to conduct an evaluation of the materials. The IEQ appointed one of its researchers (myself) to conduct this evaluation. I completed and delivered the evaluation report to the MCPT in December 1994.

I found the evaluation conducted in 1994 to be important in that some lessons could be learnt from the way teachers use instructional materials, if these practices were further examined within a broad debate on improving the quality of education. These lessons are necessary in informing the reconstruction and development processes that are currently taking place in the South African education system.

Theoretical Overview

The premise structuring this study is that teacher's use of instructional materials, among other strategies, determines the quality of instruction. A teacher is central to the effectiveness of instructional materials. Hence, some studies have strongly argued that the delivery of instructional materials should always be accompanied by teacher training on the use of the materials (Verspoor, n.d.; Montero-Sieburth, 1989).

The above idea concurs with Verspoor's view that the use of instructional materials by teachers is developmental, dependent on resources available and professional support teachers

receive. In terms of raising quality in education in developing countries - where there is no sign of any textbooks or materials, where teachers are often not trained, poorly motivated, isolated and have no professional support - the availability of textbooks is the fundamental step towards improvement in quality (Fuller, 1987). Once the materials are there the second stage is to pay attention to introducing some diversity in instructional techniques (Verspoor, n.d.). This is crucial because the delivery of textbooks and materials in the classrooms does not necessarily lead to their effective use by teachers. Verspoor says the second stage is the "mechanical stage", where the teaching techniques used by teachers can be described as:

Memorization: slavish adherence to curriculum, short-term activities and objectives: rigid application of one instructional technique (Verspoor, n.d.: 54).

Verspoor further argues:

When teachers have developed sufficient subject mastery and self-confidence to attain the upper levels of the mechanical stage, objectives to improve quality can become more ambitious...The availability of textbooks and instructional materials will also need to become much more diversified (Verspoor, n.d.: 54).

Before we consider what researchers suggest are appropriate ways of using instructional materials, let us briefly examine the philosophies of education underpinning the use of materials in the MCPT project.

MCPT believes in "classroom practice which is informed by constructivist methodologies". While there are many brands of constructivism, what is common among all is their belief that knowledge is not transmitted from a teacher to a learner, but is actively constructed by a learner. The theoretical underpinnings of constructivist theory of learning are epistemological and are advanced by von Glasersfeld (Cobb, 1994).

In fact, MCPT materials embody an eclectic methodology that borrows from both the radical constructivist epistemology and a socio-constructivist theory of learning. In radical constructivism learners, as individuals, are perceived as active constructors of knowledge and, in this case, constructors of mathematical concepts. Within this theory, the role of a teacher is that of "becom[ing] less of a dispenser of knowledge, but rather a facilitator of learning, supporting and guiding the child to construct his own" (Olivier quoted in Parker, 1994: 23). Socio-constructivism perceives learning as effectively occurring where learners actively construct and share learning in a social setting. From this perspective the role of the teacher is that of creating an environment conducive to "social (group) interaction which mediates cognitive (individual) reflection through discussion and negotiation of meaning..." (Olivier quoted in Parker, 1994: 27).

Constructivism, in its broadest sense, has become widely accepted as an authentic innovation by most contemporary mathematics researchers. I believe that the search for better theories of teaching and learning are driven by the need to improve the quality of instruction, and in turn the quality of education.

Informed by their belief that children need to manipulate materials in order to construct knowledge, discover and learn mathematical concepts, constructivists do not simply emphasise the need for textbooks, but perceive instructional materials as a whole forming an essential tool for instruction in every classroom. The question is how do teachers use these instructional materials to create an environment in which learners can actively construct their knowledge and demonstrate their creativity.

A theory of how teachers should use instructional materials has been advanced by Dougherty and Scott (1993), and is perceptively and fully developed by Huberman (1993).

Dougherty and Scott maintain that textbooks or any other printed materials, should be used as resources, from which a teacher selects material that is relevant and appropriate in terms of content and context. The danger in using any textbook like a bible or as a source of the entire classroom curriculum is that "the philosophy of the textbook [becomes] the driving force of the classroom curriculum in both content and instructional aspects" (Dougherty and Scott, 1993: 298). Montero-Sieburth (1993) argues that instructional materials developed by education departments or commercial publishers to meet national goals of education or the syllabus, may not necessarily meet the personal needs of teachers. For this reason, she and other educators recommend that teachers develop their own materials, which will reflect their perceptions, beliefs and expectations of their children.

To develop and illustrate his theory, Huberman compares a teacher to an independent artisan.

I find his model fascinating:

Let us imagine, for a moment, the classroom teacher as a tinkerer or an instructional handyman, a do-it-yourself craftsperson who can put to use a host of materials lying around at various stages of a construction or repair job. ...As our tinkerer accomplishes a succession of different tasks with ever-varying combinations of the materials made to fit the purposes of each job, he or she develops an increasingly differentiated and integrated set of procedures, representations, and algorithms for reading the next task to be accomplished and for knowing which materials will be required at the outset (Huberman, 1993: 14).

Indeed, the teacher's profession is unique in that teachers interact and work with children who come from different home backgrounds, economically and culturally; who are at different developmental stages; and who also bring with them different life experiences.

From this perspective, no single philosophy, principle or approach is guaranteed to work in all situations, or to solve a particular problem that may arise. Similarly, predetermined lesson plans containing a series of sequenced activities are not guaranteed to work. From this perspective, the role of a teacher becomes very challenging, and demanding. In Huberman's model a teacher is envisioned

as creating or repairing learning activities of different kinds with a distinctive style or signature. He or she adapts on the spot the instructional materials that have been bought, given, or scavenged, as a function of the time of day, the degree of pupil attentiveness, the peculiar skill deficiency emerging in the course of the activity, the little unexpected breakthrough on a grammatical rule, and the apparent illogic to the children of mathematical bases other than 10. In doing this, the teacher relies heavily on concrete bits of practice that have proved successful in the past but that must be reconfigured as a function of the specific situation in the classroom, in order to make them work (Huberman, 1993: 15, emphasis mine).

It is clear that Huberman's teacher is one who is versatile, who through the years of teaching has gained a wealth of experience which enables him to design lessons which match the developmental stages of his learners, constantly assesses learners' understandings and accordingly adapts, improvise and formulates thought-provoking problems suited to the developmental stages of his learners. Huberman's model focuses on teacher-centred methods, and it is important to say that this does not mean that teaching is not child-centred.

The model of a teacher suggested by Huberman seems to match that of constructivists Kamii and De Vries in De Vries and Kohlberg (1990: 84). They maintain that the role of a teacher is:

To provide materials, suggest activities, and assess what is going on inside the child's head from moment to moment. ... In general, the teacher tunes in and picks up on children's reactions and ideas rather than trying to impose her own predetermined goals. Proposals focus on action rather than on verbal answers to questions. Assessment is a continuous process. By watching what the child does and says, the teacher who is well acquainted with the child and with Piaget's theory can gain many

insights into what the child is thinking. These insights help her decide what to do next.

Teachers carry heavy loads of teaching tasks and at the same time have administrative duties to execute, in addition to all other pressures of life. For this reason, some teachers might like the idea of a book which might simply be followed in a parrot fashion because that would make their work easier. While this might seem attractive, it, however, deprives the teachers of the opportunity to take control of classroom curriculum. Dougherty and Scott (1993) are firm believers of the need for a teacher to take control of the classroom curriculum. They maintain that teachers must decide how to teach a topic, what topic should be covered in a day, how much time to spend on a topic, what supplementary materials to use, and what the objectives of a lesson are. It is important to note that this approach should not be understood to mean that teaching will not be child-centred; but it simply means that teachers are better enabled to create an environment conducive for child-centred teaching. Dougherty and Scott argue that this approach places responsibility on teachers and emphasises professionalism needed in making decisions. Indeed, teachers who develop this professionalism in their careers, can only be the ones to meaningfully contribute to broader debates about the improvement of the quality of education.

The MCPT programme, based on constructivist ideas of teaching and learning, provide teachers with an opportunity to try out using instructional materials in ways that promote quality instruction. Huberman's model of a teacher fits in perfectly well within the frameworks of constructivism. If teachers are found to value the instructional materials; if the use of materials transforms classroom practice, and empowers teachers to take full control of the classroom curriculum, it could be said that great strides have been made to improve the quality of education.

CHAPTER 2

RESEARCH DESIGN

The purpose of this study is to examine how teachers use instructional materials in the teaching of mathematics in junior primary schools.

Critical Questions

The key question of the study is: do teachers use materials in a way which promotes "quality education", and specifically:

- (i) Do teachers value instructional materials?
- (ii) Do teachers use instructional materials in a manner that promotes meaningful learning by pupils?
- (iii) Does the preparation and presentation of instructional materials by teachers provide opportunities for teacher development?
- (iv) What support do teachers need to enhance the impact of the materials?

Data Collection

Empirical data for this study were collected in two phases. For phase I, I collected data

between June and October 1994 in fifteen Soweto classrooms for purposes of the evaluation. For phase II I collected data in August 1995 in five Soweto classrooms. The purpose of collecting data in 1995 was to supplement the data that was available from 1994, and to focus data collection activities on those aspects that were not given prominence in 1994, and yet very important in this study.

Most of the data collected was qualitative in nature, and therefore it was necessary to conduct repeated classroom observations, use as many different data collecting techniques and sources as possible. I studied all of this data closely and I further investigated emerging patterns of behaviours in order to arrive at conclusive judgements. In all, I conducted twenty five observations with fifteen teachers who participated in the study. Some teachers were observed more than once.

I spent an hour and a half to two hours in each classroom, during which time I observed the teacher teaching, observed children working on assigned tasks, and interviewed the teacher.

Data Collection Instruments

To answer the above critical questions, I designed and used the following instruments:

(i) Structured questionnaires

I used self-administered, structured questionnaires to collect quantitative information on teachers' perceptions about the MCPT materials. See Appendix 3.

(ii) Interview Schedule

I conducted semi-structured interviews with teachers in order to collect in-depth information about their perceptions of MCPT materials. Interviews were conducted after the teachers had been observed teaching and using the instructional materials. These interviews also served to clarify for myself issues that were not clear from the lesson presentations. See Appendix 4.

(iii) Classroom checklists and classroom observation schedules

I used classroom resources checklists to collect data about the physical attributes of the classrooms. In the same classrooms, using the observation schedules, I observed the usage of materials by teachers, the usage of materials by pupils, teacher interactions and pupil interactions. The checklist required me to simply indicate by Yes or No next to each of the resource items in a classroom, as well as a descriptor of teaching or learning practice. See Appendix 2.

(iv) Teacher Profile

Teacher profile data forms were used to collect information about teachers who were using MCPT materials. The instrument gathered information about teachers' formal education levels, teaching experience and experience in involvement with MCPT. See Appendix 1.

(v) Questions for Classroom Observations

I used a list of questions, covering a number of aspects of teachers' and children's use of materials. The purpose of this instrument was to guide and to assist focus observations.

(vi) Other instruments

The other data gathering activities that I completed were observing children carrying out assigned tasks; talked to them and collected exhibits of their written work; observed and interviewed MCPT facilitators facilitating in schools. No instruments were drawn for these particular data collection activities. I investigated a model of implementation via the MCPT facilitators who worked with teachers in lower classes (Sub A and B). These teachers had not started using MCPT textbooks yet, but "are being prepared for future use of MCPT textbooks". The evaluator observed two facilitators in each classroom.

Data Analysis

I conducted both quantitative and qualitative data analysis. In the case of a questionnaire survey and a classroom checklist, I made frequency calculations. In the case of qualitative data coming from teacher interviews and teacher profiles, I made preliminary observations which I retested in subsequent multiple classroom observations. I analysed these findings further in order to arrive at the best possible explanations of what was observed.

I reviewed and interpreted all of the data I collected in 1994 as well as the additional data I collected in 1995 in order to develop a formal theory which explains how teachers use instructional materials.

Sample

I selected a purposive sample of fifteen teachers which was representative of the different levels of involvement in MCPT activities. Some teachers had had a long relationship with the MCPT, had attended MCPT workshops and had had intensive facilitation on the use of MCPT materials in the classrooms. Other teachers had had a brief relationship with MCPT, they were using the MCPT materials and therefore had started attending MCPT workshops and meetings.

During the second round of observations in 1995, I took a random selection of five Soweto teachers who were using MCPT materials. All five teachers were among those I had observed in 1994.

Validity Concerns

To increase the reliability and validity of the findings in this study, I undertook the following measures:

(i) Pilot Study

After I had developed the first set of evaluation instruments, I tested them in schools in June

1994. I documented my observations in a pilot study report. The process of documenting the results of the pilot study helped me to think through the issues, helped me to focus the study, pointed out the best possible data collecting techniques, and ways of refining the already existing instruments.

(ii) Multiple classroom observations

Given the qualitative nature of the large part of the study, multiple classroom observations became necessary in order to avoid as much as possible any misrepresentations of what was observed in the classrooms.

(iii) Co-observer

Prof. M. Atkin, a visiting lecturer from Stanford University, and a consultant to the IEQ, conducted classroom observations in six classrooms within a period of three days in 1994. My observations were analysed and reviewed in the light of his observations and experiences, which he shared with me both orally and in writing.

(iv) Reference Group

The reference group consisting of mathematics and evaluation experts was set up to review and make recommendations to the evaluator. This ensured that findings were valid and could be relied on.

Organisation of the Findings

Prior to findings, a summary of the profile of teachers who were observed, as well as the summary description of the classrooms observed will be presented. The findings will be presented by addressing each critical question. For each critical question, there will be objectives, and an explanation of how the objectives were measured.

Female:	14
Male:	1
Average teaching experience:	12
Academic Qualifications:	
Teachers with a Std 8	1
Teachers with a Std 10	14
Teachers with a degree	0
Teachers studying towards a degree	3
Professional Qualifications:	
Teachers with no training	1
Teachers with post Std 8 training	7
Teachers with post Std 10 training	5
No response	2
Other INSET training attended	0

As shown in Table 1, the majority of teachers who were observed were female, and only one was male. Their average number of years of teaching experience was 12 and the mean was 14. The majority of teachers (14 out of 15) had satisfied the requirements of

the education departments which stipulated that every teacher should have a minimal qualification of Std 10. A few teachers had begun studying towards a junior degree. The large number of teachers (12 out of 15) had received teacher training, while one had no training, and two did not respond to the question. None of the teachers observed had attended mathematics in-service training other than that of MCPT in 1993.

A summary description of classrooms observed

All the classrooms observed fell under the Department of Education and Training (DET). The DET had in the past few years put some effort in building, repairing and furnishing classrooms. As a result, all classrooms observed had doors, no broken windows, electricity, and heaters. The heaters were not always provided by the DET; some of them had been donated by various funders. So, even though earlier observations were conducted during the middle of the Transvaal winter, the temperature in the classrooms was usually one that was comfortable. Despite the location of schools in the townships, there was never any noise which disturbed learning and teaching inside the classrooms.

Out of 15 classrooms observed, 8 of them had a rich and stimulating environment. These classrooms had walls which were adorned with bright multi-colour pictures and teacher-made posters. Posters covered a wide range of subjects. However, it was noticed that almost all classrooms did not have mathematics posters. One class had lovely flower pots which added beauty and warmth to the environment. It seemed that some teachers took a lot of trouble to make their classrooms attractive. It was noticed that there seemed to be a high correlation between teachers who took trouble to make their working places

attractive, and those teachers who taught well and looked confident in their teaching.

The average number of pupils in a class was thirty nine, and the mean was thirty six. Except for one classroom, pupils were seated in two-seater desks in either groups of four or groups of six. This arrangement of desks gave teachers plenty of room for movement during pupils' activities. It was only in one classroom where desks were arranged in the conventional way with all desks in rows facing the front. In all classrooms boys and girls were mixed together.

Children kept their books in their bags which were on the floor. In some classes all the equipment was kept in the teacher's cupboard. In others they were kept in the big class bookshelves alongside the walls, where they were readily available to the pupils. On top of the bookshelves were old ice-cream boxes which contained counters for mathematics activities.

CHAPTER 3

FINDINGS

A. DO TEACHERS VALUE INSTRUCTIONAL MATERIALS ?

- Goal:**
- To assess the frequency with which teachers used materials;
 - To assess accessibility of materials to pupils;
 - To assess teachers' perceptions of materials;
 - To assess if there were attitudinal changes as a result of the use of materials.

To assess the frequency with which a teacher used materials as well as assess the accessibility of materials, I used a classroom checklist. The checklist required me to simply indicate with a NO or YES if materials were visible, displayed or used during the lesson. I used teacher interviews to assess teachers' perceptions of materials and their attitudes towards mathematics as a result of the use of materials.

Findings

There was no doubt that the booklets plus the accompanying equipment were invaluable to the teachers. All teachers used these materials almost on a daily basis. Pupils' booklets, and items in the equipment kit such as counters, were worn-out from constant use.

The accessibility of booklets and manipulative materials varied considerably with different

teachers. Some teachers allowed pupils to keep the booklets with them, while others kept them away from pupils and only handed them out to them during the mathematics lessons. Some teachers kept equipment kits in shelves that were accessible to learners. Others kept equipment kits in the teacher's cupboard, and could only be taken out either by the teacher or selected pupils who were group leaders, who had been assigned that task. During interviews teachers said that giving out the booklets and equipment kits only during the lessons ensured that materials were kept neat and safe from wear and tear.

The display of wall charts, posters and other learning materials by teachers varied from classroom to classroom. There were classrooms whose environment was rich and stimulating, with colourful teacher-made posters and materials that covered a wide range of subjects. However, very few classrooms had display materials on mathematics. At the other extreme, there were classrooms that were almost bare, cold and uninviting.

During interviews teachers reported a significant change in their attitudes towards teaching mathematics. Some teachers confessed that before they used MCPT materials they loathed teaching mathematics, but only did so because they were required to teach the subject. Attitudes towards teaching mathematics were negative for two reasons.

Firstly, teachers found the methods they used to be difficult for their pupils. Teaching the computation of division, in particular, to pupils using the conventional method was the most difficult task, said most teachers. With instructional materials and manipulatives, in particular, they found concepts could be better illustrated, and their teaching was made effective.

Secondly, teachers knew all the time that their teaching would be effective if they used teaching aids. Most teachers said they asked pupils to bring to school such items as bottle tops, small stones, and others, to be used as teaching aids. However, this never worked well because there were never enough materials. For teachers, who for many years struggled to find teaching aids, the MCPT manipulatives provided the solution.

Thirdly, some teachers had, out of frustration, abandoned their DET-prescribed mathematics textbooks. These were written in vernacular and for a large number of schools whose internal policy had changed to that of using English as a medium of instruction, they were useless. Within the context of this desire to enforce the new language policy, teachers welcomed the MCPT booklets as they are written in English.

As a result of using MCPT instructional materials, teachers confessed that they had developed intense passion for maths. In the words of one Rishile Junior Primary school teacher:

"I love maths now, I forget I have other subjects to teach"

I found most teachers' preparedness to have an observer in their classrooms while teaching to be unusual. This was indicative of a positive attitude and an improved level of confidence that teachers then possessed about their teaching practice. Furthermore, with the assistance of MCPT, teachers from neighbouring schools were engaged in open discussions about their teaching practice. Even though this was not entirely their initiative, their willingness to participate in these discussions was undoubted.

Almost all teachers reported an overwhelming positive attitude towards learning mathematics among their 1994 pupils compared to pupils of previous years. Pupils were found to respond positively and to be more willing to learn because with MCPT instructional materials, "doing maths is playing games to them." One teacher from Rishile Primary School reported:

"...if children are not at school, they phone asking for maths homework"

B. DOES USE OF INSTRUCTIONAL MATERIALS BY TEACHERS CONTRIBUTE TOWARDS CREATING AND SUSTAINING CHANGE IN CLASSROOM PRACTICE?

Goal: To assess if teachers allowed hands-on activities;
To assess if teachers encouraged thinking, reasoning and problem-solving;
To assess if teachers' use of instructional materials had an
impact on pupil learning.

To assess classroom processes, I used a classroom checklist as well as took some notes down as I observed both teacher and children at work. I took some of the children's work home with me. In selected classrooms I took narratives which described step by step what the teacher and learners did. After observations I conducted semi-structured interviews with teachers which served to probe and clarify some aspects which were not understood during observations.

Findings

Teachers created learning environments which were conducive to interactive work amongst pupils. Out of all classes observed, only one class had desks arranged in the conventional fashion with rows facing the chalkboard. Teachers grouped their pupils into pairs, and small groups of four or six. Where teachers found individuals working by themselves, they encouraged them to find partners to work with. Teachers presented tasks to learners to explore and solutions were found co-operatively.

Teachers allowed pupils opportunities to investigate problems independently. They did not only articulate this philosophy, but they practically gave their pupils time to play with equipment so as to investigate and discover concepts by themselves. Some teachers had selected certain pupils to be group leaders, whose role was to facilitate the sharing and manipulation of materials among different members of the groups, and to ensure the groups carried out the assigned tasks. Teachers maintained that this ensured that even the so-called slow learners were quite easily integrated and learnt in a group of fast-learners.

Three quarters of the mathematics periods (twenty to twenty five minutes) were usually spent on meaningful pupil activities. All pupils seemed to enjoy themselves while working with materials. In some classrooms there was a lot of talking in groups as children touched and played with materials. A large number of teachers allowed this to happen while a few seemed annoyed with the level of noise.

I found the attitudes and enthusiasm of the pupils to vary from class to class. Where teachers were confident in their teaching, pupils tended to display greater enthusiasm and love for exploration. On the other hand, where teachers were themselves less confident, or concerned themselves a lot about maintaining order in the classroom, pupils lacked the enthusiasm displayed by others.

The majority of teachers asked the two famous questions "why?" and "how?" very often during the lesson. Teachers asked pupils to explain how they arrived at an answer; and why they solved the problem the way they did. Most teachers listened to children's answers and acted on them by either probing or requesting pupils to demonstrate their answers practically using manipulative materials. Some teachers rewarded correct answers by the clapping of hands by the class or by giving thumbs up.

However, I observed that most of the questioning was initiated by the teachers. Even though teachers encouraged pupils to talk, they had not gone as far as to create in pupils a questioning mind at all times. Not a single class was observed where there was a debate among the pupils about a problem that pupils attempted to solve. If there was anything close to a debate it was when other pupils offered "correct" answers, and these were directed not to the other classmates but to the teacher.

In some cases children's activities were linked to real-life situations. This was made possible and easier by the availability of manipulatives. For example, learners learnt the money concept and how money could be divided into smaller units using paper money. Concrete and real life situations were used to teach the computations of addition and

subtraction. The concept of fractions was taught using the idea of cutting a cake; thereafter teachers led pupils in paper cutting and folding as a means of illustrating the concept.

To facilitate understanding MCPT teachers were observed switching over to children's home language from time to time. There was evidence to suggest that pupils' English proficiency had improved as a result of using MCPT booklets. For example, pupils read and carried out activities as instructed in the booklets, and some of them actually spoke in English in answering teachers' questions. I found that pupils easily learnt English because the model used in the booklets required pupils to engage with the books. Besides this, some teachers used the booklets to specifically teach children English and the reading of English by making children read out loud the stories and instructions in the books over and over again. As co-observer remarked, the usefulness of this approach is that it facilitates both the learning of English as well as English reading.

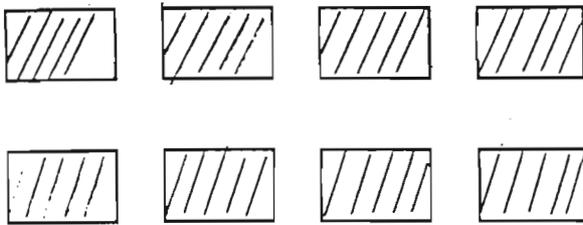
Teachers encouraged learners to think of their own methods of solving problems using manipulative materials. Pupils demonstrated understanding of concepts, and this was evident in the many diverse methods that they used. The evaluator made a note of these different methods used by Std 1 pupils in one class to solve:

6 taken 8 times is -----.

The teacher had the following colour code on the chalkboard:

White = 1
Red = 2
Light green = 3
Pink = 4
Yellow = 5
Dark green = 6
Black = 7
Orange = 8
Blue = 9
Brown = 10

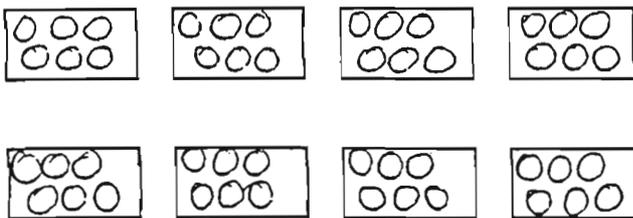
PUPIL 1



$$6 \times 8 = 48$$

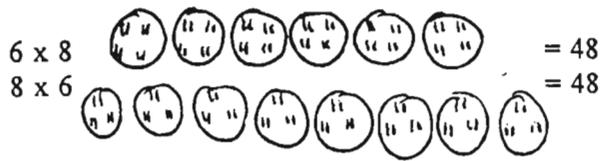
(boxes are coloured in dark green)

PUPIL 2



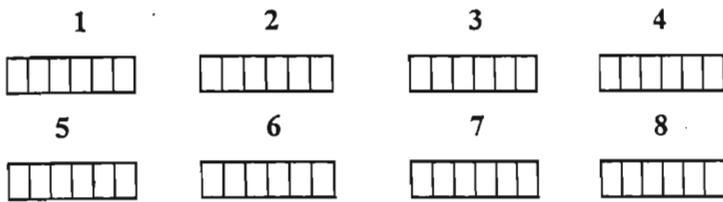
(boxes are coloured in dark green)

PUPIL 3



green x orange = 48
orange x green = 48

PUPIL 4



$6 \times 8 = 48$

(the rectangles are coloured in green)

All of the these pupils demonstrated an understanding of the concept of multiplication through the use of their own pictures to depict eight groups of six. Each group had six parts, and they then added all the parts which amount to 48. Secondly, the pupils were able to read the colour code and use it to work out the problem. Boxes were coloured in dark green to indicate the quantity of six, and others in orange to represent eight.

Thirdly, these pupils had also grasped the commutative property of multiplication:

$6 \times 8 = 8 \times 6.$

(See original written work of children in APPENDIX 7).

White = 1
Red = 2
Light green = 3
Pink = 4
Yellow = 5
Dark green = 6
Black = 7
Orange = 8
Blue = 9
Brown = 10

PUPIL 1

$$6 \times 8 = 48$$

(boxes are coloured in dark green)

PUPIL 2

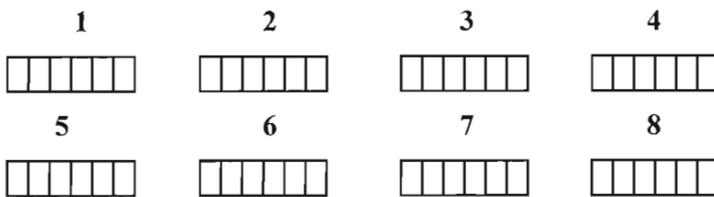
(boxes are coloured in dark green)

PUPIL 3

$$\begin{array}{l} 6 \times 8 \\ 8 \times 6 \end{array} \qquad \begin{array}{l} = 48 \\ = 48 \end{array}$$

green x orange = 48
orange x green = 48

PUPIL 4



$$6 \times 8 = 48$$

(the rectangles are coloured in green)

All of these pupils demonstrated an understanding of the concept of multiplication through the use of their own pictures to depict eight groups of six. Each group had six parts, and they then added all the parts which amount to 48. Secondly, the pupils were able to read the colour code and use it to work out the problem. Boxes were coloured in dark green to indicate the quantity of six, and others in orange to represent eight.

Thirdly, these pupils had also grasped the commutative property of multiplication:

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(See original written work of children in APPENDIX 7).

C. DOES THE PREPARATION AND PRESENTATION OF MATERIALS PROMOTE TEACHER DEVELOPMENT?

Goal: To assess teachers' preparations before lesson presentations;

To assess teachers presentations of lessons and whether they achieved their lesson goals.

To assess the above objectives, I asked those teachers with whom I had established a good working relationship (these were teachers I observed more than once) to show me their lesson preparations. The purpose was to check what the teacher's objectives of the lessons were. I observed lessons and in post-lesson conference with the teacher I enquired about aspects I did not understand during observations.

Findings

Teachers used the MCPT booklets in different ways. Even amongst teachers who were said to be on the same level in terms of classroom support and facilitation received, different usages were noticed. With regards to the way they used textbooks, teachers fell mainly into two groups:

"Textbook-bound" teachers

One group of teachers (four out of ten teachers observed) was that which may be called "textbook-bound" teachers. Moulton (1994) describes the "textbook-bound" teacher as one

who "begins the school year with the lesson on page one and progresses page by page through the book over the course of the year". Through teacher interviews and observations I found this label to describe precisely what these teachers were doing: "methodically plod[ding] through each successive page" (Dougherty and Scott, 1993: 298). In addition, I observed that these teachers required pupils to have their books on the desks in front of them right from the beginning of the lesson. They followed the text from the beginning of the lesson to the end.

Both teacher interviews and observations revealed that "textbook-bound" teachers did not prepare own lessons but simply followed the lessons in the textbook. When one of these teachers were asked how she prepared her lessons she said:

I simply look at the book (MCPT book), to see what equipment children will need for the lesson, and then teach.

It was further discovered that "textbook-bound" teachers tended not to have objectives for their lessons. I asked one teacher to explain the objectives of her lesson. She admitted that she was not quite sure herself, but carried on to give me what she thought were possible objectives. Asked if she had experienced another lesson where she could not understand the objectives, she said it happened with book Three, pages 2 and 3. The significance of teaching pages 2 and 3 only became clear to her at a later stage. I further asked if the teacher did not have a problem with teaching a lesson for which the objectives were not clear, she answered:

I like the idea of not having objectives. Objectives limit both the teacher and the children. If the teacher has a set of specific objectives she tends to steer learning according to the objectives set. The book has objectives. It is good that I do not know these objectives - it keeps me guessing.

Some of the "textbook-bound" teachers made pupils read over and over again the stories and instructions from the textbooks. These teachers had not prepared the stories or similar ones, so that they could relate and interpret them to the pupils. They did not find or use other physical materials that could be found in their environment, but they relied on the booklets.

"Management by objectives" (MBO) teachers

The second group of teachers is the one called "management by objectives" teachers (another term created by Moulton). It was quite evident from the way they taught that the "management by objectives" teachers prepared their lessons (even though these preparations were sometimes not on paper). In their preparations they formulated some objectives which guided them in their lessons. These teachers had all the competencies in mind that they expected their pupils to acquire during the lesson.

The MBO teachers did not require pupils to take out their books from the beginning of the lesson. Most of the examples the teacher used during her lesson were created by the

teacher herself. Books were taken out only when they were needed. In most cases this was at the time when pupils were required to work at problems and these were found in the booklets. It was at this stage that pupils were asked to take out manipulative materials. According to the teachers, this method guaranteed that learners paid attention to the teacher while she revised previous work or introduced a new lesson topic.

General observation with all teachers

There was not a single teacher who was observed using other books to complement MCPT booklets. All teachers seemed to rely heavily on the MCPT booklets. In the teacher interviews (See Appendix 4), teachers told me they had abandoned the DET-prescribed and supplied textbooks because they had become obsolete in that they were written in a vernacular language and still promoted old fashioned models of teaching. Some of them said they had stopped using the DET textbooks even before they were introduced to the MCPT program.

From hands-on to mechanical computations

Some teachers, especially Std 2 teachers, were consciously moving away from "stories" into the use of mathematical symbols. For example, these teachers started with "put out ... times" at which stage the children grasp the concept of multiplication through the use of concrete materials. Once the concept is known, they insisted that pupils write "put out ... times" in symbol. The next stage is the mechanical solving of problems.

For example, here are extracts from one pupil's exercise book:

Date: June 6 1994

2 put out 7 times

II II II II II II II

= 14

Date: June 9 1994

5 put out 6 times

00000 00000 00000 00000 00000 00000

5 times 6

5 x 6

= 30

Date: June 10 June 1994

2 x 8 = 16 and 8 x 2 = 16

3 x 8 = 24 and 8 x 3 = 24

4 x 8 = 32 and 8 x 4 = 32

Pupils' written work

The evaluator noticed that teachers put unequal emphasis on pupils' written work. Some teachers insisted that pupils do written work every day, either as class work or as

homework. One of these teachers displayed the work of the pupils on the walls. She said she did this so that pupils would take pride in their written work. Incidentally this teacher also insisted that pupils use the basic mathematical notation in their writing. (The above work was copied from one of her pupil's exercise book).

Other teachers did not necessarily insist on everyday written work. These teachers seemed to pay little attention to pupils' written work (in some cases teachers put ticks even where answers were incorrect). Also, these teachers did not encourage their pupils to later move away from stories and laborious and time-consuming use of counters to mechanical solving of problems. For instance, there is no point in expecting a pupil beyond Std 1 to keep on using counters to work out 3×5 . Once a pupil has grasped the concept of multiplication, (s)he should be able to give the answer without the use or drawing of counters.

Teachers who had had a longer history of interaction with the MCPT displayed higher levels of confidence in their teaching than those whose relations with MCPT was recent. However, the different categories of teachers observed did not reveal definite patterns with regards to their teaching. For instance, teachers who received facilitation in 1992 or 1993 did not necessarily show improved pedagogical practices when compared to teachers who only started using MCPT materials in 1994. Longitudinal and more indepth research is needed to determine the long term impact of the MCPT programme on teacher development.

My co-observer noticed that teachers were "exceptionally articulate about their

educational philosophies, compared with teachers I have talked with in other countries.

Among other points, they affirmed the importance of listening to the children's ideas, and seemed to be doing so". This was confirmed in the words of a Senyamo teacher,

I used to give children my methods. Now they come up with their own solutions and explanations.

I heard similar utterances by other teachers. A Rishile Primary school teacher put it this way:

The attitude that some kids can't do maths is gone - because children walk maths, they talk maths, they sleep maths, and they play maths.

The DET syllabus was proved to be conservative in its stipulation of the boundaries within which children can handle numbers. Pupils in the program could successfully handle big numbers. For instance, pupils:

- (i) could read numbers far exceeding 200;
- (ii) could count in twos, fives and tens up to and including 100, using a number board;
- iii) knew the place value of digits in numbers up to thousands, using number cards;
- (iv) could work out the multiples of 3, 4, 5, 6, 7, and 8, by grouping and then counting the counters; and

(v) could add and break down South African coins and notes up to and including R50, using paper money in different units.

Both Std 1 and 2 pupils had clearly grasped the basic laws such as

(i) multiplication is repetition of addition of the same quantity, and

(ii) the commutative properties of addition and multiplication.

D. WHAT SUPPORT DO TEACHERS NEED TO ENHANCE THE IMPACT OF MATERIALS?

Goal: To assess teachers' confidence in the use of materials;

To assess teachers' perceptions of facilitation and classroom support given to them by MCPT.

To achieve the above goals, I took down notes during classroom observations, observed a facilitator facilitating in a classroom, and conducted interviews with teachers and facilitators.

Findings

Facilitators had no doubt established a positive working relationship with all teachers they

worked with. This relationship did not only exist at the level of teachers, but facilitators had established an amazing repertoire with all members of staff: school principals, non-maths teachers, clerks and school caretakers.

This relationship created an atmosphere of trust. The presence of facilitators in classrooms posed no threat to teachers, but, in the words of a teacher at Margaret Gwele:

"...they (facilitators) are welcome because we do not see them as 'inspectors'".

Facilitators were regarded as partners in the shaping of the most effective education practice. Some teachers admitted that their own education training did not empower them with skills and knowledge to be innovative in their teaching.

Teachers admitted that the work of facilitators was invaluable and indispensable. However, they made it explicit that they did not want facilitators in their classrooms very often. All teachers who received facilitation even before the production of the booklets, said they could carry on on their own, they did not need further facilitation. Amongst those who received facilitation for a few months in 1994, three out of six specifically asked about this, saying they preferred a visit by a facilitator twice a month; two teachers preferred a visit once a month, and the last person preferred two to three visits in a quarter. Teachers (of Sub A and B) who did not use the booklets said they would like to

have facilitators once every week in their classrooms.

Some teachers expressed concern over the fact that facilitation took longer than the time allocated to mathematics periods. As a result other subjects suffered when there were facilitators at school. Related to this point, was a concern that mathematics lessons took a long time since they started using the MCPT approach. They said that mathematics always "ate into" other subjects' time.

I observed the facilitators assisting teachers by either taking over a lesson to illustrate a point using concrete objects or quietly suggesting to the teacher an alternative method. This did not seem to offend teachers, but both teacher and facilitator worked collaboratively to achieve the best out of children.

An interview with teachers revealed that the highest attribute of facilitators was their patience with pupils. A teacher at Dr. Mary Malahlela Junior Primary school relayed the story of a pupil who was very slow in class.

She could not count beyond five. I would teach her today, the following day she would not remember a thing. I was convinced that she had to go back to Sub B. But she is doing very well now, thanks to you (facilitator), thanks for your patience. I just did not have the heart.

There are a few items that the teachers did not know how to use until they got explanations from the facilitators. For instance, teachers did not understand the concept

used in the colour strips (different colours represented different numbers) until somebody else explained it to them.

Even though the language used in the books was understood by most teachers, they all said they would never be able to use the books without prior facilitation. However, this did not mean teachers needed facilitation on every booklet. They said they could cope with the booklets once the investigative approach was understood, and they had become familiar with the equipment. Most teachers pointed out that for difficult sections of the books they still relied on facilitators and workshops with other teachers who were using the same books. During interviews with teachers the booklets were described as "easy". However, after conducting the classroom observations teachers admitted that they were "challenging", and "not so easy".

CHAPTER 4

DISCUSSION AND CONCLUSION

It is evident that the MCPT has produced instructional materials that are likely to bring about radical changes in the teaching of mathematics in junior primary schools. The availability of materials in the classrooms was a first major step towards improving the quality of instruction. A significant level of effort has been put into the MCPT project: in my opinion teachers know the content of the mathematics subject better than before; attitudes are now positive and confidence levels have been raised among teachers. A seed of change has been sown in the teaching and learning of mathematics, and pupils seem to like what is happening in mathematics classrooms.

The MCPT project had the support of teachers, hence MCPT facilitators were allowed access into classrooms quite freely. This was important in the context of a moratorium issued by a teachers' union against the inspectors' classroom visits. Quite important is the fact that this allowance of "outsiders" into the classrooms, meant that teachers became willing to workshop ideas through being observed and constructively critiqued. This spilled over to positive collaborative work amongst teachers in neighbouring schools.

MCPT teachers had the benefit of attending MCPT workshops, and of receiving classroom support from MCPT facilitators and authors of the booklets. This served to ensure that teachers were socialised into philosophies underlying the development of MCPT instructional materials. Indeed, this training was important in enabling teachers to

begin to use the materials. Without this initial training, teachers would have been overwhelmed by the innovations and would have shunned attempts at using them.

Moulton's finding that teachers use instructional materials in different ways was confirmed. Presented here is a discussion of the findings and the overall patterns that emerged from the way teachers used materials.

MCPT intervention was evident in teachers' enthusiasm about the materials. Teachers' responses in the questionnaires were very positive: they thought that the materials had been effective in making them better teachers, in improving their knowledge of mathematics, and in improving their methods of teaching. Teachers' appreciation of MCPT instructional materials was clearly evident in their persistent use of them. The fact that teachers were happy with and generally valued the instructional materials, was not only an indication of their constant use of materials, but it also meant that teachers had positive attitudes towards the materials and in that way they were open to workshops and classroom support intended to enhance the impact of materials. Positive attitudes towards materials also meant that teachers did not only realise the utility of the materials, but they could also derive maximum benefits from use of these materials.

Most teachers believed that the instructional materials and methods embodied in them had brought about a complete transformation of their classroom environment and ethos.

Teachers created a classroom arrangement that was conducive to the manipulation and sharing of materials, and interactive learning by pupils. They arranged desks such that learners could sit and work in groups, a departure from the usual rows of desks all facing

the teacher. Even though there was little displayed on the subject of mathematics, pictures and posters hanging on the walls created a rich and stimulating environment. In some classrooms, learners had easy access to instructional materials and could use them at their own initiative. Changed classroom environments was an indication that teachers were seriously implementing innovations in their classrooms. It also meant that learners were learning in a pleasant environment and one that enhanced learning.

✓ Teachers had grasped the constructivist methodology embodied in the instructional materials. This was clearly evidenced in their classroom practice, where they did not teach "algorithms" or simply mathematical procedures, but allowed pupils hands-on activities in order for pupils to formulate their own methods of solving problems. Pupils were encouraged to demonstrate their understanding by explaining themselves and illustrating with the use of materials. Real-life situations were sometimes constructed to bring mathematics closer to learners' everyday experiences, especially with computations such as addition, subtraction, division and in dealing with concepts such as money. It was amazing how these methods seriously engaged learners in meaningful learning, and this was evident in the variety of methods learners devised for themselves. Even more important was the fact that learners were able to perform beyond the expectations of the DET syllabus designed for the same age levels - that is, they could handle big numbers, and could grasp mathematical concepts and properties of basic computations, such as commutative properties of addition. Quality instruction was evident and such was likely to lead to quality education.

Teachers allowed learners to work with manipulatives independently in groups or in pairs

and encouraged them to communicate among themselves and share their learning, so that the so-called slow learners could benefit from interaction with fast learners. The enthusiasm and interest of learners was obvious as they worked with manipulatives and talked amongst themselves. This talking resulted in levels of noise that were acceptable and encouraged by some teachers, while a minority were irritated by any noise. The level of enthusiasm of learners seemed to strongly correlate with the level of enthusiasm and confidence of teachers: where teachers were confident in their teaching, and did not seem to bother so much about noise and order in the classroom, learners were also enthusiastic and showed interest in their work. On the other hand, where teachers lacked confidence, they seemed bothered and irritated about the noise, and similarly, pupils seemed restrained and showed little interest.

- ✓ It seemed that if all teachers put emphasis on the development of cognitive skills and paid less attention on strict order and discipline, learners would learn much more freely, be creative and express themselves without restraints.

Teachers believed that one of the greatest achievements of the program was the improved levels of English proficiency of learners. This was as a result of teachers' use of the booklets to teach English and English reading. This practice would be welcomed by some educationists as it promotes the idea of teaching English language across the curriculum. However, the "Language Across the Curriculum" movement which started in Britain and was formally supported by education authorities, failed to influence teachers' classroom practice (Barnes, 1992). In addition, some constructivists would frown at the idea of putting emphasis on language development at the expense of the development of cognitive skills. However, a fully developed constructivist alternative to the issue of language in

teaching a subject like mathematics still does not exist (De Vries and Kohlberg, 1987). This is therefore something that still needs further research and debate.

One of the biggest achievements of conducting workshops to enable teachers to use the materials according to their principles of development, was the fact that teachers became exceptionally articulate about their philosophies of education. They particularly referred to those aspects of the MCPT programme that constituted a departure from the traditional ways of teaching. Teachers affirmed the importance of listening to children's ideas; they talked about their conviction of allowing learners an opportunity to derive their own methods of solving problems. Teachers pointed out the importance of asking pupils questions such as "how" and "why" - how they arrived at an answer and why they employed a particular method. Teachers utilised instructional materials in illustrating concepts, and similarly expected learners to manipulate materials to express and illustrate their understanding. This was powerful and consolidated what was being learnt. However, not all of the articulated philosophies were translated into practice. Questioning still remained very much something that was initiated by the teacher, and rarely challenged high-order thinking, nor encouraged learners to ask questions.

Despite the many positive aspects of teacher usage of instructional materials, the one disappointing thing was their heavy reliance on MCPT materials. No other books or materials were used to supplement MCPT materials. No other examples or stories were used other than those suggested in the booklets. During interviews teachers seemed confident that as a result of being involved in the MCPT programme they could develop their own lesson plans, and design their own materials, based on the MCPT approach.

However, this was not confirmed during the observations. No single teacher was observed using her own lesson plan or using materials other than those of MCPT. Teachers did not create their own materials that could be salvaged from their environment. It is perhaps an unrealistic expectation that teachers should create their own materials, given the lack of resources, and skills necessary to create these materials. However, if they did their materials would be most appropriate in terms of relevance of content and context. The appropriateness and effectiveness of these materials would greatly enhance the quality of teaching and learning in the classroom.

Most teachers correctly followed the lessons as suggested in the textbooks, and they did all the activities as set out in the books. However, they used the booklets almost mechanically.

The "textbook-bound" teachers taught their lessons without any goals or objectives for the lesson. In reality, their objectives were to complete work covered in a certain number of pages, or to complete a certain number of activities. Some teachers made no effort in preparing for lessons, other than checking from the teacher's guide what activities would be carried out by pupils during the lesson, and taking out of the kits materials needed for that particular lesson. These teachers could not articulate the objectives for the lessons. They also did not regard it a serious problem that they did not have objectives for the lessons. Some had a misconception that if a teacher had objectives for the lesson, she could steer the lesson in a particular direction, away from the interest of the learners. The problem in not having objectives in mind is that the lesson could take many tangents, which might at the end not achieve anything. This is not to suggest that a teacher should not allow learners to relate the subject to many different situations, but it simply suggests

that the teacher must be able to relate and tie everything said and done together perceptively at a certain point during the lesson. The teacher can only do that if she is aware of the goals or objectives of the lesson.

There were instances when the planned lesson did not work as set out in the workbooks or teacher's guide - see APPENDIX 6. When this happened teachers carried on with the subsequent stages of the lessons, even though there was a clear indication from children's body language and their failure to solve certain problems that they were confused.

Teachers did not drop or change plan suggested in the booklets, but carried on despite the confusion. As Huberman (1993) would emphasise, quality instruction would entail continuous assessment of learners' understanding, and presenting contingent or alternative plans to clarify unclear sections of the lesson. Lack of skills to adapt and devise a plan to address a particular problem which arises during the lesson, seriously disadvantages the learners and might lead to confusion.

Finally, the many positive aspects of teacher usage of instructional materials need to be recognised and strengthened. These entail the creation of rich and stimulating classroom environment conducive for manipulation of materials and group work; the abilities of teachers to present materials in ways that gave learners opportunities for creativity, and devising their own methods, using manipulatives, to solve problems. These must form the basis for the reconstruction and development of the education system. It seems that the MCPT programme has succeeded in laying a solid foundation for quality improvements, and what follows, in my opinion, is a necessity for advanced in-service training that focuses more on teacher development. The heavy reliance of teachers on MCPT

materials; their lack of instructional goals; their incapability to adapt or improvise materials; and their failure to present a contingent plan if the original plan did not work out, suggests that teachers now need advanced training on the use of instructional materials. Such training could focus on empowering teachers with skills to design and manage classroom curriculum. Huberman's model of a teacher as an independent artisan, could inform the curriculum for advance training. If such training were made available we will not only be guaranteed of high quality teachers, but will be assured of great improvements in the quality of education.

Bibliography

Adams, D. (1993). "Defining Educational Quality" IEQ Publication #1: Biennial Report, University of Pittsburgh.

Adams, D. (1994). Ginsburg, M. and Sylvester, J "Improving Educational Quality: A New Approach" A paper written for the Improving Education Quality Project.

Atkin, J.M. (1994). Report on HPI/PSP and MCPT Evaluations. Draft. School of Education, Stanford University.

Barnes, D. (1992). "The Significance of Teachers' Frames for Teaching" Teachers and Teaching: From classroom to reflection Edited by Tom Russell and Hugh Munby. The Falmer Press.

Carrim, N. (1992). "Effective Schools in South Africa" Proceedings of a conference on Effective Schools in South Africa, held at the Education Department, University of the Witwatersrand.

Chetty, D. R. (1992). "School Efficiency and Effectiveness: Pointers for Educational Transformation in South Africa" Paper presented to the Economic Aspects of Education Conference, University of Cape Town.

Cobb, P. (1994). "Where is the Mind? Constructivist and Sociocultural Perspectives on Mathematical Development" Educational Researcher Vol. 23 No. 7 October.

Commonwealth Secretariat (1991). "Improving the Quality of Basic Education" March 1991.

De Vries, R. and Kohlberg, L. (1990). "Constructivist Early Education: Overview and Comparison With other Programs" National Association for the Education of Young Children Washington D.C.

Dougherty, B. and Scott, L. (1993). "Curriculum: A Vision for Early Childhood Mathematics" Research Ideas for the Classroom. Early Childhood Mathematics. National Council of Teachers of Mathematics Research Interpretation Project. Macmillan Publishing Company, New York.

Evans, L. and Ellet, C. (1991). "An Application of a Direct Observation System to Assess Teaching and Learning in Higher Education Contexts" A paper presented at the Annual Meeting of the Southwest Educational Research Association.

Fuller, B. (1985) "Raising School Quality in Developing Countries: What Investments Boost Learning?" World Bank Discussion Paper.

Fuller, B. and Clarke, P. (1993). "Raising School Effects While Ignoring Culture? Local Conditions and the Influence of Classroom Tools, Rules and Pedagogy" Harvard

University.

Heyneman, S. & Jamison, D. (1978). "Student Learning in Uganda: Textbook Availability and Other Factors" Comparative Education Review.

Huberman, M. (1993). "The Model of the Independent Artisan in Teachers' Professional Relations" Teachers' Work: Individuals, Colleagues, and Contexts Teachers College Press, New York and London.

Jamison, D. Searle, B. Galda, K. & Heyneman, S. (1981) Improving Elementary Mathematics Education in Nicaragua: An Experimental Study of the Impact of Textbooks and Radio on Achievement. Journal of Educational Researcher, June/July.

Jansen, J. (1994). "Beyond Effective Schools: A Critical Synthesis of the Literature and an Alternative Proposal with Particular Reference to Developing Countries" Proceedings of a Seminar on Effective Schools, Effective Classrooms, Improving Education Quality Project.

Macrae, M. (1994). "A Legacy of Apartheid: The Case of Mathematical Education in South Africa" International Journal Educational Development, Vol. 14 No. 13.

Maja, B. (1993). "The Breakdown of the Culture of Learning: A case study" EDUPOL The Urban Foundation.

Maths Solutions (1994). "Replacement Units" The Newsletter for Math Solutions Participants Number 16 Spring.

McGinn, N. (1989). Foreword in Bridges Research Report Series No.4

MCPT (1994). Proposal for funding for the continued development and evaluation of the "My Maths" text book series for primary schools.

Montero-Sieburth, M. (1989). "Classroom Management: Instructional Strategies and the Allocation of Learning Resources" Bridges Research Report Series No. 4.

Moulton, J. (1994). "How Do Teachers Use Textbooks and Other Print Materials?: A Review of the literature" A paper written for the Improving Education Quality Project.

Parker, D. (1994). "Knowledge and subjects in mathematics curriculum innovation". Research Report submitted in partial fulfillment of the requirements for the degree of Master of Education (Social Theory). Department of Education, University of Natal.

Reaching All Students with Mathematics, (1993). National Council of Teachers of Mathematics United States of America.

Snyder, C. W. (1993). "Affective Context of Schools as A Potential Indicator of Teacher Receptivity to Instructional change and Teacher Worklife Quality" An occasional paper.

University of Ohio.

Suydam, M. N. (1993). "Planning for Mathematics Instruction" Mathematics for the Young Child National Council of Teachers of Mathematics.

Verspoor, A. M. (n.d.). "Using Textbooks to Improve the Quality of Education" World Bank Education and Training Department, Education and Training Series, Report EDT12. Washington D.C.