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Success and failure in mathematics among standard seven students in the Bafokeng Region of Bophuthatswana.

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Table 9.22. Comparison of boys and girls' performance in the picture problems

GROUP	NUMBER			PERCENTAGE	
	BOYS	GIRLS	TOTAL	BOYS	GIRLS
TOTAL POPULATION	262	321	583	45%	55%
Interview sample	30	30	60	50%	50%
Students good at maths	10	5	15	67%	33%
Students poor at maths	7	12	19	37%	63%

There were twice as many boys i the group of good at maths students and almost twice as many girls in the group of poor at maths students but the differences are not statistically significant using chi squared test.

It was shown in section 9.4. that there was no significant correlation between scores on the Group Embedded Figures Test (GEFT) and maths test marks. When a comparison between boys and girls scores on this test was done, however there was a big difference to be seen. The figures are given in Table 9.23.

The difference on the GEFT are remarkable because it is not possible in this instance to attribute it to societal influences as is usually done with performance in mathematics. Girls are said to be discouraged by custom from performing well in mathematics. But in the GEFT there can be no such influences operating because the whole test is foreign to the boys and girls in

Tswana society. The same pattern was recorded for standard 8 maths students in Bafokeng High school - the figures are given for students who were good at maths (scored 40% or over in maths tests) and students poor at maths (scored 30% or less in maths tests).

Table 9.23. Comparison of boys and girls' scores on GEFT

CLASS	BOYS GEFT SCORES			GIRLS GEFT SCORES		
	N	Ave	Percent	N	Ave	Percent
Matale 7B	13	12,[illegible]	67%	29	9,0	50%
Matale 7C	17	12,7	71%	32	8,3	48%

The shorter time allowed for each section for the Bafokeng students - 10 minutes compared to 15 minutes for the Matale students - would account for the lower average scores given here but the difference between boys and girls was even more pronounced. The smaller numbers in this sample naturally would also affect the interpretation of these scores.

Table 9.24. Comparison of boys and girls' GEFT scores according to maths test results

GROUP	BOYS GEFT SCORES			GIRLS GEFT SCORES		
	N	Ave	Percent	N	Ave	Percent
Students good at maths	10	9,5	53%	5	3,6	20%
Students poor at maths	9	8,2	46%	4	3,0	17%

9.5.4. Grade repetition

In general repetition studies have shown that the more often a student repeats a grade the poorer his schoolastic performance tends to be. In a review of research carried out in more than 20 developing countries Schiefelbein and Simmons (1978) counted grade repetition as significantly related to achievement scores in seven out of eight studies. The authors note however that repeating could be a proxy of a student ability or teaching perception (Schiefelbein & Simmons 1978, p.28). In another review of 11 research studies carried out in developing countries. Alexander and Simmons (1975) report four instances of research into grade repetition. Three of these, viz Levy (1971), Simmons (1972) and Carnoy & Thias (1974), found the number of grades repeated at school was negatively correlated with arithmetic achievement (Alexander & Simmons 1975, p.20). The

fourth study which was done by Beebout (1972) in Malaysia found repeating of grades was not significant. In South Africa, Auerbach (1978), Nyikana (1982) and Mdluli (1980) considered the effects of repetition on non-white students. Mdluli (1980) described the education system in KwaZulu and although no variables are specified, repetition in primary schools can be taken as the assumed dependent variable (Kelly 1983, p.42). No statistical analysis was done in that study and the relationships are not clearly spelled out. Another South African study, this time of pupil repetition in the primary schools of Ciskei was done by Nyikana (1982) and repetition was treated as an indicator of school inefficiency (Nyikana 1982, p.4). There was no correlation calculated between repetition and achievement.

Table 9.25. Standard 7 repetition in Keledi middle school

CLASS	NUMBER OF YEARS IN STANDARD 7			
	1 Year	2 Years	3 Years	Total
7A	42	31	8	81
7B	39	33	7	79
7C	46	35	3	84
7D	37	34	10	81
TOTAL	164	133	28	325

In the present research, a very high pattern of grade repetition was noted in each of the three middle schools studied. The figures for Keledi are given in Table 9.25.

Some possible reasons for this have been discussed in Chapter 8. There is no significant correlation between performance of standard 7 students in the June 1987 examination and the number of times they have repeated. The students poor at maths spent an average 3 months longer in standard 7 than the students good at maths.

Table 9.26. Average number of years spent in standard 7

GROUP	N	TOTAL	AVERAGE
Students good at maths	15	23 year	1,53 years
Students poor at maths	19	34 years	1,79 years

9.5.5. Homework patterns

The study of homework patterns in relation to school achievement has been undertaken in several developing countries. Students who do homework regularly tend to do better on the achievement tests in six of the eight studies reviewed by Schiefelbein & Simmons (1978, p.23). In his research done in Tunisia, Simmons (1972) found that homework, especially the physical conditions of home study, can have a significant effect on school achievement (Alexander & Simmons 1975, p.20). In the

I.E.A. study covering 23 countries it was found that hours of homework per week positively correlated with achievement (op cit p.40). In general it has been shown that the amount of homework performed by students, the physical conditions of home study and the amount of reading performed at home are important predictors of student achievement. All these variables indicate that the more the student can be exposed to a learning enviroment in the home the higher will be his achievement level (Alexander & Simmons 1975, p.55). There is no clear explanation of the relationship between achievement and homework and the real nature of homework patterns has not yet been identified. It may very well be, as some authors point out that homework may be a proxy for the length of time a student spends studying or such teacher-related variables as teacher training, teacher-supervision or teacher-motivation (Schiefelbein & Simmons 1978, p.23). Again homework must be considered in relation to home conditions as was noted in chapter 7 and if the children have no books light or quiet then the homework might not be too effective (ibid).

During the interviews for the five picture problems students were asked about homework and the results are summarized in Table 9.27.

Table 9.27 Homework frequency for good and not good maths students

HOMEWORK PATTERN	STUDENTS GOOD AT MATHS		STUDENTS POOR AT MATHS	
	Number	Percentage	Number	Percentage
Do homework frequently	10	67%	5	26%
Occasionally do homework	4	27%	7	37%
Never do homework	1	6%	6	32%
No reply	0	-	1	5%
TOTAL	15	100%	19	100%

There is a definite link between frequency of doing homework and success in the picture problems. Twice as many students who scored A or B on the five picture problems do homework frequently compared to the students who scored D or E. Only one of the good maths students said he never did homework but six of the students poor at maths stated they never did homework. An unexpected result which was found during the interviews was that there was no difference between the two groups in regard to having someone at home with whom to discuss mathematics - seven of the group of 15 students who were good at maths compared to eight of the 19 students who were not good in maths said there was someone at hand to discuss maths with. A great amount of further research needs to be done in relation to homework patterns before

any definite conclusions can be drawn. It may be simplistic to try to correlate homework with achievement. Firstly those students who do homework may be highly motivated, have better attitudes, more sure of career choices, older, more mature, come from more stable homes, have higher S.E.S. which in turn enables them to find a place where homework is possible with adequate space, light etc. Secondly the relationship may merely indicate more enthusiastic teachers who are more hard working, enlightened etc and who therefore exert a more positive influence on their students.

9.5.6. English language ability

The relationship between language and mathematics achievement has been reviewed in chapter 4 section 4.7. and also in Chapter 7 section 7.4.2. In Chapter 4 a number of possible instruments to examine the relationship were tested but none proved satisfactory. It was decided not to repeat them for the major study but to approach the investigation in another manner. During the interviews and the five picture problems the interviewer spent from 30 minutes up to an hour with each subject. Throughout this time the exchanges were in English and it was possible for the interviewer to build up a good judgement about the English language ability of each subject. Detailed notes were made. Two aspects in particular were scored for each subject viz. fluency

and comprehension. It is not possible to do a statistical analysis on the basis of these scores because what was judged was simply: Good, Fair, Poor ability in English as revealed by the subject's comprehension and speaking ability. No attempt was made to estimate reliability or validity. It must however be added that the interviewer is a qualified high school teacher with over ten years experience of teaching in the Bafokeng region. The results are summarised in Table 9.28. Where the performance of the students good at maths (scored A or B in the picture problems) is compared with that of students poor in maths (scored D or E in the picture problems).

Table 9.28. English language ability of "Good" and "Not Good" maths students

ABILITY IN ENGLISH	STUDENTS GOOD AT MATHS		STUDENTS POOR AT MATHS	
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
Good	13	87%	4	21%
Fair	1	6,5%	7	37%
Poor	1	6,5%	8	42%
TOTAL	15	100%	19	100%

It can be seen from this table that a far greater number of students good at maths were also good at English and on the other hand a large number of students poor at

maths were also poor at English. The differences are statistically significant ($p<0.01$) in Chi squared test after Yates' correction.

Another set of records which were made during the interviews was the ability, or lack of it, to explain what they were thinking or how they had arrived at an answer to one or other of the five picture problems. This was measured and scored in the same manner as language ability above and it may well be linked to it. For the purposes of this research it was termed "reflective ability" and the findings are given in Table 9.29.

Table 9.29. Reflective ability of "Good" and "Not Good" maths students

REFLECTIVE ABILITY	STUDENTS GOOD AT MATHS		STUDENTS POOR AT MATHS	
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
Good	9	60%	2	11%
Fair	5	33%	5	26%
Poor	1	7%	12	63%
TOTAL	15	100%	19	100%

It appears from this table that most of the good maths students also have good reflective ability and most of the students poor at maths have poor reflective ability, bearing in mind the limits due to the subjective nature of the scoring mentioned above for the English language

ability.

Finally the marks obtained by all the standard 7 students in the June 1987 examination were analysed and correlation coefficients between maths mark and English mark using Spearman's formula were calculated. These figures are given in Table 9.30.

Table 9.30. Students performance in English according to school

SCHOOL	N	AVERAGE ENGLISH MARK	S.D.
Keledi	301	42,0%	11,6
Matale	157	41,9%	9,1
Mafenya	126	30,9%	7,3
TOTAL POPULATION	584	39,6%	11,1

Both Matale and Keledi have practically the same averages but that of Mafenya is 11% lower than the other two schools. One possible explanation for this is the geographical location of Mafenya school - by comparison to the other two it might be called a rural school situated approx 20 km from Phokeng as described in Chapter 8.

The overall correlation is $p < 0.01$. The lack of significant correlation for Mafenya is difficult to explain except in terms of the conflict between the maths teacher and the head of department referred to pre-

viously in Chapter 8.

Table 9.31. Spearman's correlation coefficient for maths - English marks

SCHOOL	N	r	Significance
Keledi	301	0,4148	p<0.01
Matale	157	0,3428	p<0.01
Mafenya	126	-0,0357	none
TOTAL POPULATION	584	0,3718	p<0.01

An important finding in relation to Maths-English correlation was given in Chapter 5 where it was noted that a considerable number of students, classified by their teachers as "poor in maths" were unable to converse fluently in English.

9.5.7. Summary

Highly significant correlations have been found between sex and performance in both maths exams and picture problems. Small differences do exist between age and maths performance as well as between grade repitition and maths performance but no definite conclusions can be drawn from the figures given. Further research is required in these areas. Homework patterns and English language ability are positively related with performance

in the picture problems. Also a high positive correlation between English test marks and maths test marks obtained in June 1987 examinations was found.

9.6. Conclusion

The investigations described in this chapter enable a profile of a good maths student and another profile - of a student not good at maths - to be drawn. The good maths student has a very positive attitude to maths and this enables him to spend more time at maths homework since he obviously finds satisfaction at working in a subject in which he is rewarded with high marks. As a group the good maths students are very much controlled by their strong desire to do well in the maths tests and this seems to exert a somewhat inhibiting effect on their willingness to deviate from what the teacher tells them. They are not prepared to explore alternative ways of approaching a problem and tend to keep rigidly to the teacher's methods.

The good maths student is younger than his peers and is more likely to be male than female. He is good in English both in his ability to speak it and in his comprehension of the written and the spoken word.

By comparison the student who is poor in maths, judging from his maths test marks, is older than his companions and is considerably less fluent in English. He may indeed be unable to work maths problems because he

doesn't understand what he is being asked. He tends to lack attention in working a problem and easily forgets what he was asked to do or gets sidetracked from the main aim of the problem. His attitudes to maths are less positive than those of his classmates. He spends little or no time doing maths homework and he doesn't enjoy it. As a group, the students poor at maths are more willing to risk deviating from the methods described by the teacher in trying to solve maths problems and they are not so afraid of experimenting for themselves.

No differences were found between the two groups in self-concept scores nor in the GEFT scores when using the maths exam marks as the criterion of success. The explanation for this may well be in the manner in which maths is taught in the Bafokeng region schools. A mismatch between teacher style and students' learning style was shown to be conductive to serious learning difficulties. It was noted that lack of flexibility in the teaching style and ridgid adherence to the text book and use of the lecture method of presentation were the dominant features of how maths is taught in the classes visited. Very little opportunity for individual differences is catered for and it is postulated that herein lies the mismatch between teaching and learning. For this reason many students now fail maths who might otherwise be successful.

There was no correlation found between self-concept and maths performance and this was explained in the unique perception the Tswana students have of maths as a subject which brings certain monetary rewards and can lead to a soft job. It is however seen as an imported (western) way of looking at the world. Only about 25% do maths in high school and approx 70% of all the standard 7 students who must do maths in the standard 7 external examination fail to pass. They view maths simply as a school activity bearing little or no relation to their own lived experiences. Failure in maths therefore is not built in to self-concept.

CHAPTER 10

SUMMARY OF FINDINGS

10.1. Introduction

10.1.1. Research Question

This research undertook to investigate mathematics teaching and learning among the Bafokeng of Bophuthatswana at the middle chool level. It had become appazent to the researcher in his capacity of mathematics teacher in Bafokeng High School and as area organiser for mathematics in-service courses for middle school mathematics teachers that there were serious problems associated with mathematics teaching and learning in the region. It seemed two things needed to be examined namely the problems the teachers had and the problems the students had. It was decided to concentrate on the latter and to investigate the factors associated with success and failure in mathematics at the standard 7 level, because this was the last year when all students did mathematics and this was also the year which determined whether a student could proceed to high school or not and whether or not he could join the mathematics stream to prepare for matric. The research question was formulated thus:

> What factors are associated with success and failure in mathematics among standard 7 students in the Bafokeng region of Bophuthatswana?

10.1.2. Research Design

Phokeng is the capital of Bafokeng and it has one high school viz. Bafokeng High School and there are three feeder middle schools which together form a single educational unit composed of approx 2500 students. About 600 of these are in standard 7. All the students take mathematics as a subject in the middle schools which ends at standard 7 with a public examination. When they move into high school, which starts at standard 8, they are streamed for maths or not-maths according to their performance in the standard 7 examination and according to their own preference. Only 20% do maths in the high school and of these only about half manage to pass mathematics three (or more) years later in the standard 10 matriculation examination. Invariably the high school maths teachers complain that the students are not properly taught in the middle schools and this allegation is borne out in the examiners' reports for the standard 7 maths examination which states:

> it can be said most schools do not teach the Euclidean geomety at all, few schools train their students to use mathematical instruments and a lot of students show fundamental flaws in their attempts to do algebra and to change word problems into simple equations (Bophuthatswana Department of Education Report 1987/1988).

The facts chosen from the literature which seemed to have a bearing on school performance were:

socio-economic status

degree of westernization

self-concept

attitudes to mathematics

age

sex

english language ability

cognitive style

homework patterns

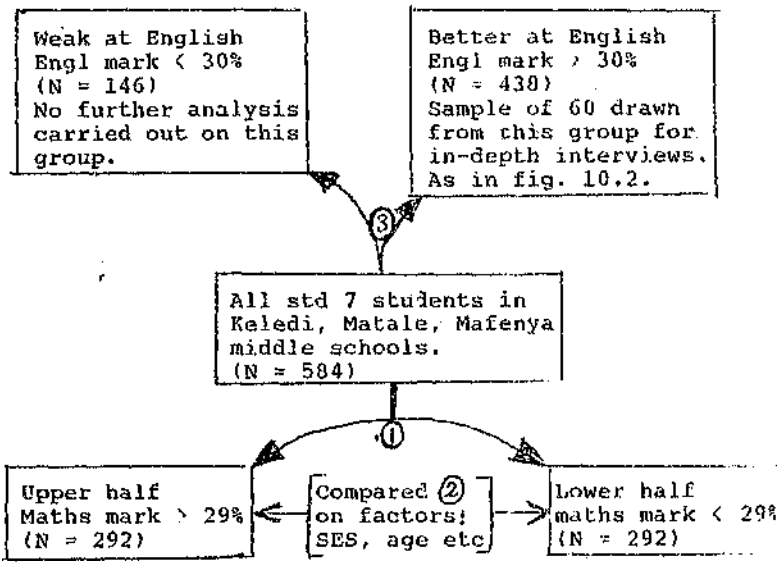
grade repetition

instruments to test for these were designed and administered either to the whole population or to a 10% sample. The scores obtained in the tests were the independent variables and the standard 7 mathematics mark was the dependent variable. Spearman's rank order correlation was used for the statistical analysis of the data. The steps followed in this part of the research are shown in Fig. 10.1. Using the mathematics test mark as the standard of pass or fail in the school mathematics as the criterion of success was in line with the normal procedure in other research. However on closer study of the standard 7 mathematics marks it was felt that they did not give a true picture of the students' ability for the following reasons:

i) there was a severe skew in the frequency distribution of the marks

ii) the average mark in the maths examination for the population was only 39%, which was con-

Fig. 10.1. Flow chart to show initial research steps



Step 1 On the basis of their performance in the maths examination of June 1987 the std 7 students were divided into two equal groups, those who scored above or below 29%.

Step 2 These two groups were compared on the factors described in chapter 7 and 9 using correlational tests.

Step 3 On the basis of their performance in the English examination of June 1987 the std 7 students were divided into two unequal groups - those whose English ability made it impossible for meaningful interviews through the medium of English to be conducted and those who could be interviewed in that medium.

sidered to be very low and almost half of the students were awarded symbol "H" which is the lowest category of marks recognised in the public examination.

iii) the researcher's own experience of students in the Bafokeng region is that they are not unintelligent and that the mathematics marks from the standard 7 examination do not give a good indication of how the students will cope with high school mathematics.

iv) the nature of the examination paper itself promotes cramming and rote learning

v) during the pilot study it was found that using mathematics test marks did not clearly differentiate between good mathematics students and students not good at mathematics, as reported in chapter 4.

For these reasons it was decided to use a second criterion for "success". This was based on the performance of students in five picture problems involving the operations of addition, subtraction, multiplication, division and a number line problem. The testing and scoring of students in these picture problems is given in chapter 6. The testing of performance in the picture problems was done during an in-depth interview of approx 1 hour per student. A 10% sample of the standard 7 population was drawn to make up 60 students for these

interviews. The steps taken in drawing up this sample are shown in Fig 10.2. The sample was drawn up as follows:

a) Eliminate those weak at English i.e. about 25% of the total

b) Have equal numbers of boys and girls

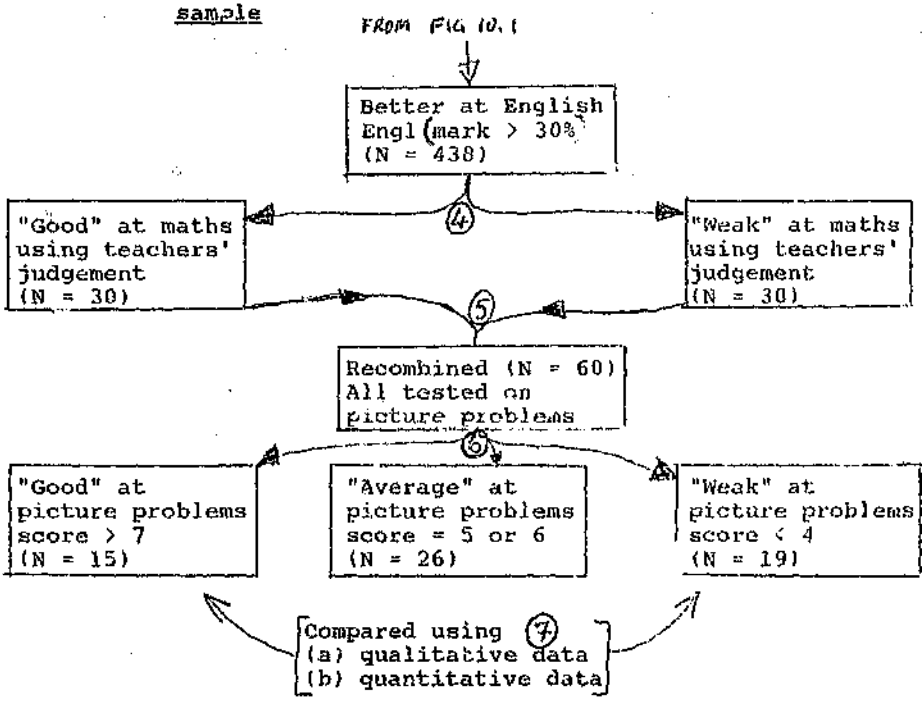
c) Draw equivalent numbers from each class. Thus the classes in Keledi which have about 80 students per class gave 8 students (4 boys and 4 girls); the classes in Matale and Mafenya which had about 40 students per class gave 4 students per class (2 boys and 2 girls).

d) The teacher was then asked to classify the students as good or not good at mathematics and one of each was taken.

This procedure yielded someone from the best three at maths in the class and someone from the middle group as the not good at maths student.

There is a positive correlation between the two criteria of success in mathematics for Keledi school ($r = 0,345$; $p < 0,01$) but not for the other two schools. The question of the validity of the standard 7 examination must be raised because of the reasons given above - low average, skewed frequency distribution and also because of lack of correlation between GEFT scores and the mathematics marks as reported in chapter 9.

Fig 10.2. Flow chart to show research steps with interview sample



Step 4 Stratified sampling procedure used to draw 60 students for interviews
- i) eliminated those weak at English
- ii) equal numbers of boys and girls
- iii) equivalent numbers from each school and each class
- iv) teacher grades assigned i.e. either "good" or "weak" at maths and one from each grade taken.

Step 5 All 60 subjected to same interview procedure without regard to teacher grading.

Step 6 On the basis of their performance in the picture problems the sample was divided into "good", "average" and "weak" groups.

Step 7 These groups were used for comparisons based on both
(a) qualitative data as described in chapter 6; and
(b) quantitative data given in chapter 7 and 9.

10.1.3. How the research was carried out

The method of illuminative research was used, following a broad survey. First the problem was investigated in a general manner in the schools by means of non-structured interviews, observations etc. That which seemed of greatest concern to everybody, as reported in chapter 1, was the poor examination results in mathematics and what could be done to improve these results.

A comprehensive survey of relevent literature was undertaken to find out what had already been done in this area of research. The work of Dewey, Piaget, Skemp, Witkin and Bruner seemed to present the most promising guidelines for a theoretical framework.

A considerable amount of school based research into how children learn mathematics by studying how they actually "do mathmatics" exists and this was also reviewed.

The research into mathematics in third world countries was looked at with special attention to Africa. The work done in South Africa is not inconsiderable and both HSRC and MATIP have been active in this field. Finally two "local" maths projects were reviewed. These local efforts pointed to the possibility of improvement by using a new teaching method. The chief characteristics of this method were active, dynamic and positive teaching and the provision of rewarding success experiences for students.

In general it was noted in the literature that certain

factors were identified as being associated with success - these could be grouped into (i) personal factors such as age, sex etc. (ii) home factors such as socio-economic status and (iii) school factors such as provision of facilities, textbooks etc. The usual kind of design was correlational in order to establish relationships between the various factors, treated as independent variables and mathematics treated as dependent variable.

In the school based research in first world countries there was more focus on the individual child and use was made of interviews and specially designed tests. Where such tests were used in third world countries the literature suggested danger of non-valid results because the material might not be meaningful in another culture and further complications might arise because of altered nature of interviewer-subject relationship and because also of language problems. Resulting from the literature review a research design based on correlational studies of factors associated with success and failure in mathematics was constructed as shown in Fig 10.1. There were no suitable instruments for measuring the factors and these had to be designed.

A pilot study was carried out in 1986 to test the suitability of the instruments and to check the feasibility of the research. As a result of the pilot study a major reorientation of the research design was

found necessary and a new design based on the anthropological approach was constructed. This new design made provision for gathering data by means of in-depth interviews as well as statistical material from the whole population. It was also foreseen that further deepening of the investigation would be required in specific areas such as language, perception, organisation of data.

The field work was done in 1987 using all the standard 7 students in one educational unit of the Bafokeng region. This consisted of 584 standard 7 students attending three middle schools which served as feeder schools for the one high school in Phokeng, capital of the Bafokeng region. Questionnaires had been constructed to gather data on:

(i) socio-economic status
(ii) degree of westernization
(iii) attitudes
(iv) self-concept
(v) age
(vi) sex

and these were distributed to all the standard 7 students. A 10% sample was drawn as described above in Fig 10.2. from each school for interviews. The sixty students so drawn were each interviewed and as part of the interview they "talked through" each of five picture problems as described in chapter 6.

10.1.4. What emerged

Certain critical areas emerged during the research and the investigation was further deepened in these areas.

(i) Language study of Setswana in three areas

1. Number system
2. Setswana vocabulary for maths concepts
3. Preferred use of language among students and teachers.

(ii) Organisation of data

How students tackled a problem which required them to distribute 36 counters with 3 different characteristics among four people.

(iii) Self concept (unexpected findings)

No correlation between self concept and maths achievement - this was further explored - it was found that questions about locus of control and relative importance of maths in students' lives gave unexpected results - it was found students only thought in terms of maths test marks but had no feel for the subject itself.

(iv) Visual perception GEFT

No correlation between scores and maths performance between groups matched for age, sex, father's education and father's occupation.

10.2. What the literature says relevant to this Research

10.2.1. Theorists

Dewey: revolt against formalism - in the schools of his day subject matter was clearly described and written up in text books and the work of the school was to get as much of this given content into the children's minds as possible (Dewey 1902 P.8).

Dewey believed the aim of education is the forming of skilled powers of thinking. Th best way to achieve that was to allow children to work on meaningful (for them) projects in a loosely organised democratic style of school. For him the emphasis was most definitely on the child and not on the subject matter. The present research would have to examine the school and classroom organisation among the Bafokeng. It was found to be subject orientated rather than child centred.

Piaget: cognitive development follows a universal pattern while the ages at which children reach a given stage may vary. It seems African subjects lag behind their European counterparts by up to two years. Many questions have been raised about the validity of Piaget style tests - their validity for other cultural groups is challenged on the grounds of language and test materials. Piaget's work on how children learn about number and how they develop the ability to handle natural numbers flexibly in solving problems suggested

that an investigation was needed into this area among the Bafokeng. This investigation would have to look at the Tswana language and the "number vocabulary". It would also have to examine the ability of children to use the basic operations of arithmetic.

Skemp: Skemp sees mathematics as a way for dealing with life situations - i.e. speaking about school mathematics. It must be integrated with the development of the whole person. He speaks about two kinds of understanding - relational and instrumental. The latter kind is what is produced in the schools in the Bafokeng region - it relies on memorizing rules for dealing with specified problems and it does not produce insight. He defined intelligence as a goal-directed activity manifested in the ability to develop a strategy to move from one "mental state" to another. This provided the rationale for the field work using five picture problems described in chapter 6. The child had to identify the present state from information supplied in the form of pictures and words; next he had to recognise the task goal and finally he had to use the given information in order to attain the goal. The interviewer allowed the child to talk his way through this, only asking questions to clarify what the child was doing. As regards the instrumental understanding, Skemp suggests that teachers may well be responsible for this in the methods used in the classroom. Class visits were conducted to

observe what was actually taking place in the schools during mathematics lessons. The effect of the type of teaching on how the students performed in solving the picture problems was studied.

Witkin: he contributed to an understanding of personality which was based on a individual's perceptual style - either field dependent or field independent. Positive correlations were established by Witkin and his co-workers (1971) between field independent cognitive style and performance in mathematics. This was explained in terms of a disembedding ability which enabled field independent people to analyse a given situation into its component parts and to recombine them in new ways. To test this, a group embedded figures test has been designed by Witkin et al (1971). This test was administered to a group of std 7 students matched for age, sex and socio-economic status. Throughout the research observations on preferred perceptual modes were recorded.

Bruner: he studied how young children in their play "learn about number" and how this must be made the basis for mathematics teaching in school. Teachers must build on the child's experiences and if necessary provide these experiences. The obsession with examination results and cramming subject matter of the syllabus and text books seems to be a feature of schools in the Bafokeng region. There is no time for providing mean-

ingful experiences and there is no evidence in the schools to indicate that the teachers are aware of this lack i.e. no teaching aids, charts or material of any sort in the classrooms.

10.2.2. School based research

It was decided that an understanding of the problems faced by many children in the Bafokeng region could be reached by looking at how they handled questions based on the four basic arithmetic operations using only positive whole numbers. This field has been extensively researched in Europe and America concentrating on very young children. The technique used has been to study how children solve simple number problems in an interview situation and the interviewer records the strategies used by the child in solving the problems. Results of this kind of research show that children vary considerably in the level of abstraction at which they operate. Some can only deal with material objects and others rely on correctly recalled number facts which is regarded as the highest level.

10.2.3. Third world mathematics research

A number of mathematics projects based on Piaget, Skemp and Witkin were reviewed. The results were found to be very confusing due to the culture-bound nature of the tests used. In general subjects in third world

countries fared badly in cross cultural studies on many psychological measures.

Two maths projects both evaluated by Cundy (1977 and 1978) were of particular interest - one in Lesotho which made use of an English work card project and imported materials, assumptions etc. Local teachers were "trained" to implement the project. It was a failure. The other was a project to improve maths in the Caribean Islands and it started with an idea. Indigenous materials and instruments were developed, with local teachers taking an active role in development. It was a great success.

A number of researchers have done a fundamental analysis of mathematics as a way of looking at life and making sense of the world. In this manner Gay and Cole (1967) for example were able to show there was a "Kpelle mathematics" based on the needs of the people and they analysed the language for mathematics concepts and techniques for solving their own experiential problems. Others such as Bishop in New Guinea also found that when mathematics tasks were meaningful in the sense of being linked to objects significant to the local people then performance was much improved. What seems of importance in all this work is the relationship between culture and performance in mathematics. Two aspects of culture which emerged were (i) language and (ii) perception. This led to an investigation into how these two aspects

of culture are related to mathematics performance among the Bafokeng as reported in 7.4.

10.2.4. Mathematics research in South Africa

H.S.R.C.: have produced a number of papers on mathematics among blacks which acknowledge there is a serious problem. The method followed was to seek an understanding of the nature of the problem from gathering opinions of experts, which included literature analysis and discussions with mine trainers and supervisors. The assumptions underpinning this approach are that an outsider to the culture can know how people within the culture think and how they perceive situations. This was the major weakness in the HSRC work. A lot of excellent material was however gathered and structured and many useful guidelines for the improvement of mathematics teaching were given. Among the suggestions were the need to base maths teaching on the culture, the use of group work and mother tongue instruction when a child begins schooling and then an early use of the second (English or Afrikaans) language for mathematics teaching and it must be done gradually. The chief criticisms of the HSRC work are the lack of fundamental research based on black children and the reliance on expert opinions. These were seen to be pitfalls which the present research had to avoid.

MATIP: Good work is being done by this group in sponsoring research. The technique tends to be large scale surveys such as the analysis of errors in public examinations by Wilkinson (1981). This work is necessary but it must be filled out by in-depth personal interviews.

Local: Two maths projects carried out in the local area were found which had attempted to improve the situation of bad mathematics. One was carried out in Tlhabane college of education by Bauer (1984) who tried to improve the mathematics performance of teachers in training and the other was done by Murphy (1988) on a group of high school students. There was an inadequate theoretical model and it seemed both were based on a stimulus-response model. Mathematics was taken to be equivalent to "doing sums quickly and accurately". The method used was first to demonstrate how to do an operation such as addition of fractions then graded exercises were given and corrected. An important aspect of these projects was to enable the subjects to experience success in mathematics and to give them plenty of practice. Mastery learning was aimed at but it was more "instrumental" than "relational" i.e. getting the answer quickly using a given rule was the method rather than promoting insight.

That which seemed to be lacking in all the material reviewed was a description of the real situation in the

black schools. Nowhere could be found an attempt to describe how the students "think mathematics" or how the teachers "teach mathematics". Before the stage of hypothesis testing or even the formulating of hypotheses it is clear that such a description will be necessary. This was begun in the present research by studying at first hand one area, namely the Bafokeng region of Bophuthatswana. Data was gathered from middle school students by means of questionnaires, in depth interviews and observations in the schools.

10.2.5. Factors associated with success in mathematics

During the literature survey described in chapter 3 some of the factors found to be identified with success in mathematics were:

socioeconomic status
self concept
language ability
homework patterns
age
sex
cognitive style (= field independence)
adequate school facilities
class size
grade repetition (- inversely related)
modernity
attitudes

motivation and perceived expectations

kindergarten attendance

others - section 3.4.4.3. of chapter 3.

Simmons and other workers (1975 and 1978) grouped the factors into three clusters

(a) school resources and processes

(b) teacher characteristics

(c) student traits

10.3. Research Findings

10.3.1. Description of the school situation

The maths classes visited and the maths inservice courses attended by the researcher showed a remarkably similar pattern where the whole emphasis is on the text book and the learning of rules for doing specified maths questions. There is little or no attention given to mastery learning or the achievement of insight. Students are not encouraged or allowed time to think how a given question might be approached or try to work out possible methods of doing it.

The usual lesson began by the teacher telling the students what was going to be taught in that lesson and this invariably was how to do a given question from the text book. Next the teacher did the question on the blackboard, explaining the steps as he or she proceeded. The teacher made all the important decisions such as what was relevant in the given question, what was being

asked, how to arrange the material and so on. There was no training in how to go about analysing the question either in groups or by class discussion allowing individuals to suggest alternatives and encouraging other students to say if they agreed or not and to give reasons. The criterion for accepting or rejecting any answer was the teacher's response of "Yes" or "No" and the reasons were seldom explained.

The teaching style in nearly all instances observed was characterised by:

(a) lecture method

(b) authoritarian presentation

(c) rigid adherence to the text-book

(d) lack of formulation of hypotheses or testing of hypotheses

(e) lack of teaching aids, other than the blackboard, no charts, no pictures, no materials of any sort used in the lessons.

In brief the lessons were generally "chalk and talk" lessons. It appears that the teachers regard mathematics as an external body of facts and procedures which must be crammed for examination purposes but has no relevance to their own or their students' lives. This teaching may be suited to a particular type of learning style but no provision is made to adapt the teaching to a variety of learning styles. It became apparent during the interviews reported in chapter 6 that the students

do not all have the same learning style. It can be said that there is a mismatch in many cases between the teaching style and the learning style of many students. One possible route out of this morass would be in-service training of the middle school maths teachers where the emphasis would be on the meaning of mathematics in our lives and how mathematics can be and is used in our everyday situations. Up to now the stress in the inservice training has been on "how to do questions taken from the text-book".

The kind of student who will do well in the circumstances described here is not an original thinker, not a creative person, not one who will attempt alternative methods of doing a question, not one who will analyse for himself what is relevant, what the goal of the question is, not one who will know when he has arrived at a solution or be able to test for himself whether the answer is right or wrong. Rote learning is encouraged and in broad terms teachers could be said to be teaching for "instrumental" and not for "relational" understanding in Skemp's (1979) terms. There was a notable exception to the kind of teaching described above. One teacher in Keledi, as reported in chapter 8, presented an algebra lesson on equations which differed from all the others in the manner in which the teacher led the students to do serious thinking about all aspects of the lesson. He facilitated the formulation

of problems by the students themselves and allowed them to suggest various possible ways of solving the problems. Students identified what information was given (present state) and what was required (goal state). Students were allowed to find the solution using whatever method was meaningful to themselves and they were encouraged to share their individual methods with other students in the class. The teacher helped the students to evaluate these methods and to find out for themselves where they had gone wrong. There was a marked spirit of excitement and enthusiasm in this class and student participation was stimulated by their interest in maths rather than by the teacher's authority. In the section diary of student teacher it was reported how one student teacher over a two week period was able to change the attitudes of a whole class group from fear of maths to one of loving maths so that the students would spend extra time working maths problems by themselves.

10.3.2. Findings which agree with previous research

As explained in 10.1 above two separate criteria for "success in mathematics" were used in the present research and the results were not the same when variables were correlated with each of these. The findings are reported here separately. (See Table 10.1)

Table 10.1. Tabulation of research findings from this research

Factors found significant in previous research	Statistical analysis using criterion 1 of maths marks N = 584	Statistical analysis using criterion 2 of picture problems N = 60
1. Age (inversely)	significant ($p<0,05$)	significant ($p<0,05$)
2. Sex	not significant	not significant
3. Attitudes	significant ($p<0,01$)	not significant
4. Degree of westernization	not significant	significant ($p<0,01$)
5. Embedded figure scores	not significant	no data
6. Self concept	not significant	not significant
7. English test mark	significant ($p<0,01$)	significant ($p<0,01$)
8. Homework patterns	no data	significant ($p<0,05$)
9. Grade repetition	not significant	not significant
10. English fluency	no data	significant ($p<0,01$)
11. Socioeconomic status	not significant	significant $p<0,01$)

(a) Factors which were found to be significantly related to maths test marks (refer to table 10.1) were attitudes, English mark and age (inversely). It is difficult to account for the lack of correlation between socioeconomic status and degree of westernization scores on the one hand and maths marks on the other hand. One possible suggestion is to question the validity and reliability of the maths

marks. Another possibility is the truncated nature of the population. It was shown in chapter 7 that the SES level of the Bafokeng was generally very low. A factor which distorts the SES distribution is the custom among the better off families of the Bafokeng to send their children away to boarding school.

Hence this economically better off section of the population would not be well represented in the 584 standard 7 students tested.

(b) Factors found to be significantly related to performance in the picture problems were: age (inversely), sex, attitudes, degree of westernization, English mark, homework patterns, English language fluency and socioeconomic status.

All these were related to maths performance in previous research. It was further found that SES.Scores are significantly correlated ($p<0,05$) with age (inversely), attitudes, self-concept, degree of westernization and English work i.e. with all except maths mark.

10.3.3. Findings which do not agree with previous research

There were two factors which proved not to be significantly related to success in mathematics whichever criterion was used. They were: self-concept scores and grade repetition. Other research had found these to be

positively related to school achievement although mixed results for success in mathematics and self-concept have been reported, as discussed in chapter 9. The whole area of grade repetition is a very confused one in the Bafokeng schools. The decision to promote a child or not is made by the teachers in the schools on the basis of the child's performance in the end of year examination. The criterion used by the teachers for pass or fail is governed by their experience of presenting children for the public examination. However the last word does not rest with the teachers but with the circuit education officer. There is a clash of interests in the promotion procedure. On the one hand the teachers do not wish to have any students promoted to standard 7 who might fail the public examination and thus "give the school and the teacher a bad name". On the other hand the circuit education officer can't allow a build up of a huge backlog of students in any standard or the whole system will become clogged up. The argument used by the circuit education officer is that if large numbers of students are failing then it indicates that the teachers are not doing their work. A possible explanation for the lack of correlation between self-concept scores and success in maths marks and in picture problems was offered in chapter 9 as being due to the lack of perceived relevance of maths for the students. Maths for them is a school subject which they must do in

the middle school. They accept that most of them will fail it and very few get good marks.

A third factor which is reported in the literature to be related to maths performance is embedded figures scores. In the present research there was no such correlation, using the maths test marks as criterion for performance. This result is confusing and it points again to questioning the validity of the maths test marks. It was pointed out in 10.3.1. above that teaching style did not cater for a variety of learning styles and it would seem from the lack of correlation between embedded figures scores and maths marks that some children who have the potential to succeed at maths are now failing because of unsuitable teaching. Both field dependent and field independent learners appear to have been equally handicapped by the existing teaching style.

10.3.4. New and deeper understandings

The major contributions of the present research are:

1) extension of research findings about socioeconomic status, attitudes, age, sex, degree of westernization, English language achievement being positively correlated to success in mathematics for a new population, namely the Bafokeng of Bophuthatswana.

2) An in-depth analysis of how low socioeconomic status can hinder the development of experiences which are necessary pre-requisites for school mathematics

3) A study of how a low degree of westernization contributes to poor mathematics performance because of deficiencies in the Setswana language and cultural effects on perception.

4) The discovery that up to 30% of the standard 7 students were unable to carry on a meaningful conversation through the medium of English which is the medium of instruction in the middle schools.

5) The discovery that approx half of the standard 7 students have not learned basic number facts that would enable them to recall correctly such facts as 6 x 8 = 48; 28 ÷ 4 = 7; and that addition / subtraction, multiplication / division are inverse operations and can be used to check answers.

6) The discovery that approx half of the standard 7 students are unable to deal successfully with simple picture problems because of not understanding conventions used commonly in mathematics diagrams such as showing length of a plank by means of a dotted line.

7) The discovery that many of the standard 7 students could score very highly in embedded figures tests but these were not the ones who were "successful at mathematics" in terms of school tests.

8) The discovery that many students were unable to visualise such things as "eight trees, each with six apples just like the one shown in the picture" or "four friends to whom I could distribute 36 objects".

9) The two factors of attitudes and English account for approx. 25% of the variance in the maths marks.

10) The three schools differed in the factors that correlated positively with maths marks.

11) Where maths performance in examinations is generally very weak, then some other criterion such as the picture problems described in chapter 6 can be used to classify the students on mathematics success and failures.

12) When the performance of the sample of sixty standard 7 students drawn from the group of "average and above average" maths performers was analysed it emerged that students could have difficulties in any one of the five categories as follows:

i) Perception: It seems perception is basic to getting off the ground in the first place. By this is meant the ability to understand the given problem presented in pictures and words. Within the category of perception there are these sub-groups:

a) Group of students who are unable to understand the problem. This includes the literal group who ignored the given data and gave an answer drawn from their own life experience e.g. How far from Rustenburg to Sun City in picture problem number 1. It also includes the story teller group who ignored the question posed and spent time talking about "the poor boy in the picture" who was

"tired and was waiting for transport" or who was "very worried because someone had stolen his apples".

b) Group of students who are unable to visualise what is implied in the picture but not actually shown eg. Rustenburg lies 36 km to the right in problem number 1. or eg. number shown at A in problem number 4 or eg. other apple trees just like the one shown in problem number 2.

c) Group of students who were unable to understand the picture at all eg. the signboard in problem number 1 was misinterpreted as a tar road or eg. the relative positions of the man, and the two towns in picture problem number 3. There may be an overlap between this and b) above and it was not possible to distinguish where the difficulty lay for all the students

d) Group of students who were able to comprehend both the given information and what they were required to do.

ii) Operation: If the students were successful in identifying what information was relevant and what was the aim of the question then they were faced with another serious obstacle in trying to decide which operation to use.

Within this category there were:

a) Group of students who "guessed" (wrongly) which operation to use and could not be altered from their wrong guess eg. they decided they were required to subtract instead of add in problem number 1 and they decided they were required to add instead of subtract in problem number 3. Even when the interviewer used small numbers and diagrams some maintained their first decision was right. If the students guessed the right operation it was not always possible to distinguish the intuitive thinkers from the guessers.

b) The group who guessed the wrong operation at first but could be helped to see their mistake and who could be helped to change their decision.

c) The group who decided after some analysis, some very quickly, which operation was required and went ahead with it.

iii) Strategy: The third stage was to design a strategy for obtaining the answer once they had decided on the operation. These sub-groups became apparent:

a) Trial and error group. These students eg. in the number line problem said the number at A was 32 because it was two intervals up from the number marked 30. Usually, but not always they were content with this answer unless forced by the interviewer to continue to count through the other intervals and found themselves contradicting the

information in the diagram - they were saying 35 for the place marked 40 in the diagram. Some insisted they were right and the picture was wrong while others realised they must count not in ones but in twos and they altered their answers from 32 to 34.

b) The group who used the derived number fact eg. when faced with 8 x 6 some used the fact that 5 x 6 = 30 and 3 x 6 = 18 and 30 + 18 = 48 in solving this problem. Others used repeated addition strategies eg. 6 + 6 = 12 12 + 6 = 18 and so on until reaching 48.

c) The group who used a correctly recalled number fact eg. 28 ÷ 4 = 7.

iv) Reality testing: This category refers to knowing that they have arrived at an answer - whether right or wrong and knowing that the answer could or should be checked by themselves. Within this category were these sub-groups:

a) Those that saw no need to check the answer or when challenged were unable to test it.

b) Those who relied on the authority of the teacher - or during the interviews they waited for the approval of the interviewer.

c) Those who could, and did use the inverse operation to check their answer.

v) Time: Finally there was a time factor and it seemed

the students had a limited attention span. If the student hadn't arrived at the solution after 10 minutes it was found no further progress was made by prolonging the attempt to solve a particular problem. Students were getting confused between the information given and their own wrong interpretations it. Some students could complete the problem easily within four minutes.

There was strong confirmation for these categories in the manner a different sample of students performed in the "organisation of ata" experiments reported in chapter 7. Students were given 36 counters (triangles, circles and squares) and asked to make them into four groups so that they could be shared equally among four friends. The performance in this task was very poor and the biggest difficulty seemed to be in not being able to understand what was required. In some cases students claimed this was impossible since only three groups of objects (triangles, circles, and squares) were given and therefore they could not be distributed to each of four friends. Using Setswana language to describe the task made little difference to the performance. Using grapes, sweets and stones instead of counters provided some improvement. However, it was only when four persons were brought into the room and pointed out to the subject being tested as the ones to whom the objects should be given that a dramatic improvement in performance of the task was recorded and almost all the subjects could

now succeed. On the basis of triangulation theory the results of this experiment helped to validate the categories in 12) above.

10.4. Pointers for further investigation

Questions which were raised during the investigation but could not be answered properly because they need further investigation include:

1) A study of the reliability and validity of the present standard 7 examination, especially the mathematics paper. Perhaps hand in hand with this should be a study of what are the mathematical needs of the secondary school students in Bophuthatswana and the designing of a syllabus in line with these needs. At present the type of syllabus and public examination is preventing up to 80% of Bophuthatswana students from doing any sort of mathematics in the high schools. This situation must surely be unacceptable in a society which is rapidly entering the technological era.

2) Related to the above is the degree with which the present standard 7 examination predicts correctly the performance of students in high school mathematics and their ability to pass the standard 10 mathematics examination.

3) Reasons for lack of correlation between (i) self-concept scores and (ii) embedded figures scores

against maths test marks.

4) Comparison of performance of students taught using a dynamic flexible teaching style with the performance of students using the traditional "chalk and talk" style.

5) The preferred use of language among maths students discussing mathematics during informal (outside of class) sessions is a mixture of English and Setswana. The school regulations prescribe strict adherence to English only inside the mathematics class. It should be investigated whether it would make any significant difference to the mathematics performance of the standard 7 students if classes matched for size, ability etc. were taught in English / Setswana mix compared with classes taught in English only.

10.5. Discussion of findings

10.5.1. Implication of this research

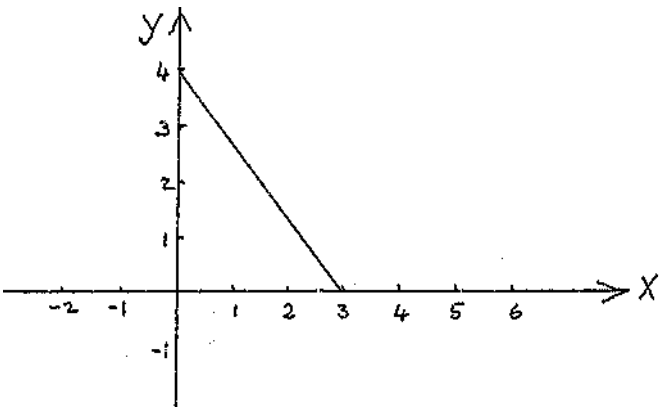
The main research findings have been summarised in section 10.3. There are some clear implications of these findings for improving what takes place inside the classrooms.

The present research investigated success and failure in mathematics among std 7 students. Now as a result of the findings a clearer picture of what failure really means has begun to emerge. It was discovered that the students interviewed in chapter 6 had difficulties with

the picture problems. From the analysis of these difficulties it became evident that many students had gaps in this knowledge which effectively blocked them from dealing successfully with the questions asked. The categories used for the analysis were: perception, operation, strategy, reality testing and time and these categories were elaborated in chapter 6. It can now be seen that a student weak at maths is not just a failure in this or that test or is unable to do a particular question. This research has shown that such a student has a difficulty and that this difficulty may be in any one or more of the five categories given in 10.3.4. The teacher must be able to recognise that a difficulty exists and he must be able to diagnose what the nature of the blockage is for the particular student. Furthermore the teacher must be able to help the student through it. Instead of merely saying that such a student is lazy or stupid or whatever, this research has shown that by and large the std 7 students are well motivated, hardworking, rational human beings who can indeed be successful in maths provided they receive the right kind of help and the right kind of teaching. The students who fail are not just bad at maths; they fail for some reason. If the reason for their failure can be recognised then the student may be able to overcome his difficulty and the whole situation may be changed. One example from the researcher's personal experience may

serve to illustrate this point. A girl doing matric maths was found to be totally unable to cope with third degree graphs. After working with her for some time the researcher found she did not properly understand the concept "gradient" but further probing revealed a much more fundamental problem. The student had not mastered the naming system (x;y) used in the cartesian plane. She thought the point (3;4) was a line joining 3 on the x-axis with 4 on the y-axis and the idea she had of the point (3;4) can be seen from how she represented it in a diagram as shown in Fig 10.3.

Fig 10.3. Misconception of point (3;4)



Once this was recognised the researcher was able to teach her the naming system which she learned readily and by means of a set of graded exercises this student was brought to the point of being ready for third degree graphs, mastering straight line graphs and the parabola

on the way. What was shocking in the example quoted here was that the student had gone through three years of high school maths without having mastered this basic concept. She had of course failed numerous tests and had come to regard herself as being "bad at maths". Such problems may emerge in group work or when the teacher works individually with a student but it can hardly be expected to emerge in class teaching where the lecture method predominates.

One obvious conclusion is that the role of the teacher must change from that of delivering chunks of maths content to be crammed by the students. In its place the teacher must take on the new role of facilitator; he must begin to see himself as one who helps the student to deal with real life situations. An understanding of maths and number operations can help the student in this task.

The implications of the present research for improved teaching of maths are presented below. Section 10.5.2. has suggestions which can be put into immediate effect and in section 10.5.3. there are long term changes and adjustment of the present system of training maths teachers.

Although in this research the focus was on the student learning and doing maths and most of the suggestions given here refer to the maths teacher, this position is not contradictory. What is given here points the way to

the teacher enabling him to bring the student to a deeper understanding. In other words the focus is still on the student.

10.5.2. Short term applications

It is not necessary to wait until a major overhaul of the school system is undertaken before doing something about improving maths teaching in the schools. Some things can be implemented immediately and thus even the present generation of std 7 students can be helped. Some of the more obvious improvements, arising out of the present research, are given here.

1. A strong positive correlation was found between attitudes to mathematics and mathematics attainment. Positive attitudes should be developed in the students. Some of the ways this could be done would be for the teachers:

   a) to set attainable goals for the students, lesson by lesson and test by test, in maths;
   b) to let the student experience success in each lesson and in each test;
   c) to explain the relevance of what is being studied in maths class not only for future careers, but for the students' own lives.

2. English language ability was also found to be a determining factor in students' performance in maths. Many students were so weak in English that they were un-

able to understand maths lessons given in English. Some remedial lessons in English clearly focussed on maths problems ought to improve this situation. If the vocabulary could be scaled down so as to be comprehensible and if the questions were designed in such a way as to be suited for straightforward oral answering then the English language fluency of the students would improve rapidly. It was also shown in chapter 7 that the preferred use of language among the students doing maths on their own or in small groups was a mixture of English and Setswana. At present the use of Setswana in maths classes is officially frowned upon. If teachers took a more flexible approach to language and encouraged the students to express themselves in whatever way they found easiest, then not only would the students be able to participate better in the maths lesson but use of the home language would help to situate the maths topics in their real experience and to link it with their home life, thus facilitating its assimilation.

3. It was found in chapter 8 that the teaching methods now common in the maths classes left a lot to be desired and that the inservice training courses concentrated mostly on the maths content and did little about presentation of material or teaching methods. Clearly if the teachers do not themselves know the content then that must be a priority for inservice but it should not exclude methodology. Some of the things that could be

handled at inservice courses are listed here:

a) How to teach new concepts is basic to successful maths teaching, yet during the lessons observed throughout the present research period few of the teachers employed any suitable method of teaching new concepts. For example in one lesson on statistics a teacher was recorded as having drawn a circle on the blackboard and told the class this was a pie chart and could be divided up into segments. He said that he found this word "pie" in the text book and he didn't know what it was but they must use it when doing this kind of question. Teachers should not only identify what previous knowledge is required when introducing a new topic, but ensure that the students have already mastered this knowledge and re-teach it if necessary. Visual and other material must be used if the new concept is a first order one and plenty of time must be allowed for proper assimilation of the concept into the students' individual schemata.

b) Once the concept has been well taught then the students must be provided with opportunities to practise, and drills are a useful method of doing this. The drills should be graded and provision made for both fast and slow learners. Organising students in groups can multiply the amount of time spent by each student in such practice.

c) The teachers should be encouraged to identify the nature of the problem experienced by so called "weak maths students". They should also be given help to find ways of assisting these weak students. The framework for problem solving given in chapter 5 could be used as a basis for a general approach to problem solving. The student could be helped to identify for himself the goal or the exact nature of the question to be solved - what he is asked to do. Then he could be helped to pick out the relevant information and make a plan which will enable him to use that information to find the answer. Lastly he should be trained always to check whether he has answered the question asked and whether he has made any errors along the way.

Again a lot of time is required for this. There is no point in rushing through a lot of topics in the syllabus without the students properly understanding and intergrating them into what they already know. The students and the teachers must appreciate that it is better "to know everything about something than to know nothing about everything" in the maths syllabus i.e. to have raced through all the topics in the syllabus is useless unless the students have mastered them, and it is better to have covered only a portion of the syllabus in a manner that everybody understands.

d) Stimulating material must be displayed on the classroom walls and should be used during maths classes. For example when teaching the std 7 geometry the teacher could summarise the std 6 material in a chart. Then as he develops each new lesson he could build up a series of diagrams and posters. This material could be used for regular revision and for drill work at the start of subsequent lessons.

e) The teacher could be taught, fairly easily, how to structure his work in units or sections. Each unit could start with revision of previously learned material on which the work in the unit is based. Each unit would end with a test for mastery - criterion referenced rather than norm referenced. Each unit should have built-in remedial lessons for work already done but not fully understood, and there should be other built-in lessons for revision and for reinforcing new material. Most importantly, the teacher himself must be trained how to devise such units of work for his own class in his own unique situation.

4. It was found much of the teaching promoted instrumental learning. One of the reasons for this suggested in the present research is the teacher's own view of maths, is the reification model, as described in chapter 2. Many of the teachers have not themselves inter-

nalized the subject matter and it is not meaningful for them. They do not see mathematics as a way of dealing with reality in their own lives. If teachers could be made aware of the difference between relational and instrumental understanding then they might be less inclined to teach a blind application of rules and rote learning. One way in which this could be brought about in the schools at present would be staff development sessions. Discussion of teaching methods arising out of teachers observing one another teaching could bring this about.

5. Another factor positively associated with success in mathematics was the homework patterns of students. Those students who did homework regularly were also the ones who performed best in the picture problems. It was further noted in chapter 8 that few of the teachers gave homework regularly or corrected it consistently and effectively. This should be a relatively easy matter to attend to right away and it could bring about better understanding provided certain precautions are taken. The tasks set for homework must be short and manageable for both students and teachers. Excessive amounts of homework would kill the joy of maths, would not likely be done by the students and never corrected by the teachers.

The points suggested here are not offered as a panacea for the ills which bedevil middle school mathematics.

Neither is it claimed that if implemented they would bring about an immediate improvement in the mathematics examination results. What is being claimed is that students whose performance in maths is poor can be helped by diagnosis of their difficulties. A change of emphasis must take place. The teacher must cease from lecturing, must cease from spewing forth subject matter and begin to focus more on the student and try to understand what the individual pupil is experiencing. For example many teachers are satisfied with lessons based exclusively on examples taken directly from the textbook. Some may even use a picture sketched on the blackboard to illustrate the question. But the written words or even the pictures may not be meaningful for the children. Pictures and words are several steps removed from real life situations and the students may need help in making these steps. What the student perceives is not necessarily the same as what was intended by the author of the textbook or the designer of the picture. This became clear in the interviews reported in chapter 6. For example picture problem 5 showed a boy cutting a 28 metre plank into 4-metre pieces. Because the picture showed a boy using a saw at approximately the midpoint some subjects thought the plank was being cut in half and ignored the words which stated it was being cut into 4-metre pieces. Others were confused by the dots which were used to show the length of the plank, some subjects

counted the dots and thought they could find the answer to the question in that manner.

What is required of the teacher therefore is that much greater attention be given to what is happening with the student and how he perceives the information given and what he is asked to do in a given exercise.

10.5.3. Long term suggestions

Many of the factors which were found to be associated with poor maths performance among the students in the Bafokeng region can be traced to deficiencies in the school system as a whole. Changes in the school system cannot be brought about by teachers alone. It is clear from reports such as the Bophuthatswana Education Commission reports of 1978 and 1986 and the South Africa De Lange report of 1983 that the authorities are aware of what needs to be done. No additional data relating to the larger social issues were gathered during the present research but some of the causes of the very poor performance of many students which became clear can be summarised as follows:

1. Legacy of Bantu education: the teachers were not expected to think for themselves, they were obliged to follow the regulations, syllabi, text-books, all of which were designed by people above them in a hierarchical structure. Keeping their jobs for teachers depended on following instructions from above.

2. In the observed lessons it was clear that most teachers used the same authoritarian approach. They handed down knowledge to the students. There was no opportunity for students to do any basic thinking for themselves.

3. The inservice training of teachers concentrated on teaching the syllabus content to the teachers. There was no effort made to deal with teaching methods, integration of the subject matter, using individual experiences etc.

4. The teachers work is controlled by the examinations; there are external public examinations at std 4, std 7, and std 10. The teachers must prepare their students for these examinations and their own belief is that the best way to prepare for exams is to practise doing exams. The whole school experience of students is reduced to one long series of examinations and tests, most of which they fail. Not unnaturally the students learn to cope with this situation by blocking off such failure from their real knowledge of life and it was found there was no correlation between self-concept scores and mathematics attainment. Another compounding factor for the teachers is the very large number of students they must deal with in their classes. Because of the large numbers it is difficult for them to find out what problems the students really have and the lecture method is the easiest way out for dealing with large

numbers.

Certain variables were found to be correlated with performance in mathematics. The personal variables were reported in chapter 7 and it was shown in that chapter how socioeconomic status and degree of westernization can operate to make it difficult for some students to learn mathematics. It was shown that many of the students come from disadvantaged homes and the school must not only be aware of this but must also provide experiences which the students may have missed out. It was also shown that students from low SES homes and traditional Tswana homes have cognitive styles and modes of perception which make it difficult for them to learn mathematics which is usually presented in an analytic style in the middle schools.

Kruteskii (1976) identified two types of problem solving behaviour among maths students namely analytic and geometric as described in chapter 9. When applied to the sample interviewed in chapter 6 of the present research, a third type seemed to emerge: those whose preferred mode of learning is geometric but because of a mismatch of teaching styles they are forced to operate in the verbal-logical mode i.e. analytic mode. From the observations of classroom teaching made in chapter 8, there was a strong leaning toward the analytic mode because this prevailed in the textbooks being used. Only one instance of geometric learning was noted. Care must

be taken when discussing teaching and learning styles and authors such as Bennett (1976, P.23) have pointed out that there is no one best teaching style for all teachers. This research is not suggesting a simplistic solution nor does it claim that the introduction of creative innovative teaching styles to the schools will bring about a miracle change in students' maths achievement. It has been pointed out already that two aspects of teaching need to be stressed viz:

a) learning of concepts which must be accompanied by experiments, manipulation of materials etc. Bennett (ibid P.2) describes this as progressive education;

b) but this is not enough, there must also be drills and practice of skills and this is best done using the traditional formal methods of teaching.

What is advocated, therefore is that the teachers should use mixed methods taking the pupils' personalities and cultural milieu into account. This leads to the question of how to bring about fundamental changes in teaching. The change is a long term one and must start with the teacher training colleges. It is suggested that many of the bad features of what happens in maths teaching could be overcome by adopting a new approach to the preparation of student teachers in the colleges. At present the focus is on mathematics content. The model of mathematics underpinning much of this work is the reification model presented in chapter 2. If the inter-

action model could be made the basis for training student teachers then their work in the classrooms might be transformed. Mastery learning, diagnostic testing, revision work and remedial teaching would hopefully, replace the present system of lecturing and predominance of tests and examinations, which most of the students fail, would be moderated.

No effort is made here to present a blueprint for maths education of student teachers. The above discussion of findings of the present research is simply meant to question the existing patterns of teacher training. It is up to the people involved in this training to work out for themselves how the ideas put forward here may be implemented.

10.6. Conclusion

In this research what has been uncovered is the apallingly low level of mathematical understanding among the standard 7 students of the Bafokeng region. This has been traced in the first place to environmental and cultural factors obtaining in the home situation of the students. Secondly the rigid teaching method used in maths classes with heavy reliance on the text book does not make for learning with any insight. It has been suggested that those students who can cope with the existing system are not necessarily those with mathematical ability but more likely those who can cram and learn

rules. Such learning, in most instances, is meaningless fo[illegible]h students and teachers.

It was proposed that one way to tackle the problem in the short term is to organise in-service courses for the std. 7 maths teachers where the emphasis would be on creative dynamic teaching methods. In the long term a whole change of attitude is called for. There is a deep rooted view of mathematics as a western import which has little meaning outside the classroom. In the kind of society the Bafokeng wish for themselves, mathematics is an integral part of that society. This is where the long term solution must begin. The need exists; it ought not be too difficult to answer that need. In middle school mathematics there are two components for success, namely the understanding of basic concepts and mastery learning of these concepts. This can only come about if mathematics is seen to answer a real life need. In teaching the concepts at primary level teachers must be aware that most of the children have no abstraction of number in their home language nor have they had many stimulating experiences of number, shapes etc. from their home enviroment. So the teachers must adopt a two pronged attack which will aim for mastery of basic mathematics concepts such as addition, division, subtraction and multiplication in the second language and then drilling of number bonds until mastery level is reached.

APPENDIX A: Personal Interviews conducted during the research.

Appendix A.1. Khutlapye, E. (1989)
Has been a teacher at Bafokeng High School since 1972. Was appointed Principal in 1989. Topics discussed included general history of the school, teachers and parents attitudes to mathematics, school boycotts of 1976, possible perceptions of students relative to paper and pencil tests.

Appendix A.2. Moteane, Z. (1983)
Born 1910, died 1986. An old man regarded as an elder of the Bafokeng. Topics discussed were the chiefs of the Bafokeng and the tribal customs and traditions.

Appendix A.3. Mputle, M. (1989)
Born 1900. Still active and living in Ga-Luka where he runs a poultry business. He was active in the South African communist party in Johannesburg and Cape Town. He returned to the Bafokeng region in the sixties and was a member of the tribal kgotla. The discussion covered his own life history with particular emphasis on his experiences of schooling.

Appendix A.4. Phiri, D. (1988)
Is a student teacher at Hebron college of education. During a two week teaching practice period in 1989 he kept a diary of his experiences as a middle school maths teacher at the request of the researcher.

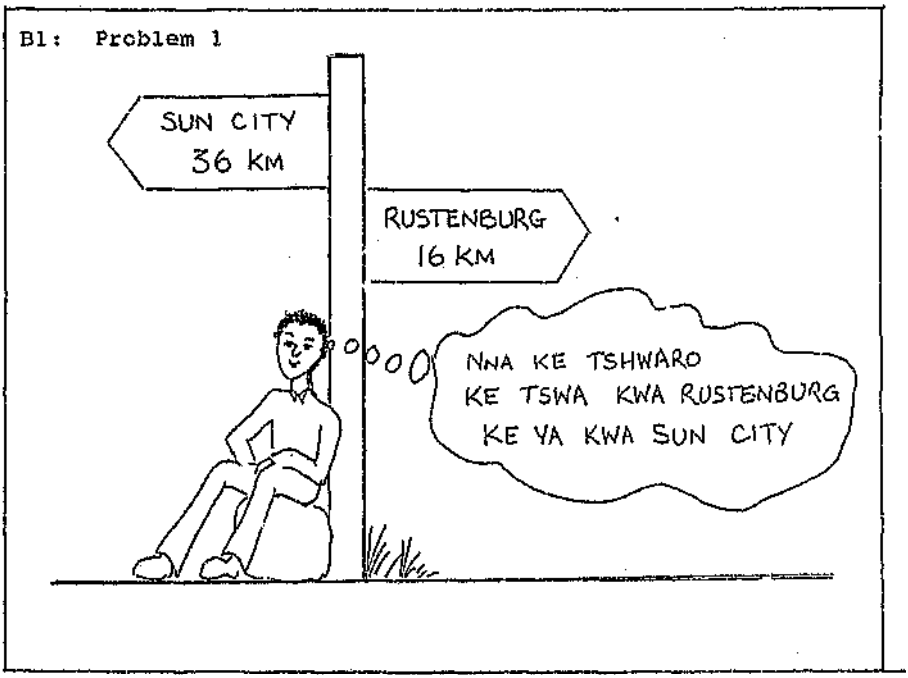
Appendix A.5. Pitsoe, A. (1988)
Belongs to an old Bafokeng family who have been involved in teaching since the beginning of the century. He was a student at the Bafokeng High School in the fifties and later joined the staff and was some time deputy principal. At present is a school inspector. In the interview, education among the Bafokeng, introduction of mathematics to Bafokeng High School, general history of the school were discussed, as well as the activities of his uncle Dedrick Pitsoe who had been trained as a teacher in Lovedale college and established his own private school in Kgale after breaking away from the Lutheran church school at Saron.

Appendix A.6. Ramoroa, R. (1987)
Is the owner of a cafe in Phokeng and is chairman of the Bafokeng High School Parents' Committee. As well as general history and customs of the Bafokeng and uses of the language, the interview covered the early period when Mrs. McGregor helped to establish schools in the Bafokeng region.

Appendix A.7. Setshedi, V. (1987)
Was born in 1912 and is a member of the parents' school committee. The topics discussed included general history, and how the people view education. Having been a herdsboy in his youth, he was able to relate how he and his companions used to count the cattle and recognise which were missing.

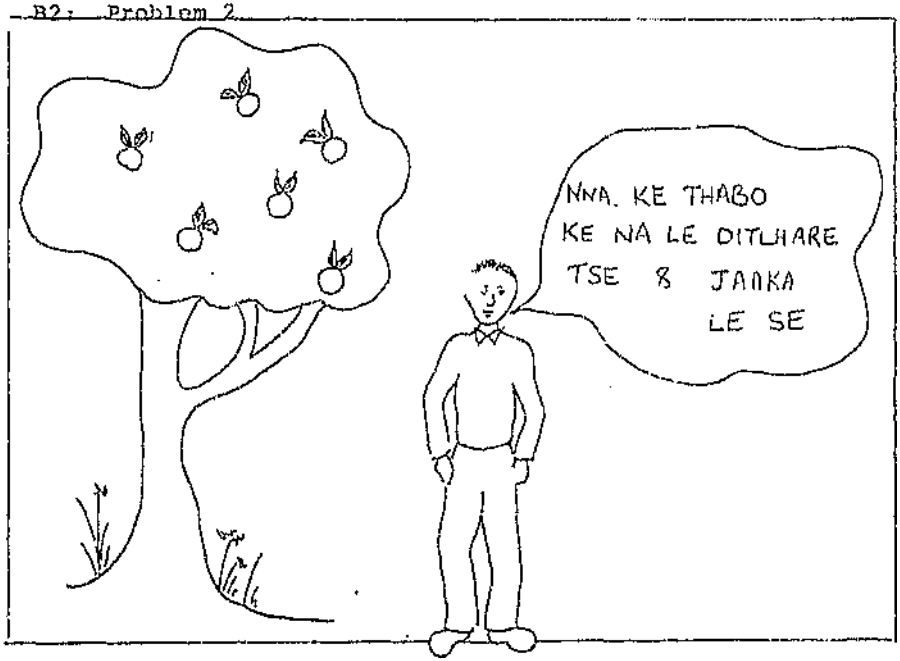
APPENDIX B: Picture Problems

B1: Problem 1

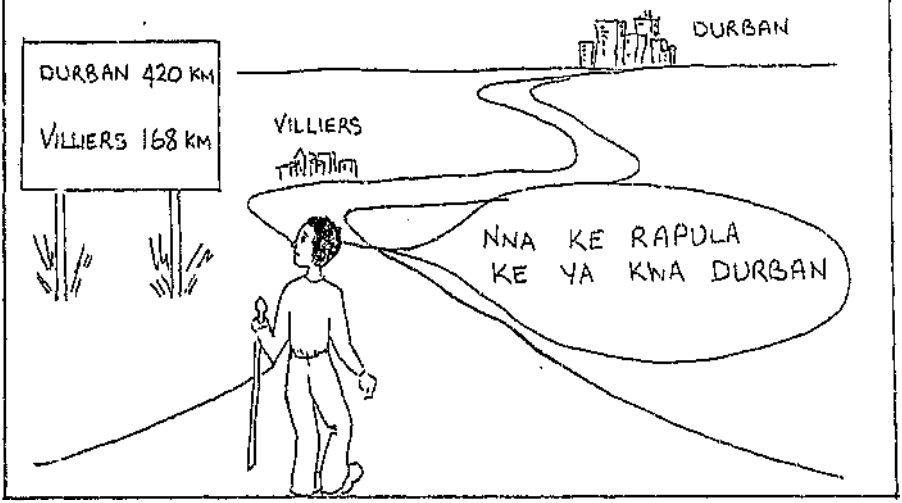


How far from Rustenburg to Sun City?

B2: Problem 2

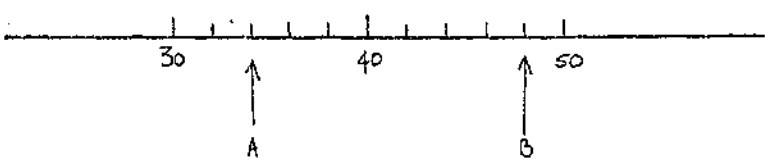


B3: Problem 3



HOW FAR FROM VILLIERS TO DURBAN?

B4: Problem 4



WHAT NUMBER IS SHOWN AT 'A'? AT 'B'?

B5: Problem 5



HOW MANY 4M PIECES CAN THOMAS GET FROM THIS BOARD?

APPENDIX C: Attitudes Closed Question
Place a tick ✓ in the space you prefer for each statement

	YES I AGREE	I DON'T KNOW	NO I DISAGRE
1) I find maths very difficult			
2) I enjoy doing maths homework			
3) I have a good maths teacher this year			
4) Maths has no meaning for me outside of school			
5) Maths is of great use to me in other subjects			
6) My parents don't care about how I do in maths			
7) It is best to cram maths and not to try too hard to under stand it			
8) Most students can't do maths because they have bad teachers			
9) Most students can't do maths because the textbooks are dull			
10) I was good at Maths in the Primary school			
11) I was good at maths in standard 5			
12) I was good at maths in standard 6			
13) I had a good maths teacher in Primary school			
14) I had a good maths teacher in standard 5			
15) I had a good maths teacher in standard 6			
16) Maths in necessary for everyone			
17) Maths can be learned by anyone if they try hard			
18) Most Tswana students find maths very difficult			
19) Whites are always good at maths			
20) I enjoy solving maths problems			
21) I find maths very easy			
22) I try to learn maths, only because of my future career			
23) In maths we use very difficult words			
24) Maths is easy to learn when the teacher uses Setswana			
25) I would not like to be a maths teacher			
26) Maths students are much admired by non-maths students			
27) I can never solve a maths problem			
28) Now that we have calculators there is no need for maths			
29) Good maths students always get good jobs			
30) My maths text book in standard 7 is very nice			
31) I like maths			
32) I hate doing maths problems			
33) I think maths helps me to think clearly			
34) I dont like doing maths homework			
35) I am the only person in my family who has done maths in standard 7			

APPENDIX D: Attitudes Open Question

Please answer these questions by writing what you think. There are no right and r answers. What you think may help me in my work as a maths teacher.

1) Do you think everybody should do maths in standard 7 ? YES ☐ NO ☐

2) Can you please give some reasons for your answer ?
   (i) _____
   (ii) _____
   (iii) _____

3) Would you like to do maths in High School ? YES ☐ NO ☐

4) Can you please give some reasons for your answer ?
   (i) _____
   (ii) _____
   (iii) _____

5) What qualities do you think a good maths teacher should have ?

   _____

6) What do you think is the most difficult thing in maths ?

   _____

   example: _____

7) What do you think is the easiest thing in maths ?

   _____

   example: _____

8) How often do you do maths homework ?

   _____

9) Do you have someone with whom you can discuss maths ? YES ☐ NO ☐

10) If YES - Who is this person ? _____

11) Is there anything else you wish to tell me about maths ?

   _____
   _____
   _____
   _____
   _____

MORUTWANA - Ke lebogela thuso ya gago.
Ke go eleletsa katlego le masego mo thutong tsa gago.

Nna, ke Brother Joseph.

APPENDIX E: Cultural Beliefs

Please answer these questions briefly. There are no right or wrong answers.

1) What is your Tswana name ? _____

2) What does it mean ? _____

3) Who gave you this name ? _____

4) Why did they give you this name ? _____

5) Do you like this name ? _____

6) Do you think everyone should have a Tswana name ? _____

7) Do you wish your own children in future will have a Tswana name ? _____

8) To whom do you like to go for advice at home ? _____

9) What happens at home when you do something wrong ? _____

10) What happens when you do something good ? _____

11) Who are the badimo ? _____

12) Have you ever consulted a witchdoctor ? _____

13) How can the witchdoctor help people ? _____

14) If there is trouble between members of your family - how is it usually solved ? _____

15) During weekends how do you spend your free time ? (list a few things you do) _____

16) Who is your favourite singer ? _____

17) What kind of work is suitable for men ? _____

18) What kind of work is suitable for women ? _____

19) Who do you like best at home ? _____

20) What person in the world do you admire most ? _____

Here are some things people do - tick what you think about each one:

	IT IS GOOD	DON'T KNOW	OLD FASHIO
21) shaving the head after a death of relative			
22) digging the grave at night ti[illegible]			
23) making bojalwa for funerals			
24) wife remaining indoors for months after her husband's death			
25) usin[illegible]gers to eat from a common bowl			
26) payin[illegible]bola for future wife			
27) waiting until properly married before having a baby			
28) walking in a slow manner like a person in the village			
29) mother carrying her baby on her back go pepa ngwana			
30) children being reared by grandparents			
31) young people going for bogwera/bojale			
32) doing mmino wa setso			
33) carrying loads on the head			
34) washing clothes at the river			
35) reporting disputes to the kgotla			

APPENDIX F: Socio-economic Status

1. Name: _____ Male ☐ Female ☐
2. Date of Birth: _____
3. Address: _____
4. Is your mother alive ? Yes ☐ No ☐ Is your father alive? Yes ☐ No ☐
5. Did your mother attend school ? Yes ☐ No ☐ Highest standard done by her: ___
6. Did your father attend school ? Yes ☐ No ☐ Highest standard done by him: ___
7. Where do your parents live ?

	(a) Mother	(b) Father
Lives at home	_____	_____
Lives away from home	_____	_____
Comes home every weekend	_____	_____
Comes home every month	_____	_____
Comes home occasionally	_____	_____
Never comes home	_____	_____

8. Is your mother: Working _____ Not working _____ Self-employed _____
9. What type of work does your mother do ?
   Clerk/Secretary _____ Domestic worker _____ Sales lady _____ Teacher _____ Nurse ___
   Other kind of work (please describe it) _____
10. Is your father: Working _____ Not working _____ Self-employed _____
11. What type of work does your father do ?
    Clerk _____ Farm worker _____ Salesman _____ Teacher _____ Mine Worker _____
    Other kind of work (please describe it) _____
12. What kind of house do you live in ?
    Brick house _____ mud hut _____ Tin shack _____ Other (please describe it) _____
13. Number of rooms in your home: _____
14. What fuel do you usually use for cooking ? _____
15. What kind of light do you use for reading at home ? _____
16. Do you have: Indoor flush toilet _____ Pit latrine _____ Other _____
17. Do you obtain water from: river _____ village pump _____ your own pump _____ other ___
18. Does your family have a Post Office Box ? _____ What is the number ? _____
19. Do you listen to the radio ? _____ Which station ? _____
20. Does your family buy a newspaper ? Every day _____ Weekly _____ Never _____
21. Do you watch television ? Every day _____ Sometimes _____ Never _____
22. Who is the bread-winner of the family ? _____
23. Who is paying your school fees ? _____
24. I don't know you - please tell me about yourself:

_____

_____

_____

_____

_____

_____

_____

APPENDIX G: Content Analysis for Interviews

KIELY 1987 SUCCESS AND FAILURE IN MATHS INTERVIEW A

NAME: _____ EXAM RESULTS:

AGE: ____ SCHOOL: _____ STD: ___ (i) JUNE: MATHS% ___ AGG % ___

MATHS TEACHER: _____ (ii) NOV: MATHS% ___ AGG % ___

PARENTS father: alive ☐ dead ☐ mother: alive ☐ dead ☐

likes best: father ☐ not sure ☐ mother ☐

reason: _____

MATHS likes maths: Yes ☐ not sure ☐ No ☐

reason: _____

good at maths: Yes ☐ not sure ☐ No ☐

reason: _____

TEACHER thinks him good in maths: Yes ☐ not sure ☐ No ☐

reason: _____

does maths at home: frequently ☐ once or twice ☐ never ☐

reason: _____

someone at home to help: Yes ☐ No ☐

general comment: _____

STUDENT male ☐ female ☐

right handed ☐ left handed ☐

spoken English ability: Good ☐ Fair ☐ Poor ☐

personality: Open outgoing ☐ normal ☐ shy introverted ☐

reflective ability: good ☐ fair ☐ poor ☐

other comments: _____

TIME TAKEN FOR PART A: ____ minutes

EVALUATION OF INTERVIEW BY STUDENT: Liked it: Yes ☐ No ☐

reasons: _____

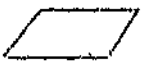
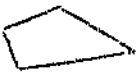
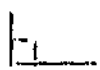
other comments by student: _____

other comments by interviewer: _____

APPENDIX II: Geometric Shapes: Vocabulary Test

Ke léka ka thata go ribolola tsela e o moithuti a ka ithutang maths. Ke kopa gore o nthuse. Ka kopa kwala mafoko a setswana mo bocnong ba di figures.
Fa o itse mafoko go feta dongwe, a kwala mo di phatlheng. Morago o dira jalo ka go kwala ka English.

LEINA: _____ BONG: Mosetsana ☐
DINGWAGA: _____ MOPHATO: _____ (tshwaya) mosimane ☐

	Figure	Mafoko a Setswana	English word
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

APPENDIX I: GEFT

NAME: _____ CLASS: _____

AGE: _____ MALE FEMALE MATHS MARK _____

FATHER'S EDUCATION: _____ FATHER'S OCCUPATION: _____

SIMPLE FORMS

A



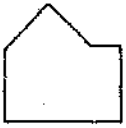
B



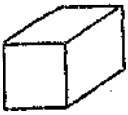
C



D



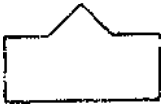
E



F



G



H



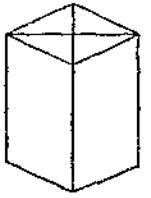
FIRST SECTION	SECOND SECTION	THIRD SECTION
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5.	5.	5.
6.	6.	6.
7.	7.	7.
	8.	8.
	9.	9.
TOTAL: _____	TOTAL: _____	TOTAL: _____

INSTRUCTIONS. This is a test of your ability to find a simple form when it is hidden within a complex pattern.

Here is a simple form which we have labeled 'X'

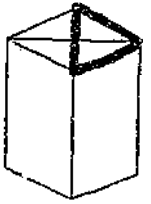


This simple form named 'X', is hidden within the more complex figure below:

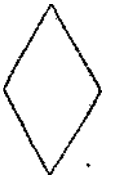


Try to find the simple form in the complex figure and trace it in pencil directly over the lines of the complex figure. It is the SAME SIZE, in the SAME PROPORTIONS, and FACES IN THE SAME DIRECTION within the complex figure as when it appeared alone.

This is the correct solution, with the simple form traced over the lines of the complex figure:



Note that the top right-hand triangle is the correct one; the top left-hand triangle is similar, but faces in the opposite direction and is therefore *not* correct.





Solution



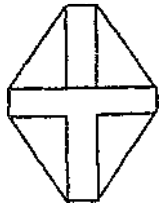
In the following pages, problems like the ones above will appear. On each page you will see a complex figure, and under it will be a letter corresponding to the simple form which is hidden in it. For each problem, look at the *BACK COVER* of this booklet to see which simple form to find. Then try to trace it in pencil over the lines of the complex figure. Note these points:

1. Look back at the simple forms as often as necessary.
2. ERASE ALL MISTAKES.
3. Do the problems in order. Don't skip a problem unless you are absolutely "stuck" on it.
4. Trace ONLY ONE SIMPLE FORM IN EACH PROBLEM. You may see more than one, but *just trace one* of them.
5. The simple form is always present in the complex figure in the SAME SIZE, the SAME PROPORTIONS, and FACING IN THE SAME DIRECTION as it appears on the back cover of this booklet.

Do not turn the page until the signal is given

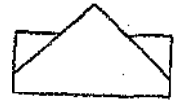
FIRST SECTION

1



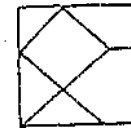
Find Simple Form "B"

2



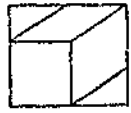
Find Simple Form "G"

3



Find Simple Form "D"

4



Find Simple Form "E"

5



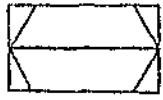
Find Simple Form "C"

6



Find Simple Form "F"

7

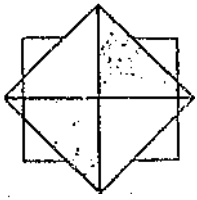


Find Simple Form "A"

PLEASE STOP. *Wait for further instructions.*

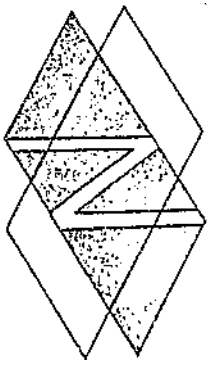
SECOND SECTION

1



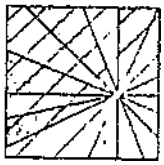
Find Simple Form "G"

2



Find Simple Form "A"

3



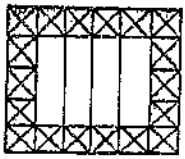
Find Simple Form "C"

4



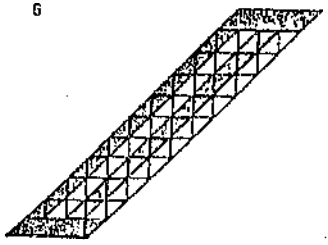
Find Simple Form "E"

5



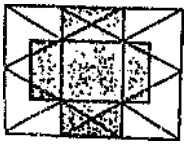
Find Simple Form "B"

6



Find Simple Form "C"

7



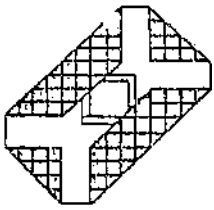
Find Simple Form "E"

8



Find Simple Form "D"

9

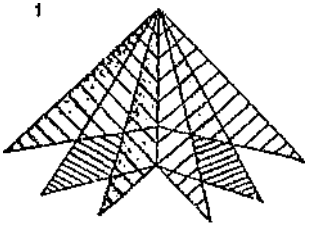


Find Simple Form "H"

PLEASE STOP. *Wait for further instructions.*

THIRD SECTION

1



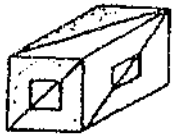
Find Simple Form "F"

2



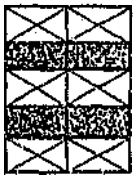
Find Simple Form "G"

3



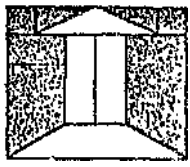
Find Simple Form "C"

4



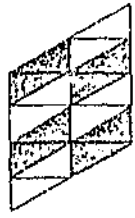
Find Simple Form "E"

5



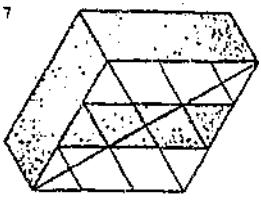
Find Simple Form "B"

6



Find Simple Form "D"

7



Find Simple Form "A"

8



Find Simple Form "C"

9



Find Simple Form "A"

PLEASE STOP. Wait for further instructions.

APPENDIX J: Extension of Self Concept Instrument

Please mark an X in the square you think is best.

1) When you succeed in school tests it is because:
   (a) You studied hard ☐ OR (b) The test was easy ☐
2) When you remember something in maths it is because:
   (a) You went over it many times ☐ OR (b) It was an easy thing to learn ☐
3) When your parents reward you for succeeding in your studies it is because:
   (a) They love you very much ☐ OR (b) You work so hard ☐
4) When your teacher says that your homework is unsatisfactory it is because:
   (a) The homework is difficult ☐ OR (b) You did not try hard enough ☐
5) When you find it hard to solve maths problems it is because:
   (a) You did not study enough ☐ OR (b) The teacher gave difficult problems
6) If your teacher thinks you are stupid in maths it is because:
   (a) You don't study very hard ☐ OR (b) You just don't have brains for maths

For each of these please mark an X in the square you think is best for a good student

	AGREE	DISAGREE
7) It is better in maths to do exactly what the teacher says than to think about solving a problem in your own way	☐	☐
8) It is better to love maths for itself than to get good marks in maths	☐	☐
9) It is better to be hard working in school than to be an honest person	☐	☐
10) It is better to get good marks in test than to love doing maths problems	☐	☐
11) It is better to be considerate to you friends than to succeed in school	☐	☐
12) It is better to spend time doing your own homework than helping your friend who is week in maths	☐	☐

NAME _____ S

AGE _____ SEX MALE / FEMALE

FATHER'S EDUCATION _____

FATHER'S OCCUPATION _____

MATHS TEST MARK: _____

LIST OF REFERENCES

Acton, T.A. (1980) Educational criteria of success. Educational Research, June 1980, vol. 23, no. 3. P.163-169.

Alexander, L. and Simmons, J. (1975) The Determinants of School Achievement in Developing Countries. International Bank for Reconstruction and Development. Staff working paper no. 201.

Allan, J.C. (1982) Learning about Statistics. Johannesburg: Macmillan South Africa.

Allport, G.W. (1961) Pattern and Growth in Personality. New York Holt.

Allport, G.W. and Pettigrew, T.F. (1957) Cultural influence on the perception of movement - The trapezoidal illusion among the Zulus. American Psychological Association 1957. P.104-113.

Anastasi, A. (1968) Psychological Testing 3rd ed. London Macmillan Company.

Ary, B., Jacobs, L.C. and Razavich, A. (1985) Introduction to Research in Education. New York: Holt, Rinehart and Winston.

Assan, T.E. (1986) Teaching strategies in accounting education. Popagano, November 1986. vol. 7. no. 3. Bophuthatswana: Department of education.

Auerbach, F.E. (1978) S.A. School Enrolment Patterns 1920-1970 and Problems of Early Leaving in African Coloured and Indian Schools. Unpublished Ph.D. Thesis. Pietermaritzburg: Natal University.

Bauer, G. (1984) Thlabane Miracle Maths. Unpublished work-sheets and evaluation. Thlabane College of Education.

Beard, P. (1977) Theoretical underpinnings disputes about teaching styles and pupil progress. Journal of Education. (University of Natal). vol. 9. P.49-57.

Becker, P. (1962) Path of Blood. London: Longmans.

Beebout, H.S. (1972) The production surface for academic achievement. In L. Alexander, and J. Simmons (1975) The Determinants of School Achievements in Developing Countries. P.31-37.

Behr, M.J. Lesh, R. Post, T.R. Silver, E.A. (1983) Rational number concepts. In Lesh R. and Landau M. (1983) Acquisition of Mathematics Concepts and Processes. P.92-127. New York: Academic Press.

Bennett, N. (1976) Teaching Styles and Pupil Progress. London: Open Books.

Bernstein, B. (1977) Class Codes and Control Vol. 2. London: Routledge & Kegan Paul.

Berry, J.W. (1966) Temne and Eskimo perceptual skills. International Journal of Psychology. 1966 vol.1 P.207-229.

Berry, J.W. (1969) On cross-cultural comparability. International Journal of Psychology. 1969 vol.4 P. 119-128.

Berry, J.W. and Witkin, H.A. (1975) Psychological differentiation in cross-cultural perspective. Journal of Cross-cultural Psychology. 1975 Vol.6 P.4-87.

Bertini, M. Pizzamiglio, L. Wapner, S. eds. 1986. Field Dependance in Psychological Theory, Research and Application.

Bishop, J. (1983) Space and Geometry. In R. Lesh, & M. Landau, eds. (1983), Aquisition of Mathematics Concepts and Processes. P.176-204. New York: Academic Press

Bophuthatswana, (1978) Report of the First National Education Commission. Mmabatho: Republic of Bophuthatswana.

Bophuthatswana, (1985) Mathematics in the Middle School: Syllabus. Mmabatho: Department of Education.

Bophuthatswana, (1986) Report of the Second National Education Commission. Mmabatho: Republic of Bophuthatswana.

Bophuthatswana, (1989) Annual National Education Report Mmabatho: Department of Education.

Bramhare, M.M.D. (1977) Shona Culture and Mathematics Learning. D.Ed. student paper. University of Rhodesia: Faculty of Education.

Breutz, P.L. (1953) The Tributes of Rustenburg and Pilanesberg Districts. Pretoria: Government Printer.

Brewer, R.I. and Haslum, M.N. (1986) Ethnicity and the experience of socio-economic disadvantage and educational attainment. British Journal of Education: A World Problem. Paris: UNESCO.

Brown, M. (1981) Number operations. In K. Hart ed (1981) Children's Understanding of Mathematics 11-16. London: John Murray.

Bruner, J.S. (1960) On learning mathematics. The Mathematics Teacher. December 1960. P.610-619.

Bruner, J.S. (1976) Learning how to do things with words. In J.S. Bruner and A. Gorton eds (1978). Human Growth and Development. Oxford: Wolfson College.

Bruner, J.S. Olver, R.R. Greenfield, E. eds (1966). Studies in Cognitive Growth. New York: Wiley.

Bulpin, T.V. (1965) Lost Trails of the Transvaal. Johannesburg: Thomas Nelson and Sons.

Carpenter, T.P. Moser, J.M. Romberg, T.A. (1982) Addition and Subtraction: A Cognitive Perspective. New Jersey: Lawrence Erlbaum Associates.

Carpenter, T.P. Moser, J.M. (1983) The aquisition of addition and subtraction concepts. In R. Lesh and M. Landau eds (1983) Acquisition of Mathematics Concepts and Processes P.7-44. New York: Academic Press.

Carrier, J.G. (1984) Cultural themes in educational debates. British Journal of Sociology of Education. 1984 vol. 5 no.1.

Cartwright, D.P. (1953) Analysis of qualitative material. In L. Festinger and D. Katz eds (1953) Research Methods in the Behavioural Sciences. Chapter 10. New York: Holt Rinehart and Winston.

Cates, W.M. (1985) A Practical Guide to Educational Research. New Jersey: Prentice-Hall.

Chaplin, J.P. and Krawiec, T.S. (1960) Systems and Theories of Psychology. New York: Holt, Rinehart and Winston.

Christie, P. (1985) The Right to Learn: The Struggle for Education in South Africa. Johannesburg: Sached Trust/Raven Press.

Coertze, R.D. (1987) Bafokeng Family Law and Law of Succession. Pretoria: SABRA.

Cohen, L. and Manion, L. (1980) Research Methods in Education. London: Croom Helm.

Cole, M. Gay, J. Glick, J. Sharp, D. (1971) The Cultural Context of Learning and Thinking. London: Methuen & Co.

Coleman, J.S. (1966) Equality of Educational Opportunity Washington: U.S. Office of Education. Reprint 1979: New York: Arno Press.

Cundy, H.M. (1977) The Caribbean Mathematics Project: Training the Teacher as the Agent of Reform. Paris: UNESCO.

Cundy, H.M. (1978) The Lesotho Mathematics Work Card Project: An Evaluation. British Council.

Davenport, T.R. and Hunt, K.S. eds (1974) Documents on South African History: The Right to the Land. Cape Town: David Philip.

Dawson, J.L.M. (1967 b) Cultural and physiological influences upon spatial-perceptual processes in West Africa Part 1. International Journal of Psychology 1967 vol.2. no.2 P.115-128.

Dawson, J.L.M. (1967 b) Cultural and physiological influences upon spatial-perceptual processes in West Africa Part 11. International Journal of Psychology. 1967 vol.2. no.3. P.171-185.

De Jong, T. (1988) A Handbook for Guidance Counsellors. Mmabatho: Bophuthatswana Department of Education Psychological services.

De Lange (1981) Provision of Education in the RSA. Report of the Main Committee of the H.S.R.C. Investigation into Education. Pretoria: H.R.S.C.

Denoon, D. and Nyeko, B. (1984). Southern Africa since 1800. London and New York: Longman.

Deregowski, J.B. (1968) Difficulties in pictorial depth perception in Africa. British Journal of Psychology. 1968 vol.59. no.3. P.195-204.

Deregowski, J.B. (1972) Reproduction of orientation of Kohs-type figures: a cross-cultural study. British Journal of Psychology. 1972 vol.63. no.2. P.283-296.

Deregowski, J.B. (1978) Thinking in perspective. Cross-cultural Studies. 1978 P.132-158.

Deregowski, J.B. (1980) Illusions, Patterns and Pictures. London: Academic Press.

De Vaal, D.J. and Van den Berg, D.J. (1977) Design and Implementation of Criteria for the Compilation of Differentiated Mathematics Syllabuses. H.S.R.C. Pretoria: H.S.R.C. Report 0-44.

Dewey, J. (1902) The Child and the Curriculum. University of Chicago Press: Phoenix Books.

Dewey, J. (1910) How We Think. Boston: D.C. Heath & Co.

Dewey, J. (1915) The School and Society. University of Chicago Press: Phoenix Press.

Diaz, R.M. (1983) Thought and two languages: The impact of bilingualism on cognitive development. In E.W. Gordon ed (1983) Review of Research in Education 10. P.23-54 Washington D.C.: American Educational Research Association.

Dickson, L. Brown, M. Gibson, O. (1984) Children Learning Mathematics: A Teacher's Guide to Recent Research. Schools Council, England: Holt, Rinehart and Winston.

Dienes, Z.P. (1959) The growth of mathematical concepts in children through experience. Educational Research 2. P.9-28.

Dienes, Z.P. (1964) The Power of Mathematics. London: Hutchinson Educational Ltd.

Dienes, Z.P. (1965) Modern Mathematics for Young Children. Pinnacles, Harlow, Essex: E.S.A. schools materials division.

Dienes, Z.P. (1967) A theory of mathematics learning. Building up Mathematics. 3rd edition. Chapter 2. London: Hutchinson Publishing Group.

Donaldson, M. (1978) Children's Minds. Glasgow: William Collings & Sons.

Duncan, H.F. Gourlay, N. and Hudson, W. (1973) A study of pictorial perception among Bantu and white primary school children in South Africa. Human Sciences Research Council Publication Series no.31. Johannesburg: Witwatersrand University Press.

Dunkin, M.J. and Biddle, B.J. (1974) The Study of Teaching. New York: Holt, Rinehart and Winston.

Evers, J.M. (1983) Mr Evers replies. South African Journal of Science. July 1983. vol.79. P.261-265.

Ewan, C. and White, R (1984) Teaching Nursing: a self-instructional Handbook. New York: Croom Helm.

Ferguson, C.A. (1959) Diglossia. Word 15. P.325-340.

Festinger, L. and Katz, D. (1973) Research Methods in the Behavioural Sciences. New York: Holt Rinehart and Winston.

Fey, J.T. (1970) Pattern of Verbal Communication in Mathematics Classe. New York: Columbia University Teachers College Press.

Fleming, W. (1980) The school mathematics project. In L. Stenhouse ed 1980. Curriculum Research and Development Action. P.25-41. London: Heinemann Educational Books.

Floyd, A. ed (1981) Developing Mathematical Thinking. England: Open University Press.

Freer, D.J. (1973) Sex bias as a variable in primary education. In S.F.W. Orbell, D.J. Freer, E. Hendrikz. Pre-school Opportunity and Sex Differences. Occasional paper no.2 1973. P.16-21. Salisbury: University of Rhodesia.

Freer, D. and Randall, P. eds (1983) Educating the Educators. Johannesburg: Department of Education, University of the Witwatersrand.

Freire, Paulo (1972) Pedagogy of the Oppressed. Harmondsworth: Penguin Books.

Fuson, K.C. (1989) An analysis of the counting-on procedure in addition. In T.P. Carpenter et al (1982) Addition and Subtraction. P.67-82 New Jersey: L. Erlbaum.

Fuson, K.C. and Hall J.W. (1983) The acquisition of early word meanings In H.P. Ginsburg ed (1983) The Development of Mathematical Thinking. Chapter 2, P.50-109. Orlando, Florida: Academic Press.

Gardner, R.W. Holzman, P.S. Klein, G.S. Linton, H.B. Spence, D.P. (1959) Cognitive Control: A study of individual consistencies in cognitive behaviour. Psychological Issues Monograph 4. 1959. vol.1. no.4.

Gay, J. and Cole, M. (1967) The New Mathematics in an Old Culture. New York: Holt, Rinehart and Winston.

Gelman, R. and Gallistel, C.R. (1978) The Child's Understanding of Number. Cambridge Mass: Harvard University Press.

Ginsburg, H.P. (1982) The development of addition in contexts of culture, social class and race. In Carpenter et al (1982) Addition and Subtraction: A Cognitive Perspective. Chapter 14, P.191-210. New Jersey: Lawrence Erlbaum.

Ginsburg, H.P. ed (1983) The Development of Mathematical Thinking. Orlando, Florida: Academic Press.

Ginsburg, H.P. and Opper, S. (1969) Piaget's Theory of Intellectual Development. Englewood Cliffs: Prentice-Hall.

Gonzales, R.R. and Roll, S. (1985) Relationship between acculturation, cognitive style and intelligence. Journal of Cross-cultural Psychology. June 1985. vol. 16. no.2. P.190-205.

Good, T.L. Biddle, B.J. and Brophy, J.E. (1975) Teachers Make a Difference. New York: Holt, Rinehart and Winston.

Goodenough, D. (1986) History of the field dependence construct. Bertini et al eds (1986) Field Dependence in Psychological Theory, Research and Application. Chapter 2. P.5-14.

Gordon, I.J. (1975) Human Development: A Transactional Perspective. New York: Harper and Row.

Greeno, J. Riley, M.S. and Gelman P., (1978) In Resnick L.B. In H.P. Ginsburg ed (1983) Chapter 4

Groen, G. Kieran, C. (1983) The many faces of Piaget. In J.P. Ginsberg ed (1983) The Development of Mathematical Thinking. Chapter 9. P.352-375. Orlando, Florida: Academic Press.

Groenwald, R. (1976) Aspects in the Traditional World of Culture of the Black Child which Hamper the Actualization of Intelligence. H.S.R.C. Report no. 0-54. Pretoria: H.S.R.C.

Guilford, J.P. (1950) Fundamental Statistics in Psychology and Education. 2nd ed. New York: McGraw-Hill.

Cuma, T.A. (1982) A Comparison of Black and White Photographs vs Black and White Line Drawings on Comprehension of a Test in English by Zulu Children. University of Pittsburg: Ph.D. thesis. University Microfilms International.

Hamilton, D. (1976) Curriculum Evaluation. London: Open Books.

Hart, K.M. ed (1981) Children's Understanding of Mathematics: 11-16. London: John Murray Ltd.

Heritage, R. (1980) The sixth form mathematics curriculum project. In L. Stenhouse ed (1980) Curriculum Research and Development in Action. P.190-199. London: Heinemann Educational Books.

Holt, J. (1964) How Children Fail. Harmondsworth: Penguin Books.

Hughes, E.R. (1981) A comparative study of the order of acquisition of the concept of weight, area and volume. In A. Floyd ed (1981) Developing Mathematical Thinking. P.87-116. England: Open University Press.

Hurd, D.L. and Kipling, J.J. (1985) The Origins and Growth of Physical Science, vol 1. Harmondsworth: Penguin Books.

Husén, T. ed (1967) International Study of Achievement in Mathematics: A Comparison of Twelve Countries, Vol.1. Stockholm: Almqvist and Wiksell.

Husén, T. (1979) The School in Question. Oxford University Press.

Illich, I. (1970) Deschooling Society. Harmondsworth: Penguin Books.

Inhelder, B. (1976) New currents in genetic epistemology and developmental psychology. In J.S. Bruner and A. Garton eds (1978) Human Growth and Development. Oxford: Wolfson College Lectures.

Jencks, C. Smith, M. Acland, H. Bane, M.J. Cohen, D. Gintin, H. Michelson, S. (1972) Inequality: A Reassessment of the Effect of Family and Schooling in America. New York: Basic Books.

Jersild, A.T. (1952) In Search of Self. New York: Teachers College.

Jordaan, W. and Jordaan, J. (1989) Man in Context. Johannesburg: Lexicon Publishers.

Jordaan, W. Jordaan, J. and Nieuwoudt, J.M. (1975) General Psychology: A Psychobiological Approach, Vol.1 and Vol.2. 2nd edition. Johannesburg: McGraw Hill Book Co (S.A.).

Karplus, R. Pulos, S. and Stage, E.K. (1983) Proportional reasoning of early adolescents. In R. Lesh and M. Landau eds (1983). Acquisition of Mathematics Concepts and Processes. P.45-86. New York: Academic Press.

Katz, D. (1953) Field Studies. In L. Festinger and D. Katz eds (1953) Research Methods in the Behavioural Sciences. Chapter 2. New York: Holt, Rinehart and Winston.

Kerlinger, F.N. (1986) Foundations of Behavioural Research. 3rd ed. New York: C.B.S. Publishing Japan Ltd.

Khutlapye, E. (1989) Personal interview with the researcher. Unpublished.

Kiely, J.H. (1983) Some Factors Relating to Dropping-ing-out from Bafokeng High School Senior Standards. Unpublished M.Ed dissertation. Johannesburg: University of the Witwatersrand.

Kruteskii, V.A. (1976) The Psychology of Mathematical Abilities in School Children. London, Chicago: U.P.

Lawrence, M. and Roodt, M. (1984) Socio-economic locality, aspirations - a pilot study of three Bophuthatswana schools. Education Research Monograph 2. Mmabatho: University of Bophuthatswana Institute of Education.

Lehobye, S.M. (1987) Managing a large class: a case for small group instruction. Popagano Nov.1987.Vol.8, no.2 P.9-10. Journal of the department of education Bophuthatswana.

Lesh, R. and Landau M. (1983) Acquisition of Mathematics Concepts and Processes. New York: Academic Press.

Lester, F.K. (1983) Trends and issues in mathematical problem solving research. In R. Lesh and M. Landau eds. (1983) Aquisition of Mathematics Concepts and Processes. Chapter 8 P.229-261. New York: Academic Press.

Levin, J. (1973) Elementary Statistics in Social Research. New York: Harper and Row.

Levy, M.B. (1971) Determinants of primary school dropouts in developing countries. Comparative Education Review. February 1971, P.44-58.

Lewis. L.J. ed. (1967) The Learning Process and the Teaching of Science and Mathematics in Developing Countries. Paper prepared by Bruner, J.S.; Lee, D.; Lewis, J.; Rogers, C.; and Stone R.H.

Lloyd, B. and Gay, J. eds (1981) Universals of Human Thought: Some African Evidence. Cambridge University Press.

Macnab, D.S. and Cummine, J.A. (1986) Teaching Mathematics 11-16. A Difficulty Centred Approach. Oxford: Basil Blackwell Publishers.

Macnamara, J. (1966) Bilingualism in Primary Education. Edinburgh University Press.

Macnamara, J. (1967) The effects of instruction in a weaker language. Journal of Social Issues. 1967, Vol.xxiii, no.2. P.121-136.

Mangope, L.M. (1988) Mandatory Sanctions: Bophuthatswana and Frontline O.A.U. Nations. Lagos: Emmcon Books.

Mason, R.J. (1983) Oori or Moloko: The origins of the Sotho-Tswana on the evidence of the iron age of the Transvaal. South African Journal of Science. July 1983, Vol.79, P.261.

Mathematical Association (1974) Mathematics Eleven to Sixteen. London: G. Bell & Sons Ltd.

McClelland, D.C. (1961) The Achieving Society. New York: Irvington.

McClelland, D.C. (1975) Power: The Inner Experience. New York: Irvington.

Mdluli, S.B. (1980) A Description of the Educational System of KwaZulu with Emphasis on Pupil Retention. Bloemfontein: University of the Orange Free State.

Michau, J.M. (1978) Problem areas in the acquisition of mathematical concepts by black children in South Africa. Journal of Education. July 1978, vol.10, no.3, P.21-29.

Minkowich, A. Davis, D. and Bashi, J. (1982) Success and Failure in Israeli Elementary Schools: An Evaution Study with special Emphasis on Disadvantaged Pupils. New Brunswick: Transaction Books.

Molotlegi, E.P. (1982) A Short Note on the History of the Bafokeng People Of Bophuthatswana. Phokeng: Bafokeng Tribal Authority.

Molotlegi, E.P. (1985) The Bafokeng: A Calling Card. Phokeng: Bafokeng Tribal Authority.

Molotlegi, S. (1989) Go-ahead geese and platinum eggs. Frontline Magazine. March 1989, vol.8, no.7, P.35-36.

Morrison, A. and McIntyre, D. (1973) Teachers and Teaching. 2nd ed. Harmondsworth: Penguin Books.

Moteane, Z. (1983) Personal interview with the researcher. Unpublished.

Mputle, M. (1989) Personal interview with the researcher. Unpublished.

Murphree, M.W. Cheater, G. Dorsey, B.J. Mothobi, B.D. (1975) Education, Race and Employment in Rhodesia. Salisbury: University of Rhodesia.

Murphy, F. (1988 a) Head, heart and hands or "sit-stillery". Educamus. February 1988, vol.34, no.2, P.26-30. Journal of the Department of Education and training, Pretoria.

Murphy, F. (1988 b) How young are our schools? Popagano. December 1988, vol.9, no.2, P.17-19. Journal of the department of education, Republic of Bophuthatswana.

Nisbet, J. (1980) Educational research: The state of the art. In W.B. Dockrell and D. Hamilton eds. (1980) Rethinking Educational Research. P.1-10. London: Hodder and Straughton.

Novillis-Larson, C. (1980) Locating proper fractions. School Science and Mathematics. 1980, vol.53, no.5, P.423-428.

Nyikana, H.K. (1982) Pupil Repetition in Primary Schools of Ciskei. Bloemfontein: University of the Orange Free State.

Okonji, M.O. (1969) The differential effects of rural and urban upbringing on the development of cogni-

tive styles. International Journal of Psychology. 1969, vol.2, no.4, P.293-305.

Okonji, M.O. (1971) Culture and children's understanding of geometry. Journal International de Psychologie. 1971, vol.6, no.2, P.121-128.

Orbell, S.F.W. Freer, D.J. Hendrikz, E. (1973) Pre-school Opportunity and Sex Differences as Factors Affecting Educational Progress. Salisbury: University of Rhodesia.

Peak, H. (1953) Problems of objective observation. In L. Festinger and D. Katz eds. (1953) Research Methods in the Behavioral Sciences. Chapter 6. New York: Holt, Rhinehart and Winston.

Peaker, G.F. (1975) An Empirical Study of Education in 21 Countries - a Technical Report. Stockholm: Almqvist & Wiksell.

Peel, E.A. (1956) The Psychological Basis of Education. Edinburgh: Oliver and Boyd.

Phiri, D. (1989) Personal Diary. Unpublished.

Piaget, J. (1950) The Psychology of Intelligence. London: Routledge and Kegan Paul.

Piaget, J. and Inhelder, B. (1969) The Psychology of the Child. London: Routledge and Kegan Paul.

Pitsoe, A. (1988) Personal interview with the researcher. Unpublished.

Pizzamiglio, L. and Zoccolotti, P. (1986) Individual differences: cerebral structure and cognitive characteristics. In M. Bertini et al eds (1986) Field Dependence in Psychological Theory, Research and Application. Chapter 4, P.27-44.

Plaatjie, Sol T. (1930) Mhudi. Ed. T. Couzens (1978). London: Heinemann.

Polit, D. and Hungler, B. (1983) Nursing Research: Principles and Methods. 2nd ed. Philadelphia: Lippincott Co.

Popagano Editorial (1987) Popagano. November 1987, vol.8, no.2, P.1-2. Journal of the department of education, Republic of Bophuthatswana.

Power, E.J. (1962) Main Currents in the History of Education. New York: McGraw-Hill.

Price-Williams, D.R. Gordon, W. Ramirez, M. (1969) Skill and conservation: a study of pottery-making children. Developmental Psychology. 1969, vol.1:769.

Purbrick, K.J. Plant, E.L. Kheong [illegible] (1982) Relational and Instrumental Learning: a classroom Experiment in Understanding Mathematics. Unpublished paper, Singapore: Institute of Education.

Ramoroa, R. (1987) Personal interview with the researcher. Unpublished.

Resnick, L.B. (1983) A developmental theory of number understanding. In H.P. Ginsburg ed (1983) The Development of Mathematical Thinking. Chapter 3, P.108-150. Orlando, Florida: Academic Press.

Riley, M.S. Greeno, J. Heller, J. (1983) Development of children's solving problem ability in arithmetic. In H.P. Ginsburg ed (1983) The Development of Mathematical Thinking. Chapter 4, P.153-196. Orlando, Florida: Academic Press.

Rockeach, M. (1968) International Encyclopedia of the Social Sciences. (1968) vol.1. USA: Macmillan Company.

Romberg, T.A. (1982) An emerging paradigm for research on addition and subtraction skills. In T.P. Carpenter et al eds (1982) Addition and Subtraction: A cognitive perspective. New Jersey: Lawrence Erlbaum Associates.

Rose, B. and Tunmer, R. eds (1975) Documents in South African Education. Johannesburg: Ad Donker Publisher.

Rosier, M.J. (1978) Early School Leavers in Australia. Stockholm: Almqvist & Wiksell.

Ruperti, R.M. (1975) The Education System in Southern Africa. Pretoria: Van Schaik.

Rutter, M. Maughan, B. Mortimore, P. Ouston, J. (1979) Fifteen Thousand Hours: Secondary Schools and their Effects on Children. London: Open Books.

Rutter, M. Maughan, B. Mortimore, P. Ouston, J. (1980) Educational criteria of success: a reply to Acton. Educational Research. June 1980, Vol.22, no.3, P.170-173.

Schapera, I. (1953) Ethnographic Survey: Southern Africa Part III The Tswana London: International African

Institute.

Schaeffer, B. Eggleston, V.H. Scott, J.L. (1974) Number development in young children. Cognitive Psychology 6. P.357-379.

Schiefelbein, and Simmons J. (1978) Determinants of School Achievement: A Review Of the Research for Developing Countries. Manuscript commissioned by the research review and advisory group, Inter national bank for reconstruction and development.

Schofield, H. (1972) The Philosophy of Education: an Introduction. London: Allen & Unwin.

Schools Council (1967) Mathematics for the Majority, Working Paper No.14. London: H.M. Stationery Office.

Serpell, R. (1976) Cultures Influence on Behaviour. Great Britain: Methuen & Co. Ltd.

Setshedi, V. (1987) Personal Interview with the researcher. Unpublished.

Sharp, R. and Green, A. (1975) Education and Social Control: A study in Progressive Primary Education. London: Routledge & Kegan Paul.

Shipman, S. and Shipman, V.C. (1985) Cognitive styles: some conceptual methodological and applied issues. Review of Research in Education 12, 1985, P.229-287 Washington: American Educational research association.

Siann, G. and Ugwuegbu, D. (1980) Educational Psychology in a Changing World. London: George Allen & Unwin.

Simmons, J. (1972) Towards an evaluation of adult education in a developing country. In L. Alexander & J. Simmons (1975) The Determinants of School Achievement in Developing Countries. P.16-20 International bank for reconstruction and development.

Skemp, R.R. (1971) The Psychology of Learning Mathematics. Harmondsworth: Penguin Books.

Skemp, R.R. (1976) Relational understanding and instrumental understanding. Mathematical Teaching. December 1976, No.77.

Skemp, R.R. (1979) Intelligence, Learning and Action. Chichester: John Wiley & Sons.

Skemp, R.R. (1980) The Functioning of Intelligence and the Understanding of Mathematics. Paper presented at the 4th International congress on mathematical education, August 1980. Berkley, California.

Skemp, R.R. (1981) What is a good environment for the intelligent learning of mathematics? Recherches en Didactique des Mathematiques. 1981, vol.2, no.2, P.257-266.

Skemp, R.R. (1982) Theories and Type 2 Theories in relationship to Mathematical learning. In J.P. Carpenter et al eds. (1982) Addition and Subtraction: A Cognitive Perspective. Chapter 13, P.183-190. New Jersey: Lawrence Erlbaum Associates.

Smith, M.B. (1968) Attitude Change. International Encyclopedia of the Social Sciences. 1968, vol.1. Cromwell, Collier & Macmillan.

Snow, R.E. (1976) Research on aptitude for learning. Review of Research in Education 4, 1976, American educational research association.

Snow, R.E. and Lohman, D.F. (1984) Toward a theory of cognitive aptitude for learning from instruction. Journal of Educational Psychology. 1984, vol.76, no.3. P.347-376.

Thias, H.H. and Carnoy, M. (1969) Cost benefit analysis in education: a case study on Kenya. In L. Alexander and J. Simmons (1975). The Determinants of School Achievement in Developing Countries. P.13-16 International bank for reconstruction and development.

Thompson, A.R. (1981) Education and Development in Africa. London: Macmillan Press.

Tuckman, B.W. (1972) Conducting Educational Research. New York: Harcourt Brace Jovanovich Inc.

Van den Berg, D.J. (1978) A Pedagogical Study of the Black Man's Mathematical Ability. Pretoria: H.S.R.C. report no. 0-75.

Van den Berg, D.J. (1980) Group Oriented Education as a Means of Promoting Black Pupils Insight into Mathematics. Pretoria: H.S.R.C. report no. 0-96.

Vergnaud, G. (1982) A classification of cognitive tasks and operations of thought involved in addition and subtraction problems. In T.P. Carpenter et al (1982) Addition and Subtraction chapter 4.

P.39-59. New Jersey: L. Erlbaum.

Vergnaud, G. (1983) Multiplicative Structures. In R. Lesh and M. Landau eds. (1983) Acquisition of Mathematical Concepts and Processes. Chapter 5, P.128-175. New York: Academic Press.

Vernon, P.E. (1969) Intelligence and Cultural Environment. London: Methuen.

Verster, J.M. (1982) A Cross Cultural Study of Cognitive Proce ses using Computerized Tests. Unpublished Ph.D. thesis Pretoria: UNISA.

Verwey, C.T. (1978) The Use of Statistics on Repeaters for Educational and Manpower Planning. Bloemfontein University of the Orange Free State.

Verwey, C.T. (1981) Educational Wastage in Bophuthatswana: Its Statistical Scope, Economic Implications and Influence in Manpower Production. Bloemfontein: University of the Orange Free State.

Visser, K. (1988) Mathematics as language. Matlhasedi. Aug/Sept. 1988, vol.7, no.1/2, P.28. University of Bophuthatswana: Education Bulletin.

Walraven, F. (1981) The Geology of the Rustenburg Area. Pretoria: Government Printer.

White, D.R. (1983) Teachers for Africa. In D. Freer and P. Randall eds. (1983) Educating the Educators. Johannesburg: Department of education, University of the Witwatersrand.

White, D.R. and Kiely, J.H. (1985) The drop-out phenomenon of senior secondary pupils in black schools: a case study of the drop-out of standard 9 pupils from the Bafokeng High School, Bophuthatswana. South African Journal of Education. 1985, 5 (3) P.162-166.

Wilkinson, A.C. (1981) An Analysis of the Problems Experienced by Pupils in Mathematics at Standard 5 level in the Developing States in the South African Context. Bloemfontein: University of the Orange Free State.

Witkin, H.A. Lewis, H.B. Hertzman, M. Machover, K. Bretnall, M. Wapner, S. (1954) Personality Through Perception: A Clinical Study. New York: Harper.

Witkin, H.A. Oltman, P.K. Raskin, E. Karp, S.A. (1971) Manual for Embedded Figures Tests. Palo Alto,

California: Consulting Psychologists.

Witkin, H.A. Goodenough, D.R. Oltman P.K. (1979) Psychological differentiation: current status. Journal of Personality and Social Psychology. 1979, 37. P.1127-1145.

Witkin, H.A. Goodenough, D.R. (1981) Cognitive styles: essence and origins. Psychological Issues Monograph 51. New York: International Universities Press Inc.

Wober, M. (1966) Sensotypes. The Journal of Social Psychology. 1966, 70, P.181-189.

Wober, M. (1967) Adapting Witkin's field independence theory to accomodate new information from Africa. British Journal of Psychology. 1967, vol.58, no.1 and 2, P.29-38.

Wober, M. (1969) Distinguishing centri-cultural from cross-cultural tests and research. Perceptual and Motor Skills. 1969, vol.28.

Wolff, P. (1963) Breakthroughs in Mathematics. New York: Signet Books.

Woods, P. ed. (1980) Pupil Strategies: Explorations in the Sociology of the School. London: Croom Helm.

Young, M. ed. (1971) Knowledge and Control: New Directions for the Sociology of Education. London: Collier Macmillan.

Young, R.E. (1977) Education and the image western knowledge in Papua New Guinea (Part I). Papua New Guinea Journal of Education. 1977, vol.13, no.1.

Table 7.7. Consistency of Responses for S.E.S. Instrument

SCHOOL	CLASS	NUMBER OF RESPONSES	SELF-CONTRADICTORY RESPONSES	PERCENTAGE CONSISTENCY OF RESPONSES
KELEDI	7A	79	18	77%
	7B	73	4	95%
	7C	78	25	68%
	7D	74	4	95%
MATALE	7A	39	6	85%
	7B	47	5	89%
	7C	28	5	82%
	7D	40	1	98%
MAPENYA	7A	44	2	95%
	7B	43	3	93%
	7C	39	1	97%
TOTAL		584	74	87%

7.2.5. Results of the S.E.S. questionnaire

Five hundred and eighty four standard 7 students completed the S.E.S. questionaire. The scores ranged from 5 up to 41 from a possible minimum of 0 to a possible maximum of 42. The frequency distribution of the scores

Author: Kiely JH
Name of thesis: Success and failure in Mathematics among standard seven students in he Bafokeng Region of Bophuthatswana

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