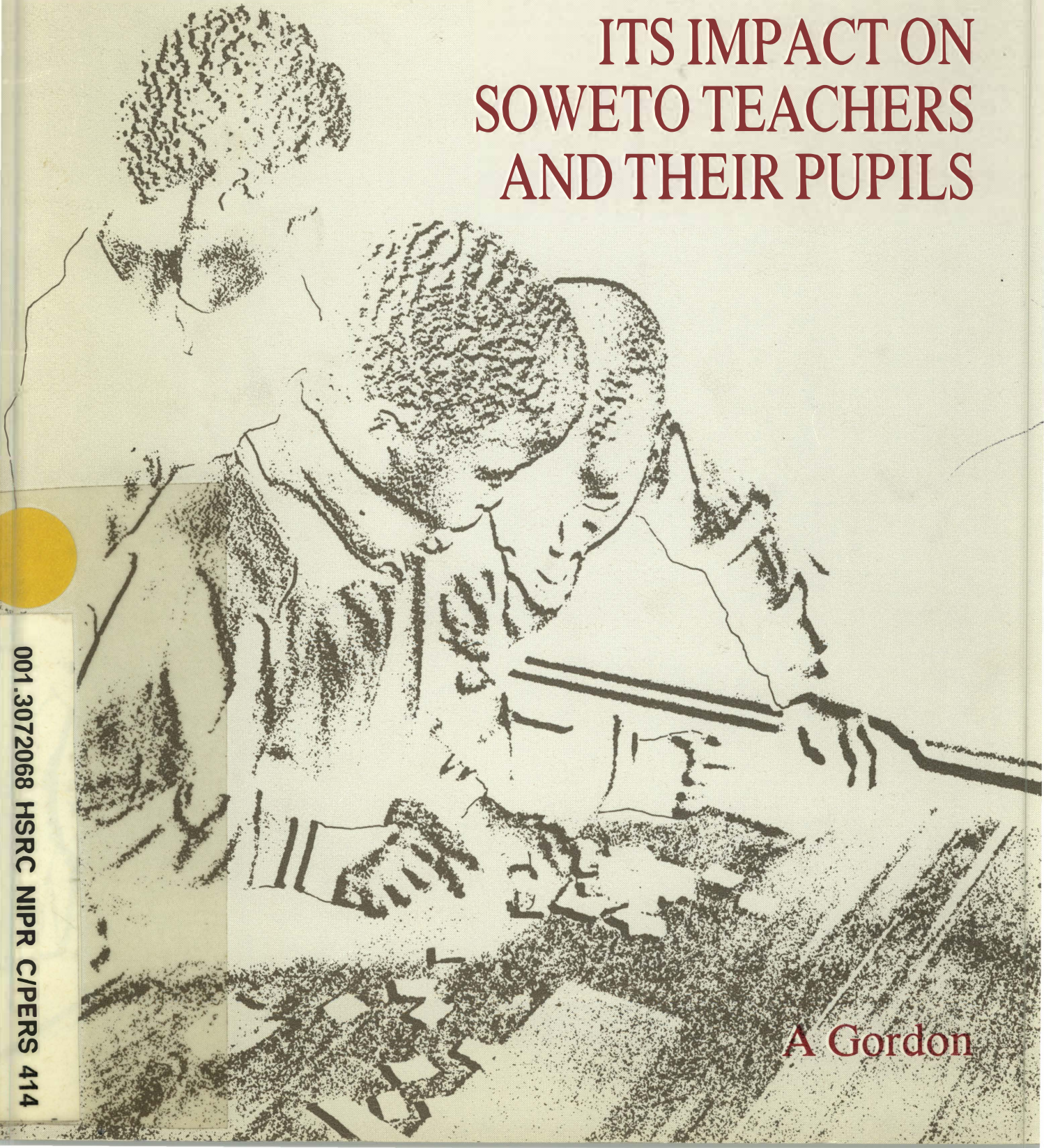


SUMMARY OF THE REPORT:

# THE MATHS CENTRE FOR PRIMARY TEACHERS

## ITS IMPACT ON SOWETO TEACHERS AND THEIR PUPILS



A Gordon

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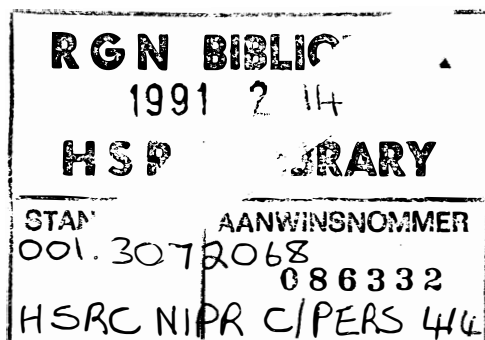
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*A Gordon*

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# CONTENTS

1. INTRODUCTION .....	1
2. THE TEACHER IN URBAN BLACK TOWNSHIPS TODAY .....	2
3. BACKGROUND TO THE EVALUATION STUDY .....	3
3.1 Available in-service mathematics courses .....	3
3.2 History of the MCPT programme .....	3
3.3 Evaluation of the MCPT introductory course .....	5
4. THE EVALUATION DESIGN .....	6
4.1 Phase one: Classroom management strategies .....	6
4.2 Phase two: Pupils' achievement levels .....	6
5. RESULTS .....	7
5.1 Phase one: Classroom management procedures .....	7
5.2 Phase two: The influence of the MCPT course on pupils' achievement levels	8
5.3 Summary of findings .....	9
6. RECOMMENDATIONS .....	10
6.1 Implementation of a comprehensive course on mathematics teaching .....	10
6.2 Community support structures for teachers .....	11
7. REFERENCES .....	12
APPENDIX A .....	13
APPENDIX B .....	15





## ABSTRACT

In 1986, a teacher training programme was established at the Maths Centre for Primary Teachers (MCPT) at Auckland Park Preparatory school. This programme aimed to improve the mathematical skills and teaching strategies of primary school teachers in Soweto. During 1989 the MCPT expanded its activities by creating an advanced course and appointing two teacher advisers to work with teachers in their classes.

In 1987 the Academic Staff Development Centre at the University of the Witwatersrand evaluated this course (Moelwyn-Hughes, 1988). In 1988, the Board of Trustees of the MCPT commissioned the National Institute for Personnel Research to extend the evaluation to examine the effects of the programme on teacher activities and pupil performance.

This report describes the impact of the programme offered by the Maths Centre. It focuses on the extent to which the programme influenced teachers' classroom management techniques and enhanced pupils' conceptual understanding of mathematics. In addition, it highlights a number of issues relevant to the future development of the project and makes a number of recommendations.

## SAMEVATTING

In 1986 is 'n onderwyser-opleidingsprogram by die wiskundesentrum vir laerskoolonderwysers (MCPT) aan die Auckland Park Preparatory School ingestel. Die doel met hierdie program was om die wiskundige vermoens en onderrigstrategie van laerskoolonderwysers in Soweto te verbeter. Gedurende 1989 het die MCPT sy bedrywighede uitgebrei deur die instelling van 'n gevorderde kursus en die aanstelling van twee onderwyseradviseurs om met onderwysers in die klassituasie te werk.

Die Academic Staff Development Centre van die Universiteit van die Witwatersrand het hierdie kursus gedurende 1987 geëvalueer (Moelwyn-Hughes 1988). Gedurende die daaropvolgende jaar het die MCPT se raad van trustees die Nasionale Instituut vir Personeelnavorsing opdrag gegee om die evaluering verder te voer en die uitwerking van die program op onderwyserbedrywighede en leerlingprestasie te ondersoek.

Hierdie verslag beskryf die impak van die program wat deur die wiskunde-sentrum aangebied word. Dit fokus op die mate waarin die program onderwysers se klaskamertegnieke beïnvloed en leerlinge se konseptuele begrip van wiskunde verbeter. Die verslag bring 'n aantal sake na vore wat met die toekomstige ontwikkeling van die projek verband hou en dit bevat ook enkele aanbevelings.



# 1. INTRODUCTION

*Principal: Soweto Primary School.*

*"We need a more holistic approach to training. Officials need to hear our voices."*

In 1986, a teacher training programme was established at the Maths Centre for Primary Teachers (MCPT) at Auckland Park Preparatory school. The purpose of the programme was to improve the mathematical skills and teaching strategies of primary school teachers in Soweto.

The Board of Trustees of the MCPT commissioned Adele Gordon of the National Institute for Personnel Research to evaluate the influence of the programme on teachers' classroom management techniques and pupils' conceptual understanding of mathematics. The findings of the study are described fully in a report (Gordon, 1989); this document constitutes an overview of the findings of the study and the ensuing recommendations.

## 2. THE TEACHER IN URBAN BLACK TOWNSHIPS TODAY

Hofmeyr and Pavlich have pointed to the dilemma faced by black teachers today:

Black teachers are caught between the pressures placed on them by pupils, parents and community leaders on the one hand and by departments and political structures on the other.

*(Hofmeyr and Pavlich, 1987: 80).*

Taunyane comments succinctly on the effects of these different pressure groups:

We, the teachers, in so many cases have lost our authority because the students equate us with something that has long been rejected. The department, our employer, often makes the system doubly worse by trying to use us as symbols of their efforts to exert authority.

*(Taunyane, 1986, quoted in Hofmeyr and Pavlich, 1987: 80).*

These demands are coupled with the effects of severe resource shortages, high pupil teacher ratios and rigid, centralized, educational structures. Together, they result in patterns of, what Hofmeyr and Pavlich call 'survival' teaching, that relies on authoritarian, rote-teaching strategies with little emphasis on discussion and spontaneous questioning in the classrooms.

The emphasis of the MCPT programme on investigative mathematics sought to break these teaching practices.

## 3. BACKGROUND TO THE EVALUATION STUDY

### *3.1 Available in-service mathematics courses*

Despite the growing number of in-service upgrading courses, few have dealt with mathematics. This is in spite of findings that many teachers at schools for black pupils have a poor understanding of mathematical concepts (Macdonald and Metrowich, 1985). Moreover, black pupils achieve poorly in mathematics. For example, of the 1 558 who wrote mathematics at the higher grade in 1987, only 41 pupils passed (Hofmeyr and Spence, 1989).

Therefore the low achievement levels in mathematics amongst black pupils and the lack of other mathematics in-service upgrading programmes emphasises the need for such programmes.

### *3.2 History of the MCPT programme*

The principal of Auckland Park Preparatory School, Mrs Jean Patchitt, established the Maths Centre for Primary Teachers (MCPT) in 1986. Funded by the private sector, its purpose was to provide mathematics courses for Sowetan teachers by making available the computer-aided instruction system, TOAM, operating at the school. The aims of the programme were set out as follows:

1. To increase the mathematical competence of Lower Primary teachers from Soweto
2. To assist them in utilizing this knowledge to develop and improve teaching techniques
3. By so doing to promote feelings of competence and positive self-regard in the mathematics teaching situation
4. To modify existing mathematical aids so that they can be produced by teachers with limited financial resources
5. To enable the teachers to acquire sufficient skills and motivation to train other teachers in their community

*(Goldstein and Rodwell, 1987: 1)*

Briefly, the psychological and educational principles upon which the MCPT programme rests specify the use of concrete learning aids, or instances from the pupils' own environment, to teach mathematical concepts. Workshops with the

teachers include role modelling exercises that simulate classroom conditions. An investigative, problem-solving, approach is encouraged which allows pupils to talk about mathematical concepts using informal, every day language before entering into the abstract world of mathematics. The long-term goal of the directors is to create an investigative classroom milieu.

Junior primary teachers were selected for the course as each teacher trained would be in a position to influence a large number of pupils, thereby increasing the scope of the programme.

Furthermore, the MCPT directors decided to concentrate on the first four years of schooling, in order to provide pupils with a solid foundation in mathematics.

In 1988, Mr Nick James of the Open University in the United Kingdom visited the MCPT and on his recommendations, the scope of the programme was expanded. At present, the following in-service training options are offered:

***1. An introductory 12-week, two hours per week course held at the MCPT at Auckland Park Preparatory School.***

Since 1986, 524 teachers have completed the course.

***2. An advanced 12-week course for teachers who have attended the introductory course.***

Two courses have been held in 1989. The dropout rate of the course has been high as only 17 of the 34 teachers enrolled.

***3. School visits by teacher advisers.***

Two advisers were appointed in 1989. Their role is to visit schools and participate in the mathematics classrooms, facilitating the implementation of the MCPT programme.

At the time of writing, four schools have been included in this scheme. Schools are visited up to three times per week. So far, the minimum time spent at the schools has been one term.

***4. Training of tutors so that they may train other teachers in Soweto.***

The two tutors trained in 1987-88 no longer work with the programme because of other commitments. A third tutor commenced training in 1989.

### ***3.3 Evaluation of the MCPT introductory course***

**I**n 1987, the Director of the Academic Staff Development Centre at the University of the Witwatersrand, Professor Moelwyn-Hughes, was asked by the Trustees to undertake an independent evaluation of the introductory 12 week course.

He reported that almost all of the teachers interviewed considered their mathematical competence to have improved as a result of the course and felt that they would be able to use the knowledge gained to improve their teaching techniques and to produce their own mathematical aids. Their comments indicated that they were more confident of their teaching methods.

Moelwyn-Hughes recommended that future evaluations should monitor the extent to which the course was implemented in the classrooms.

In 1988 the NIPR was asked to evaluate whether the course was successful in assisting teachers on their return to their classrooms and whether the course had any effect on the pupils' achievement levels.

An implicit assumption of the evaluation model was that the report would be used as an aid to decision-making concerning the future development of the project.



## 4. THE EVALUATION DESIGN

*Details of the design are given in Appendices A and B.*

The evaluation study comprised two phases:

### ***4.1 Phase one: Classroom management strategies***

The analysis of the impact of the MCPT programme was based on in-depth interviews with 22 teachers who were attending the course (project schools), observations of their mathematics classes and interviews with the principals of these schools. These interviews and observations were repeated six months after the teachers had completed the course. These data were compared with similar interviews and classroom observations conducted with a group of 21 teachers who were randomly selected from schools which had not attended the course (non-project schools). Finally, classes were observed and interviews and group discussions held with teachers and principals of two schools visited by the teacher advisers (advanced project schools).

Data analyses focused on comparing the significance of differences in these schools in the following domains; classroom management strategies; the effectiveness and efficiency with which teachers used aids; patterns of teacher pupil interaction and classroom control strategies.

### ***4.2 Phase two: Pupils' achievement levels and conceptual understanding of mathematics***

A qualitative assessment procedure was used in preference to a standardized test. This was in line with the programme's aim of furnishing pupils with an understanding of the mathematical procedures they used rather than to teach them to apply procedures mechanically. To do this, a test was constructed to measure conceptual understanding and was administered to 34 pupils individually in project, non-project and advanced project school classes.

Data analysis procedures examined inter- and intra-school differences in understanding and achievement levels.

# 5. RESULTS

## 5.1 Phase one: Classroom management strategies

**T**eachers from project schools controlled their classes more efficiently than teachers from non-project schools in the way they grouped pupils, distributed aids to the pupils, the range of tasks given to their classes and the extent to which they encouraged pupils to work together solving problems. Many of these differences were statistically significant.

These differences are discussed briefly.

### *(a) Resources*

More aids were used in project classes than in non-project classes, particularly in the standard one and two classes. Approximately one-half of the project teachers and 30% of the non-project teachers used structured aids; the rest used scraps or no aids at all. This finding was supported by teachers' comments; project school teachers were more aware of the usefulness of resources in their classes than non-project teachers.

In spite of this, all classes observed, including the advanced project classes, were short of textbooks and aids and the means of reproducing aids or workbooks for pupils. This meant that very few of the aids devised by the MCPT had been reproduced and used in the project classes.

First and second grade classes did not have mathematics textbooks and many of the standard one and two books were old, having little or no material of an investigative nature. This limited the amount of work done by pupils during their lessons and at home.

Advanced project schools had a full range of the MCPT materials; many of these had been made while the advisers were at the schools. Despite this, teachers said that they were short of work to give to their classes and proposed that the MCPT not only devise games and structured aids, but also pupils' workbooks.

***Feedback concerning resources, therefore, was consistent throughout the study;***

- ◆ teachers do not have the means of producing aids, either because of a lack of funding or the inaccessibility of equipment needed to make aids
- ◆ the shortage of resources, both textbooks and classroom aids, hindered effective teaching strategies in all classes observed.

- ◆ all teachers were short of what they labelled 'occupational tasks', that is, tasks to be given to pupils while they worked with individuals or other groups.
- ◆ no schools observed had a satisfactory range of textbooks or pupils' workbooks.

### ***(b) Teacher pupil interaction***

The pattern of teacher pupil interaction differed significantly between the non-project and project classes.

Eighty-five percent of non-project classes were organized in rows compared with 20% of project classes. In 80% of the project classes, pupils were organized in small groups, thereby facilitating pupils' language production.

### ***(c) Patterns of control***

Despite the improvement in classroom management techniques and an increased use of resources in project classes compared with non-project classes, teachers did not create classroom milieus characterized by high levels of teacher pupil interaction.

Two factors appeared to be operating. The one was the shortage of aids and the lack of adequate textbooks and the other, the teachers' lack of training in the psychological and pedagogical principles underlying the MCPT programme. In 1989 the MCPT programme introduced modelling techniques into its programme to give teachers greater insight into these principles, but the evaluation showed that there is a need for these to be taught more explicitly.

## ***5.2 Phase two: Pupils' achievement levels***

***The analysis of problem-solving strategies indicated that some of the pupils in the advanced project classes were operating on the level that the MCPT hoped to achieve. The majority of pupils, however, exhibited many areas of difficulty.***

### ***These included***

- ◆ the imprecise use of aids
- ◆ confusion about mathematical symbols
- ◆ lack of understanding of the reversibility of number operations

- ◆ the inability to do relatively simple number operations that had been covered in previous years at school
- ◆ little understanding of the meaning of their written procedures and
- ◆ the inability to understand the link between their actions with concrete aids and written sums.

In general, inter-school differences in problem-solving strategies indicated that the teachers' instructional procedures influenced their pupils' problem-solving strategies and levels of conceptual understanding. Therefore the decision of the MCPT course organizers to work with teachers rather than the pupils was a correct one.

### ***5.3 Summary of findings***

(a) The course was of most help to teachers in raising their awareness of classroom management techniques.

(b) Teachers who completed the course do need further upgrading, particularly in the field of mathematics and the psychological principles underlying the learning of mathematics.

(c) Teachers who completed the course do not receive recognition and support from their employing authorities. This is one area in which the MCPT Board of Trustees could negotiate with the DET to see how best this could be achieved.

(d) The method devised by the MCPT of extending the course to other schools has not been a success as the two tutors who originally participated left the tutoring programme. Only one tutor is in training at present.

(e) Although the results of the assessment of pupils' conceptual understanding of mathematics were not conclusive, they indicated that a long-term association with the MCPT programme improved pupils' levels of understanding of mathematical concepts.

## 6. RECOMMENDATIONS

**Findings of the present study indicated clearly that the major problems facing teachers stemmed from a lack of aids and textbooks as well as an inadequate understanding of fundamental mathematical and psychological concepts. Teachers concurred with this, saying they would be able to function autonomously when they had the requisite knowledge. To quote one principal: "We are not empowered. We need the theory on which it [the course] is based." Also, the strategy devised by the MCPT to extend the course more broadly into Soweto needs to be supplemented.**

These issues form the focal point of the recommendations concerning the future planning of the programme and are discussed below.

### ***6.1 Creation of a comprehensive course on mathematics teaching***

**F**indings of this study concur with James (1988) that the development of a comprehensive course for the in-service training of mathematics teachers is a priority.

The full realization of this goal is, of course, a long-term strategy which will take many years to achieve. James (1988) suggested that videos for such a course should be developed in 1990 and that the course itself be written in 1991. It would appear more practical to begin producing modules on a subject basis from 1990. These would include:

- ◆ the underlying pedagogical and psychological principles of that topic
- ◆ teaching strategies that embrace guidelines for all stages of the 'do, talk and record' process for that particular module
- ◆ evaluation strategies, again for all stages of the mathematics programme
- ◆ videos encompassing important principles underlying the teaching, learning and evaluating of the particular concept
- ◆ exercises for pupils, including the games that have already been created as well as additional classroom exercises. In time, these could be amalgamated into a series of pupils' workbooks.

The advantage of developing the course as soon as possible is that it could be piloted while the teacher advisers are still in the schools so that they could work with teachers to assess its impact and modify the modules accordingly.

It is suggested that this programme be implemented sequentially, with the programme being developed systematically on a modular basis.

## ***6.2 Community support structures for teachers***

**T**he MCPT tutor system was devised to enable teachers to develop the skills necessary to set up other courses in Soweto. Unfortunately the training of tutors is proceeding at a very slow pace.

Another scheme, which could work alongside the tutor training scheme, is to facilitate the creation of teacher networks that would support teachers wishing to upgrade their teaching skills. The first step in this direction would be to create a committee of principals, teachers and community members who are interested in the field of mathematics education.

### ***The functions of this committee would include:***

- ◆ input in the decision-making process concerning the progress of the programme
- ◆ monitoring the programme on an on-going basis
- ◆ considering the selection of teachers to participate in the programme
- ◆ further extensions of the programme.

It is possible that in time, these initiatives could lead to the creation of a teachers' centre for mathematics in Soweto, through which the MCPT could direct its efforts.

The importance of community initiatives in upgrading courses cannot be underestimated. Teachers resent top-down interventions; it undermines their authority, devaluing the effects of their leadership. To date, many in-service teacher training programmes in South Africa and elsewhere have resulted in a great deal of wasted effort partly as a result of top-down intervention strategies.

### ***In conclusion:***

This study has illustrated the areas in which the MCPT has made its greatest gains as well as those where it has as yet failed to make an impact. Its continued success and growth will depend on the active support of its clients - the teachers. This can only take place if structures are established that allow them to participate in the decision-making processes that control the programme.

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# APPENDIX A.

## *The assessment of the impact of the introductory course in the classrooms.*

### *(a) Sample*

It was not possible to assess changes brought about by the programme before and after teachers had attended the course because the participants were only selected a few days before the course began. The initial assessment therefore took place whilst the teachers were on the course and the final assessment six months after the course was completed.

Information on mathematics teaching practices not influenced by the MCPT course was obtained by interviewing and observing the classrooms of a group of randomly-selected junior primary teachers in Soweto.

#### *The sample comprised two groups of schools:*

- ◆ project schools (P) whose teachers had attended the MCPT course and
- ◆ non-project schools that had not attended the course (NP).

### *(b) Data sources*

Classroom visits were made to 22 classes at the 12 P schools and 21 classes at NP schools. Interviews were held with principals and teachers and classrooms observed. Project schools were visited initially in October and November 1988 (Pi classes) and in April and May 1989 (P1 classes). Non-project classes were visited in February and March 1989.

Two visits were made to the schools visited by the teacher advisers (AP1 and AP2). Group discussions were held with these teachers and principals. All classroom observations were recorded and later transcribed.

### *(c) Data analysis*

Data obtained from the interviews and observations were processed using two procedures.

#### *Procedure One*

The fairly small sample meant that analyses of the differences between the P and NP classes had to be based on broadly defined differences in teaching strategies, derived from interviews and classroom observations. The following aspects of classroom behaviour were included in the analyses:



- ◆ The use of aids.
- ◆ The range of available textbooks and manuals in the classes, as well as the language of the textbooks was noted.
- ◆ Written classwork.
- ◆ Classroom management procedures in terms of grouping strategies and how teachers allocated work to the class.
- ◆ Medium of instruction.
- ◆ The extent to which the teacher dominated classroom activities.
- ◆ The use of MCPT materials used, or available for use, in the P classes.

Two-way cross tabulations were used to compare the P and NP classes, and the differences between the P classes at the beginning of the programme (Pi) and six months later (P1). (SAS User's Guide: 1985).

*Procedure Two*

The comparisons made using Procedure One were based on broad differences between teaching strategies and use of available resources in P and NP classes. We then created more sensitive measures that allowed us to examine the change process induced by the MCPT programme.

*Four variables were selected:*

- ◆ the use of aids designed to foster activity in the classroom (A)
- ◆ classroom management procedures that enhanced teacher pupil interaction, specifically the subdivision of the class into manageable groups (M)
- ◆ teacher control mechanisms promoting teacher pupil dialogue (TC)
- ◆ pupil response patterns to teacher directives (PR).

Each of these were scored on a scale from one to five (or six). Frequencies were calculated for the categories obtained for Pi, P1 and NP classes derived from the transcripts of the classroom observations.

# APPENDIX B

## *(a) Sample*

Five or six standard two pupils were selected from two each of the P, NP schools and two advanced project schools.

## *(b) Procedure*

Pupils were assessed individually. They were asked to do a problem and then requested to explain their written work or their actions in detail. The researcher made notes of all the actions and the full text of the conversation with the pupil.

The assessment was carried out by the researcher, each assessment taking between 30 and 45 minutes.

## *(c) Data analysis*

The analyses included inter- and intra-school differences on;

- ◆ the ability of the pupils to get the correct answer to the problems.

Group means were compared using t-tests. These indicated whether or not inter-school differences between the P, NP and advanced project schools were significant.

- ◆ problem-solving strategies.

Pupils' problem-solving strategies used during the assessment test were analyzed and intra- and inter-school differences evaluated.

- ◆ error analyses.

Pupils' errors made while they were tackling the problems were related to predominant teaching strategies, as derived from classroom observations and teacher interviews.





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