EXAMINING THE CLASSROOM PRACTICES OF PHYSICAL SCIENCE EDUCATORS: A CASE STUDY IN FOUR SECONDARY SCHOOLS IN THE PIETERMARITZBURG AREA, KWAZULU-NATAL

By

GABRIEL GOODHOPE B. NDLOVU

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION, IN THE SCHOOL OF EDUCATION, UNIVERSITY OF KWAZULU NATAL, (PIETERMARITZBURG)

2004

DECLARATION

I hereby declare that this dissertation represents my original work and has not otherwise been submitted in any form for any degree or examination to any University. Where use has been made of the work of others, it is duly acknowledged in the text.

G.G.B. Ndlovu

22. 04. 2004

Date

As supervisor, I have agreed that this dissertation may be submitted.

Prof. Nithi Muthukrishna

ABSTRACT

The purpose of this study was to examine the classroom practices of the Physical Science educators and analyze how these practices influence deep conceptual learning and understanding. Four secondary schools in the Pietermaritzburg area, in the province of KwaZulu-Natal were selected as cases for in-depth qualitative study. All the schools were African schools servicing a working class community. From each school only one educator participated, and each educator was observed teaching one of his/her classes. Two educators were observed teaching Grade 12 learners and the other two taught Grade 11 learners. The study utilized participant observation, interviews and relevant documents as source of data. The main findings of the study suggest that educator practices were predominantly traditional. They were characterized by lack of effective interactions with learners, dealing with surface features of the content without probing for depth necessary for understanding. It was also found that schools lack a culture of resource development. Though resources were inadequate, the little that educators had was not effectively utilized. The educators seemed to be shifting towards employing a variety of assessment methods, but the difference was still superficial. The findings have implications for policy, practice and in-service training of educators (INSET). Evidence suggests that educators' beliefs have a major influence on how they teach, and that unsound beliefs about teaching and learning are a threat to the implementation of policy. INSET programmes need to target the beliefs of educators about science teaching and learning.

ACKNOWLEDGEMENTS

I would like to extend my sincere gratitude to my supervisor, Prof. Nithi Muthukrishna, for great supervision. Were it not for her constructive criticism and insights on the subject, this work would have remained insurmountable. I owe special thanks to Mrs Jenny Abrams for her untiring service as a typist, without whom this dissertation would not have been completed. I also like to thank the educators who participated in my study and the principals of the various schools who granted me access into the classrooms.

My wife, Bobo, and my children: Makhosazane, Monwabisi and Nkanyiso suffered many deprivations of love and attention while this research was being undertaken. Their understanding, support and endurance I acknowledge with deep gratitude. My passion became their pain. I thank them for their patience.

LIST OF ABREVIATIONS AND ACRONYMS

AEC	Australian Education Council
ANC	African National Congress
APU	Assessment of Performance Unit
CASME	Centre for the Advancement of Science and Mathematics Education
CNE	Christian National Education
Ex-DEC	Ex-Department of Education and Culture
Ex-DET	Ex-Department of Education and Training
Ex-HoD	Ex-House of Delegates
Ex-NED	Ex-Natal Education Department
HG	Higher Grade
HoD	Head of Department
HPS	Higher Performing Schools
IFP	Inkatha Freedom Party
INSET	In-Service Training of Educators
LPS	Lower Performing Schools
NDoE	National Department of Education
NRC	National Research Council
OBE	Outcomes Based Education
SG	Standard Grade
UDF	United Democratic Front

TABLE OF CONTENTS

APPENDICES

CHAPTER 1

INTRODUCING THE STUDY

1.1 INTRODUCTION

In this chapter, a brief overview of the context and issues leading to the present study will be provided. The discussion starts with a short historical background of South African education. Secondly, the research problem leading to the research questions will be presented. The statement of the problem will give the context of the present study, and how other researchers have answered questions related to the questions explored in the present study. This will be followed by the purpose of the study, then the significance of the study. In these paragraphs, the author will discuss the research process and the contribution which this study could make to the field. Towards the end of this chapter, there will be a brief summary of the rest of the chapters in this dissertation. The chapter ends by giving some definition of terms.

1.2 THE STUDY IN CONTEXT

The problems in the education of the Africans started long ago, even before the introduction of Bantu Education in 1953.

> *"... The financial provision by the state was always very far from adequate. There was understaffing, over crowding, inadequacy of building, and lack of equipment"*
>
> (Horrell, 1964:1)

The introduction of Bantu Education Act No. 47 of 1953 formalized and aggravated the problem. The education of the Africans was controlled by the apartheid Government and separated from the education of the other races. The Minister of Bantu Education regulated

"the control of the schools, conditions of service of the teachers, school funds and many other matters" (Horrell, 1964:11). The control by the Minister made it possible to restrict secondary schooling which was accompanied by high failure rates. Hartshorne (1992) refers to this condition as "Secondary Schooling: The Syndrome of Failure" (Hartshorne, 1992:59). The apartheid Government wanted to manipulate the education of the Africans with the aim of making it inferior, as Parker (1994) argues that "its role was to produce the right mental attitudes, disposition, knowledge and beliefs, and the appropriate types of skills" (Parker, 1994:93). Bantu Education had to develop trivial skills, so that the "Bantus" could not take jobs which were beyond certain levels. This is clearly depicted in the following extract from the Dr Verwoerds speech, the then Minister of Education.

> It is the policy of my Department that Bantu Education should have its roots entirely in the Native areas and in the Native environment and in the Native community... The Bantu must be guided to serve his own community in all respects. There is no place for him in the European community above the level of certain forms of labour... Up till now he has been subjected to a school system which drew him away from his own community and practically misled him by showing him the green pastures of the European but still did not allow him to graze there (Malherbe, 1977:546).

Since the introduction of Bantu education, the education of Africans was characterized by resistance in the form of strikes and boycotts. The African's education system was a "site of conflict" (Parker, 1994:94). The major events in education under the National Party are summarized below as adapted from Christie (1985).

Table 1 Major Events in Education under the National Party

1949	The government appointed the Eiselen Commission to look at African education. The commission recommended 'resorting to radical measures' for the 'effective reform of the Bantu school system'.
1953	The Bantu Education Act was passed. The Act said that all schools for Africans had to be registered with the government. As a result of the Act, almost all of the mission schools closed down. So did most night schools. This is when the system of apartheid education began.
1954-5	Black teachers and students protested against Bantu Education. The African Education Movement was formed to provide alternative education. For a few years, cultural clubs operated as informal schools, but by 1960 they had closed down.
1959	The Extension of University Education Act was passed. This Act set up separate 'tribal colleges' for black university students. Blacks could no longer freely attend white universities. Again, there were strong protests.
1963	The Coloured Person's Education Act was passed. Control over 'coloured' education was placed under the Department of Coloured Affairs. 'Coloured schools also had to be registered with the government. Coloured education was made compulsory.
1965	The Indian Education Act was passed. Control over Indian education was placed under the Department of Indian Affairs. Indian education was also made compulsory.
1967	The National Education Act was passed, setting out the principles of Christian National Education for white schools.
1969	The black student organization, South African Student Organization (SASO) was formed.
1976	The June 1976 Soweto uprisings began.
1979	The Education and Training Act was passed to replace the Bantu Education Act of 1953. African education was now in the hands of the Department of Education and Training – the DET. But education for Africans remained virtually the same.
1980	The schools boycotts began. The students were protesting against Bantu Education.
1981	The Government set up the De Lange Commission to conduct an in-depth investigation into education and to make recommendations for an education policy for South Africa. The De Lange Report recommended a single department of Education for all, education of equal equality for all, and a changed schooling structure.
1983	The Government issued a White Paper, accepting the De Lange guiding principles but refusing to accept the major recommendations of a single education department for all.
1984	Continued schools protest against apartheid education. Start of the Education Charter Campaign.

The prominent feature of the above events is the separation of the education departments according to racial groups: Bantu, Coloureds, Indians and Whites. This was the essence of

apartheid – "separate development". Separate development enabled the government to distribute the resources according to their priorities. The table below indicates that the education of the Africans was not at the top of their priority list.

Table 1.2 Pupil-Teacher Ratios in South Africa, Selected Years

Year	African	Coloured	Indian	White
1971	1:58	1:31	1:27	1:20
1976	1:52	1:30	1:27	1:20
1977	1:50	1:29	1:27	1:20
1978	1:49	1:29	1:27	1:20
1980	1:47	1:29	1:25	1:19
1982	1:39	1:27	1:24	1:18
1983	1:43	1:27	1:24	1:15

(Source: South African Institute of Race Relations cited by Christie, 1985)

Amongst the discriminations and deprivations, unequal distribution of resources and large classes seemed to have a serious impact on the education of the Africans. These conditions promoted poor teaching styles.

Apart from the imbalances in education, the education of the time was underpinned by controversial assumptions. It was assumed that learners were empty vessels, irresponsible and incomplete, needed to be moulded in order to become responsible and mature adults. "The moulding theory absolutized the content which was to be presented to the learners and a vast amount of content load to be made available" (Stuart, 1987:14). What was taught was mainly the factual knowledge, most skills were not addressed except the skill of memorizing factual knowledge.

After the 1994 democratic elections, the African National Congress (ANC) led Government of National Unity began to undo the legacy of apartheid. On top of their agenda was to redress the imbalances of apartheid education (White Paper on Education and Training, March 1995). In the place of the ethnically based Departments of Education, a single Department of Education was formed and there was an integration of education and training. An integrated approach implies a view of learning which rejects a rigid division between "academic" and "applied", "theory" and "practice", "knowledge" and "skills", "head" and "hand" (White Paper on Education and Training, March 1995:15). In other words, education and training are coupled and not viewed as parallel.

The Ministry of Education also introduced the democratic governance of the schools which is documented in the South African Schools Act of 1996. The governance of the schools is exercised by the schools governance structures called the Governing Bodies. School Governing Bodies are representative of the main stakeholders which include parents, teachers, learners, non-teaching staff and community, especially at secondary school level. The government also introduced documents such as the Bill of Rights in the Constitution which amongst other things, protects the rights of the learners. It stipulates that "every child has the right to be protected from maltreatment, abuse and degradation" (Law No. 108 of 1996 South African Schools Act of 1996). Consequently, corporal punishment is prohibited. "No person may administer corporal punishment at a school to a learner" (Act No. 84, South African Schools Act of 1996). Another document which has a direct bearing on what happens inside the classroom is the National Curriculum Framework (Department of Education (DoE, 1996)). It seems as if what is contained in this document can bring about changes in teaching and learning in schools, that is, provided the practitioners – educators,

are willing and able to practice what is proposed. Below is a summary of some of the principles stated in the National curriculum framework.

- Learning programs should put learners first, recognize and build on their knowledge and experience, and respond to their needs (learner-centeredness),
- The curriculum should be relevant and appropriate to current and anticipated future needs of the individuals and society,
- There must be an integration of academic and applied knowledge, theory and practice, knowledge and skills, teaching, learning and assessment (continuous assessment),
- The perception of educators as dispenser of knowledge, will also have to change to one where learners are valued as equal and active participants in learning and developing processes,
- Learning programmes should promote critical and creative thinking (DoE, 1996).

These principles seem to suggest drastic changes. Taking the image of a learner, for example, from viewing a learner as an empty vessel to considering a learner as a human being with dignity having prior knowledge. The teaching methods should change from teaching learners trivial skills to teaching critical and creative thinking.

1.3 STATEMENT OF THE PROBLEM

During the struggle against apartheid and Bantu Education, the education of the Africans was adversely affected. The culture of learning and teaching was lost. Everyone was hoping that things were going to be better after the 1994 elections. To a certain extent, things 'became normal', school boycotts and strikes stopped, and most of the youth went back to school. However, one would think that learners were going to show more interest in schooling,

teaching and learning would be more meaningful and exciting, and the pass rate would improve, especially to those who have been under privileged for decades or centuries. When this study was started in the year 2000, there was no significant change in the national matriculation results. This does not mean that the matriculation result are the metre stick of measuring success, but they are a concern to all the stakeholders: parents, employers, institutes of higher education and the state.

Comparatively speaking, the present situation is such that the ex-Model C schools (former white state schools) are trying to maintain their average pass rate of 90% in Grade 12, whilst the African schools are struggling to achieve an average pass rate of 55% (KwaZulu-Natal Senior Certificate Examinations statistics, 1999). The picture looks bad when one looks at the overall Grade 12 pass rate, but it becomes worse when you now consider specific subjects such as Physical Science and Mathematics. This can be seen in document in Appendices A1 to A4, which shows the KwaZulu-Natal pass rate statistics for Physical Science and Mathematics. The tables show the following important features:

- Large numbers of candidates take Physical Science and Mathematics at standard grade level.
- A significant drop of the number of higher grade candidates, and a corresponding increase of standard grade candidates in the year 2000.

From this observation, it seems as if the improvement in pass rate during the year 2000 was more quantitative than qualitative.

The tables in Appendices A1 to A4 are condensed into Tables 1.3(a) to 1.3(d), below. What is reflected on these tables are the number of Physical Science candidates in percentages and

the symbols that they obtained during the years 1996, 1997, 1998, 1999 and 2000 respectively.

Table 1.3(a) Physical Science Standard Grade Pass Rate Statistics in the Pietermaritzburg Region

	Number of Candidates in Percentages				
Year	**1996**	**1997**	**1998**	**1999**	**2000**
Total Candidates	**N=6 515**	**N=9 253**	**N=12 625**	**N=14 915**	**N=19 645**
Symbols					
A (80-100)	0,64	0,13	0,10	0,03	0,08
B (70-79)	2,32	0,75	0,45	0,38	0,70
C (60-69)	6,58	2,23	2,00	1,61	2,24
D (50-59)	12,72	5,27	5,03	4,02	6,60
E (40-49)	18,83	11,17	10,66	10,08	14,05
F (34-39)	14,40	10,53	10,74	12,16	14,98
FF(30-33)	10,27	8,72	9,62	8,84	9,28
G (20-29)	23,76	29,97	31,66	36,04	32,23
H (10-19)	10,02	27,81	27,40	26,11	19,02
H (00-09)	0,46	3,42	2,34	0,73	0,82

(Source: KwaZulu-Natal Senior Certificate Examinations Statistics, December 2000)

Table 1.3(b) Physical Science Higher Grade Pass Rate Statistics in the Pietermaritzburg Region

	Number of Candidates in Percentages				
Year	**1996**	**1997**	**1998**	**1999**	**2000**
Total Candidates	**N=13 344**	**N=16 350**	**N=17 355**	**N=17 273**	**N=13 257**
Symbols					
A (80-100)	3,32	2,85	1,90	1,72	5,24
B (70-79)	4,22	3,71	2,86	3,06	5,20
C (60-69)	6,17	5,98	4,67	4,70	7,57
D (50-59)	7,96	8,49	7,05	6,62	9,52
E (40-49)	9,52	11,93	10,05	9,22	11,98
F (34-39)	7,23	9,18	8,56	7,94	8,95
FF(30-33)	5,37	7,60	7,65	5,36	5,64
G (20-29)	12,30	25,85	27,34	24,67	20,18
H (10-19)	29,44	23,16	27,82	34,30	23,47
H (00-09)	5,47	1,25	2,10	2,41	2,25

(Source: KwaZulu-Natal Senior Certificate Examinations Statistics, December 2000)

Table 1.3(c) Mathematics Standard Grade Pass Rate Statistics in the Pietermaritzburg Region

	Number of Candidates in Percentages				
Year	**1996**	**1997**	**1998**	**1999**	**2000**
Total Candidates	**N=24 207**	**N=32 723**	**N=42 041**	**N=46 932**	**N=52 999**
Symbols					
A (80-100)	0,93	0,43	0,21	0,13	0,42
B (70-79)	2,28	1,23	0,49	0,42	1,20
C (60-69)	4,23	2,38	1,20	1,25	2,74
D (50-59)	6,34	4,03	2,15	2,72	4,85
E (40-49)	9,22	6,32	3,46	5,05	7,86
F (34-39)	7,12	5,93	3,34	5,33	7,50
FF(30-33)	5,42	4,95	3,03	3,51	4,52
G (20-29)	17,51	17,90	11,28	14,81	17,65
H (10-19)	24,80	33,42	21,93	25,16	23,77
H (00-09)	22,15	23,41	52,91	41,62	29,49

(Source: KwaZulu-Natal Senior Certificate Examinations Statistics, December 2000)

Table 1.3(d) Mathematics Higher Grade Pass Rate Statistics in the Pietermaritzburg Region

	Number of Candidates in Percentages				
Year	**1996**	**1997**	**1998**	**1999**	**2000**
Total Candidates	**N=16 777**	**N=20 916**	**N=18 628**	**N=16 976**	**N=11 468**
Symbols					
A (80-100)	1,93	1,77	2,44	2,16	4,49
B (70-79)	2,93	2,55	2,57	2,80	5,39
C (60-69)	4,26	3,16	3,64	3,72	6,69
D (50-59)	5,76	4,57	4,48	5,41	9,37
E (40-49)	7,29	6,14	6,35	7,78	10,99
F (34-39)	5,16	4,54	4,47	5,79	8,01
FF(30-33)	4,22	3,45	3,77	3,76	4,39
G (20-29)	14,69	12,20	11,91	12,91	13,24
H (10-19)	25,54	22,23	21,83	19,75	16,25
H (00-09)	28,22	39,39	38,54	35,92	21,18

(Source: KwaZulu-Natal Senior Certificate Examinations Statistics, December 2000)

For better comparison histograms of symbols against the number of learners are drawn in Figures 1 and 2 below. The 1996 entries were omitted to avoid cramping. Only the Physical Science histograms are drawn because the proposed study focuses on Physical Science.

Figure 1 **Histogram of Physical Science Standard Grade Pass Rate Statistics for the years 1997, 1998, 1999 and 2000.**

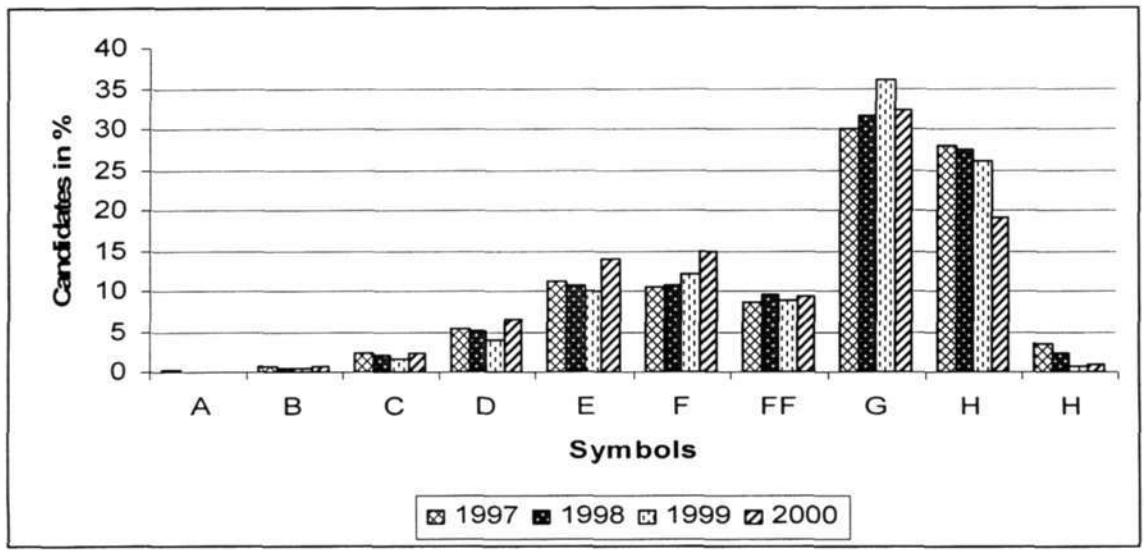
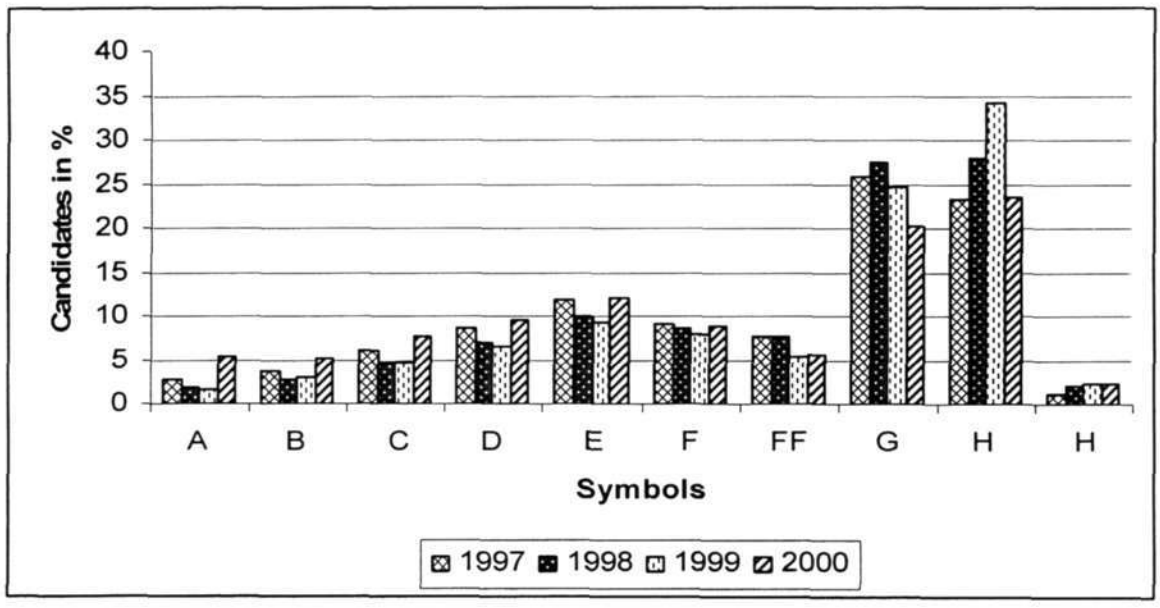


Figure 2 **Histogram of Physical Science Higher Grade Pass Rate for the years 1997, 1998, 1999 and 2000.**



The following table shows the pass rate in Physical Science in percentages. The minimum pass requirement per subject is an FF symbol. This means in order for a candidate to pass a subject he/she must obtain at least 30%.

Table 1.4 % pass in Physical Science, Standard Grade and Higher Grade in the years 1996 to 2000, in Pietermaritzburg Region.

	1996	1997	1998	1999	2000
SG	65,76	38,80%	38,60%	37,12%	47,93%
HG	43,79%	49,74%	42,74%	38,62%	54,10%

(Source: KwaZulu-Natal Senior Certificate Examination Statistics, December 2000).

The above table reflects low pass rates, which are in most cases less than 50%. The pass rates are decreasing between the years 1996 to 1999. In the year 2000, there was a slight improvement in both Standard Grade (SG) and Higher Grade (HG). There were two significant changes that took place in the year 2000, which could have affected the pass rate. The first one is the introduction of the year mark system, where 25% of the final mark is contributed by the continuous assessment. Secondly, there seem to be an increase in the number of learners who registered for standard grade and a corresponding decrease in the number of learners who wrote a higher grade paper. What is also evident from the above table is that the standard grade pass rate was always less than the higher grade, except in 1996.

From the above discussion, it is evident that there is a problem in the performance of learners in Physical Science. Some researchers in South Africa have already made their contributions towards addressing this problem. The studies include the following: the effects of the lack of resources, medium of instruction, the effect of the examination on the teaching method, and effectiveness of the process approach (Shange, 1996; McNaught, 1994; Staple, 1980; Mossom, 1989) just to mention a few. The problem with most studies is that they focus on

certain individual factors and isolate them from their context and the complexity of teaching (Doyle, 1990). The intention of this study was not to focus on one factor but to understand what really happens inside the Physical Science classrooms. The purpose of this study was to:

1. Examine the teaching practices of Physical Science educators at four schools in the Pietermaritzburg area with respect to teaching styles, development and use of resources, and learner assessment.
2. Analyze how these practices influence deep conceptual learning and understanding?
3. Propose measures for enhancing the teaching of Physical Science with the view of improving the Matriculation results.

Given the background of the education of the Africans and the proposed changes by the ANC led government, one becomes eager to know what is happening inside the classrooms. Are the educators doing what they ought to be doing? According to my understanding, there is no one teaching method which is said to be perfect. However I have the following assumptions about a good classroom practice:

- An educator employs a variety of teaching methods (DoE, 1996).
- He/she promotes a maximum, active participation of the learners (DoE, 1996).
- There is a meaningful interaction between the educator and a learner, and between a learner and a learner.
- The educator not only uses all available resources but also develops his/her own teaching materials.
- Classrooms are rich learning environments.
- Educators employ a variety of assessment tools to accommodate the different capabilities of the learners (Hatch and Gardner, 1990).

- Assessment should be fit for the purpose (Bray, 1986).

1.4 SIGNIFICANCE OF THE STUDY

As an educator involved in the teaching of Physical Science, I noticed that learners have difficulties in learning Physical Science. These difficulties eventually lead to poor performance of learners in their final Matriculation examination. Understanding the lack of resources and financial constraints one cannot stop asking oneself the following questions:

- Are we doing enough to make the learners understand science?
- Are we teaching the way learners learn?
- Are we doing what we ought to be doing?

It was hoped that this study would attempt to answer such questions. In other words, it was hoped that the results of the study would provide Physical Science educators with data which could inform their reflection on their own practices. This could apply more to those educators who were involved in the investigation. After being observed and interviewed, they could start questioning what they do, and how they do it.

It was also hoped that this study would provide subject specialists and other in-service training coordinators with data which would help them understand the needs and problems of the educators. However, the researcher acknowledges the fact that this is a small scale study and is not claiming the generalisation of the results. The resulting recommendation could form the bases for further investigations.

CHAPTER 2
REVIEW OF THE LITERATURE

2.1 INTRODUCTION

In this chapter, I review three sets of literature: the first set of literature is related to teaching style. The second set of literature deals with the utilization of resources in teaching Physical Science. The third set of literature is related to assessment of learner performance in general, and assessment of learner performance in Physical Science in particular. The purpose of the review is to locate the present study in the work already done by other researchers, and to explore useful concepts which will help the author in the analysis of the findings.

The review of literature related to the teaching styles is divided into four sections. The first two sections attempt to distinguish between the educator-centered and learner-centered teaching styles. The third section considers the development in science teaching in South Africa and elsewhere. In this section I compare developments in science teaching in South Africa with that of other countries. The last section discusses what can be learnt from research on inquiry based teaching method.

The literature on the use of resources discusses laboratory work, with special reference to the limitation of demonstrations by educators and verification experiments where learners are given a procedure to follow. The section ends with a brief discussion of the investigative method of doing experiments, as a method recommended in South Africa and elsewhere.

The last set of literature is on assessment. The first section discusses the contemporary issues in assessment. The intention is to clarify some concepts pertaining assessment. The second section deals with the assessment of higher order skills. The third section discusses the

constraints experienced by educators when assessing learning outcomes. The last section warns that we need to assess the concept of declarative knowledge. I conclude the discussion with a short summary and by pointing some gaps in the literature.

2.2 TEACHING STYLES

An educator's teaching style can be located between the two extremes of a continuum. One end of the continuum is educator-centered, the other end is learner-centered (Hofstein and Giddings, 1995; Louisell and Desclamps, 2001). Some authors prefer to use the term, teaching "strategy". Hofstein and Giddings (1995), for instance, use the term instruction (teaching) "strategy", however, they concur with the notion of two extremes. In this discussion the term teaching "style" will be used interchangeably with teaching "approach" (see for example Tobin, 1995).

2.2.1 Educator-Centred Approach

An example of an educator-centred approach is what is often called the "traditional" approach to teaching. The term "traditional" designates its dominance over the past years both in developing countries and developed countries. Some authors prefer to call it "conventional" teaching (Hofstein and Giddings, 1995) which also emphasizes the point just made. This approach is said to be educator-centred because most activities in the classroom are initiated by the educator. Even the practical work is done by the educator in the form of demonstrations. Learners are not active participants in their learning. The educator is the source of information with the help of the textbook. The information is transmitted to the learners. Tobin (1995) argues that knowledge is seen as a "commodity" to be transferred from a source (educator or textbook) to a receiver (learner). The knowledge absorbed by the

learners is regurgitated during tests and examinations. Friere (1970:58) calls this the "banking system of education".

> *Education thus becomes an act of depositing in which the students are the depositories and the teacher is the depositor. Instead of communication the teacher issues communiqués and 'makes deposits' which the students patiently receive, memorize and repeat. This is the 'banking' concept of education, in which the scope of action allowed to the student extends only as far as receiving, filing and storing the deposits.*

The educator-centred approach has a number of limitations. It is said that educator-centred teaching methods such as drill and recitation are successful for tasks that demand memorization. They have not been shown to be effective for teaching higher-order thinking and problem solving (Anderson, 1997; Darling-Hammond, 1996). Educator-centred teaching methods tend to focus on factual knowledge at the expense of practical skills including social skills. As a result it does not adequately prepare learners for proactive participation within society (Jita, 1998).

The traditional teaching approach is not a problem of developing countries only. Research shows that by the late 1980's it was still rife in the United States of America. This is in the report by Tobin, Tippins and Gallard (1994). Tobin et al (1994) reviewed three studies by Tobin and Espinet (1989); Tobin, Espinet, Byrd and Adams (1988); and Tobin and Gallagher (1987). These studies were conducted with the high school educators in the United States of America. It is reported that most educators taught using predominantly "whole class activities". The presentation of the lessons was in the form of "the lecture method". It is said that most of the class time was devoted to discussion of end-of-chapter questions which were simple "search-and-find" activities (Tobin, Tippins and Gallard, 1994). This is, learners were not given higher-order activities.

2.2.2 Learner-Centred Approach

In a learner-centred approach, learners are more responsible for their learning. It is assumed that learning takes place when there is an active participation of learners.

The South Africa national curriculum framework state that:

> *Curriculum development, especially the development of learning programmes and materials, should put learners first, recognizing and building on their knowledge and experience, and responding to their needs (Department of Education, July 1996:11).*

This statement reflects the major difference between the traditional approach and the learner-centred teaching approach, which is the recognition of learner's prior knowledge, in the latter case.

One of the examples of a learner-centred approach is the discovery learning. In this approach a learner is engaged in complete autonomous activities, which involve prediction, questioning, observing, classifying, measuring in order to figure out the solution or answer. Gil-Pérez (1996) calls this approach "extreme inductivism". It is an attempt to address the problem of spoon-feeding. Ironically, the discovery approach is criticized for its lack of attention to the content, conceptual learning and the understanding of the nature of science (Gil-Pérez, 1983; Hodson , 1985; Millar and Driver, 1987). This is because learners are given little guidance, they do most of the work on their own. However, the approach is credited for its "stimulation of a process of questioning" (Gil-Pérez, 1996). This means that it instills the habit of questioning phenomena which promotes active participation of learners.

The failure of discovery learning led to the development of reception learning (Slavin, 1994). Reception theorists (Ausubel, 1968, Novak, 1979) suggest that the role of the educator is to

structure the learning situation, to select materials that are appropriate for students, and then to present them in well-organised lessons that progress from general ideas to specific details (Slavin 1994). Ausubel (1968) is one of the proponents of this approach and he was a vocal critic of the discovery learning approach. However, Slavin (1994) identified some common themes between discovery learning and reception learning. He argues that both require that students be actively involved *in* the learning process. In other words they are both learner-centred. Secondly, both approaches emphasize ways of bringing students prior knowledge to bear on new learning. Thirdly, both assume that knowledge continually changes once it is "inside" the learner's mind (Slavin 1994). Unlike in discovery learning, the educator in reception learning is more involved. He/she presents his/her lesson in a kind of a deductive approach.

Some authors regard reception learning and discovery learning as constructivist approaches (see for example Slavin, 1994). The constructivist approach as a teaching approach gained its impetus during the past two decades following the information processing metaphor of the 1970s. The constructivist approach is a model of "how learning takes place" (Yager, 1991). It assumes that knowledge is actively constructed by learners (Wood, 1995; Tobin, 1993; Duit, Treagust and Fraser, 1996). The role of the educator is to support learners as they make sense of the problems they are solving. He/she will do so by creating situations in which learners actively participate in scientific activities. At the heart of the constructivist approach is the idea that the conceptions held by each individual guide understanding (Steffe and Gale, 1995; Tobin, 1993). This means that understanding is influenced by what the learner knows. Learner with mis-conceptions are likely to mis-understand the concepts or to take time to understand. This notion of "prior conception" was first suggested by Ausubel (1968:6), as "the most important single factor influencing learning is what the learner knows, ascertain this

and teach him accordingly". This emphasizes the importance of the pre-instructional knowledge. The fact that learners are not blank but have some experiences through interaction with objects and people is emphasized.

It is not the aim of this discussion to judge the abovementioned approaches. It is believed that each approach has some merits and demerits. However, it is acknowledged that the constructivist approach is considered as the most outstanding contribution to science education over the last few decades (Glueender and Tobin, 1991; Gil-Pérez, 1996).

In 1996, the Department of Education in South Africa introduced a curriculum reform project called Curriculum 2005. Curriculum 2005 is based on the principles of learner-centred, co-operation, critical thinking and social responsibility (Lubisi, 2000). The principles of learner-centredness is sometimes mis-interpreted as Moll (2002) points out. To some, it means that:

> *Educators are ideally and simply "facilitators" of learning environment and that learners are essentially independent, free ranging problem solvers who construct their own learning pathways" (Moll 2002:17).*

Moll (2002) argues that this view underestimates the role of the educator. The educator must be an active organizer of the frameworks of knowledge of learners and he/she remains indispensable for guiding the learners. The educator plays the role of a collaborator exchanging ideas with the learners, assisting them in constructing their knowledge.

2.2.3 Developments in Science Teaching in South Africa and Elsewhere

Since the late eighties there has been a great deal of developments and reforms in education generally, and in science education in particular. These changes are influenced by among other things, the constructivist paradigm. The following discussion is going to look at the

"new" principles guiding the teaching of science in USA, Australia and UK with the aim of locating the developments of South African science teaching.

The principles for science teaching in USA are contained in the National Science Education Standards. The teaching standards provide criteria for making judgements about progress towards the vision, they describe what teachers of science in all grade levels should understand and be able to do (National Research Council (NRC) 1996).

Teachers of Science

A. *Plan an inquiry-based science program for their students.*
B. *Guide and facilitate learning.*
C. *Engage in ongoing assessment of their teaching and of student learning.*
D. *Design and manage learning environments that provide students with the time, space and resources needed for learning science.*
E. *Develop communities of science learners that reflect the intellectual rigor of scientific enquiry and the attitudes and social value conducive to science learning.*
F. *Actively participate in the ongoing planning and development of the school science program.*

(NRC 1996:27-51)

Before we start to compare these principles with the principles informing the South African curriculum, it suffices to take a look at the principles that are underlying science teaching in Australia. The principles for effective learning experiences in science as contained in the Australia Curriculum Statement of 1994 are as follows:

Effective teaching and learning in science involves:

a) *Taking account of students views. Learning starts from and values the beliefs, concepts and skills of students.*
b) *Recognizing that students construct their own understandings.*
c) *Providing a supportive learning environment.*
d) *Learning in practice. It is believed that science learning occurs in many ways: talking, listening, reading, drawing, making, enacting, experimenting, modeling, handling animals, rocks and tools, using equipment.*

e) *Engaging in relevant and useful activities.*
f) *Complementing learning in other areas.*
g) *Using scientific language appropriately.*

(Australian Education Council, 1994:5)

When one makes a comparison, there seems to be a strong relationship between the principles of the two countries. These principles are also related to those informing the South African curriculum. Common to the principles of the three countries are the following themes:

- recognition of learners prior knowledge
- learners construct their own understanding
- integration of knowledge, skills, values and attitudes
- educator guiding and facilitating learning
- continuous assessment
- learner centredness

2.2.4 Lessons from Research on Inquiry-Based Classrooms

The inquiry-based teaching strategy is different from the ordinary hands-on experiments which tend to verify theories and laws that are found in the textbooks. Inquiry-based teaching focuses on solving real-life problems, and answers questions which are important to the lives of the learners (Crawford, 2000).

An American researcher, Crawford (2000) did research with Mr Jake (pseudonym) who, according to Crawford, successfully developed and sustained an inquiry-based classroom. Mr Jake was a biology teacher at a high school in a small rural town in the Pacific North-West in America. The school was a public school with approximately 300 learners in Grades 9 to 12. He (Jake) was observed teaching ecology to his 20 students. The purpose of Crawford's study was to examine the beliefs and practices of Mr Jakes.

In her report, Crawford (2000) identified the following six themes which were characteristic of the educator's inquiry-based classroom. Firstly, Jake situated his instruction (teaching) in authentic problems. The projects had to be meaningful, similar to scientific work, and relevant to the lives of learners. Learners did real research, for example, in one project they had to count the coliform bacteria to determine whether it was safe to swim in the Mary's River. Secondly, Jake promoted the importance of grappling with data, carefully collecting and analyzing real-world data. He had high expectations of his learners. He made them repeat data which were showing some deviation. Thirdly, it is said that Jake fostered collaboration of learners and educator. The educator helped the learners and the learners helped the educator. For example, the senior (second years) helped the educator in planning field trips. Fourthly, Jake connected students with the community. Learners were given projects which were solving environmental problems in their community. Mr Jake organized meetings and symposia where learners gave reports on their projects. The fifth point is that Jake modeled behaviours of a scientist, in the sense that he followed proper research procedures, connected studies to previous research, paying attention to careful sampling techniques. Sixthly, Jake fostered ownership by learners. His learners did not wait for the bell to ring in order to start working, Even when he was absent, they were able to work on their own. They also understood what they were doing, and were proud that their study had significance for outside agencies.

It is said that Jake assumed a number of roles, including those of monitor, diagnostician, guide, innovator, experimenter, researcher, modeler, mentor, collaborator and a role as a learner. In the study the roles of the learners were seen to be changing. At times they would assume the roles of learners in traditional information driven classroom such as a role as

learners, listeners and receivers of information. More often the learners took new roles including active collaborators, readers, apprentice, teacher and planner. The roles played by the learners suggest a mixture of teaching methods including a lecture method. Crawford (2000) argues that Mr Jake was involved in what she calls "collaborative inquiry". She believes that it takes a more active and demanding role than traditional depicted. The educator constantly changes roles that demand more active and complex participation than that suggested by the commonly used metaphor "teacher as a facilitator". She suggests that the level of involvement can be illustrated as follows:

Discovery Traditional Inquiry-based

Least - - - - - - - - - - - - - - - -> Greater - - - - - - - - - - - - - - - > Greatest

A research similar to that of Crawford (2000) was undertaken by the Education Policy Unit at the University of Natal, Durban (see Jita, 1998). This study was conducted in the Durban South region in KwaZulu-Natal (South Africa). Thirteen (13) schools with 54 educators participated in the study and seven educators were selected for intense classroom observation and interviews. The aim of the study was to investigate the context and practice of science teaching, the extent to which they meet with the criteria of transformative practice. According to Jita (1998) the goal of transformative practice is to "provide learners with the critical learning and understanding that can be used to effect personal, social, political and economic transformation in a democratic South Africa" (Jita, 1998:10). Jita reports that out of seven educators that they (Jita and the team) visited, only two transformative practice, Mrs Ntshontsho and Mrs Sally.

Mrs Ntshontsho's teaching is reported to be learner-centered. Her lessons involved learners conducting experiments. However, the experiments were limited to verification of the "scientific claims in their textbooks" (Jita, 1998:30). On the other hand, Mrs Sally had an extension lesson which was investigative, learner-centered and resembled the real world of scientists. Learners worked in groups on a research problem from its conception and definition to its execution in terms of carrying out the experiment. Learners were "doing science" (Hodson 1992).

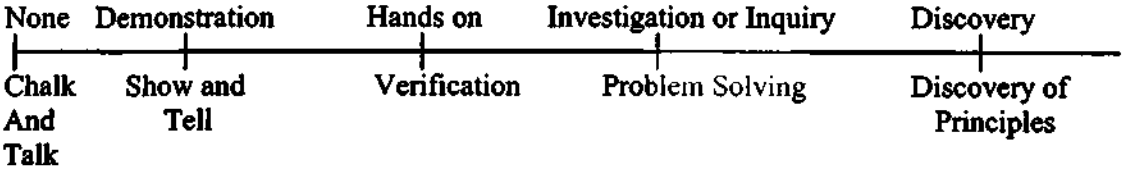
According to the report, both Mrs Ntshontsho and Mrs Sally worked very had to design and manage rich learning environments. Their "classrooms approximated the real world both in terms of facilities and human interactions" (Jita 1998:37-28). This seems to be in line with the notion of learning communities advocated by the International Reform Community (NRC 1996; Australian Education Council, 1994).

What also seemed to distinguish the teaching practices of the two educators, Mrs Ntshontsho and Mrs Sally, is the nature of the questions they asked in their classrooms. It is said that questions asked were demanding in terms of the kinds and depth of responses expected. Detailed explanation and elaboration were often requested (Jita, 1998). There are some lessons that can be learned from Mrs Sally's extension lesson. Firstly, she actually demonstrated that investigative or inquiry work can be done in developing countries with fewer resources. It is not one of those activities for developed countries only. Secondly, investigative lessons can be done even under the constraints of examination demands. An educator can use extra time or take some minutes from the normal teaching time.

2.3 USE OF RESOURCES IN SCIENCE TEACHING

The concept "resources" can be viewed in a number of ways. Spillane (1995) considers the following as resources: "knowledge, commitment and disposition, time, funding and labour, professional networks, trust and collaboration" (Spillane, 1995, cited in Jita, 1998:4). It is worth noticing that physical resources are not mentioned among these resources. The reason may be that it is taken for granted that schools have laboratory equipment. Floden (1995) views resources as teachers' knowledge required for new instructional practices, teachers' dispositions to meet the new standards of practices, teachers' beliefs about their role in classroom activity, and teachers' view of themselves (Floden, 1995:56). From this latter view, it seems as if there is an assumption that the educator is the key to transformation of education, which is a fundamental assumption informing the present study.

In developing countries like South Africa the availability and use of textual material (textbook, papers, notebooks, charts) and physical material (equipments) is still an important issue. The following discussion is going to focus more on the use of the physical materials, mainly on the practical work. The involvement of the practical work during the teaching of physical science can be located anywhere on the following spectrum.



From the above spectrum (continuum) it appears that some educators' practices can be characterized by "chalk and talk" only. This was confirmed by a study by Muwanga-Zake (2001). He carried out a survey in rural areas of the Eastern Cape. In his study he involved

educators of Grades 7 to 12. From his research he discovered that there were educators who did not use their laboratory equipment when teaching physical science. When he investigated, he found that there were some fears by both the educators and the principals, that the equipment could be damaged. In some cases educators were not confident enough to do the experiment in front of the learners, in case it did not work (Muwanga-Zake, 2001). He argues that educators have misconceptions of their problems. They often claim that lack of science equipment and laboratories prevent them from teaching science practically, but even those who have some equipment do not use them. It seems as if educators underestimate the importance of the practical work.

The second category, on the continuum, are those educators who often perform demonstrations to show scientific principles in action. It is assumed that learners learn better when they observe phenomena or demonstrations. However, some researchers (Roth, McRobbie, Lucas and Boutonné, 1997) argue that learners do not always learn from demonstrations. This group of researchers conducted a study with a year 12 physics class in Australia. This class was taught by a recognized educator who had a degree, had published in science teacher journals, and had presented workshops at many conferences. The aim of the study was to find out "why students may fail to learn from teacher demonstrations" (Roth, McRobbie, Lucas and Boutonné, 1997:509).

Roth et al (1997) discovered the following:

Firstly, that learners have difficulties separating signals from noise. This means learners do not know which part of the demonstration they need to focus on. The need to know what the educator wants them to see.

Secondly, learners bring to the classroom discourses from different out-of-school and in-school contexts. Learners draw from their prior knowledge, experiences and interaction with others including the knowledge from previous classes. Some of the prior knowledge are misconceptions that can lead to wrong interpretations.

The third factor is the interference from other demonstrations. They argue that learners use their prior experiences and mental images in predicting, interpreting and explaining their observation. Educators may not anticipate such images and past experiences.

Fourthly, students did not construct on their own the equivalence of signs from different representational systems. This is, learners sometime fail to integrate different pieces of information or observation.

Fifthly, the overall context was such that many students did not consider demonstration as something of importance. In most cases educators tend to give verbal descriptions without writing anything down. As a result, learners' notebooks did not make any reference to demonstrations, and learners assume that demonstrations are not important.

Lastly, Roth et al (1997) observed that learners had no opportunities to test whether their descriptions and explanations of the events were viable. When educators present their demonstrations they did not want to be interrupted, learners need to listen and observe only.

Educators who have enough resource allow their learners to have hand-on experience in doing experiments. This is considered as being better than a simple demonstration by the educator. However, there are some warnings that even a hands-on experiment may fail to serve the purpose. Hart (2000) a high school educator in Melbourne Australia, together with university researchers, Mulhall, Berry, Loughram and Gunstone (2000) argue that laboratory work may not achieve a meaningful learning by learners, because learners often do not know the purpose of the experiment. Hart (2000) was concerned that when her learners perform a "recipe type experiment" (following procedures) they did not learn much. She decided to design a

different task for her year 10 learners. The learners had to plan and conduct some chemistry experiments, write about them in such a way that other learners could repeat the same experiment. She discovered that learners derive a better understanding when playing a role of a scientist.

Hart et al (2000) argue that educators often give their learners a rubric to follow because they assume that:

Learners will learn and believe a particular scientific "fact" because they "see" it in the laboratory exercise. In practice learners may only rush to finish the experiment or to get the correct answer without understanding the purpose of the experiment.

The second assumption is that "educators believe that by conducting a "recipe type" experiment, learners will be following a "scientific method" similar to that which led to the original discovery of the relevant fact. This is, they equate following the procedure with scientific method which involves creativity, grappling with data and drawing conclusions.

Another assumption is that observing is a simple matter of receiving information via the senses, and does not involve any cognitive or other processing by the observer. As mentioned previously learners bring with them different experience, prior knowledge and misconceptions. All these determine how learners observe and create their own meaning, hence observers can not make the same totally objective observation during an experiment. Hodson (1993) adds that experiments are regarded by educators as revealing meaning. That will mean, all observers will get the same "revealed" meaning.

The above discussion illustrated that the "recipe" type experiments and the demonstrations have some limitations. As a result of the above-mentioned reasons and others, there is a trend to shift towards an inquiry or investigative approach (see Table 1 below). For the purposes of this discussion an investigation will be defined as "a task for which the pupil (learner) can not

immediately see an answer or recall a routine method for finding it" (assessment of performance unit (APU), UK, cited in Gott and Duggan, 1995:20). From this definition it seems as if the investigation is an attempt to involve learners so that they can learn by doing the activities rather than observing or following procedures. During an investigation a learner identifies a question to guide an investigation, formulates a testable hypothesis, designs and conducts scientific investigations, grabbles with data, formulates explanations using logic and evidence, communicates and defends a scientific argument (NRC, 1996; Crawford, 2000). It is hoped that investigative laboratory work will be able to inculcate higher order skills such as creativity, critical thinking, problem solving, and most of all make learners understand science concepts. This gives the reason why countries like USA, Australia and UK (England and Wales) emphasize the employment of investigative teaching strategy (Table 1).

Table 1 Trends Towards Investigation Method

USA	The USA content standard A As a result of activities in grade 9-12, all students should develop • Abilities, necessary to do scientific inquiry • Understand about scientific inquiry (NRC, 1996:173)
Australia	Strand 1: Working scientifically Band C (year 8-10) Learners pose questions to investigate, seek out information from sources that include interviews, surveys, libraries, literature reviews and other scientific reports, and identify testable and falsifiable hypotheses that enable them to make predictions. The design, carry out report and evaluate investigations involving dependant and independent variables (Australia Education Council 1994:30)
UK	Attainment Target 1 (Sc 1) The programme of study requires that the learners should be taught • Planning experiment procedures • Obtaining evidence • Analysing evidence and drawing conclusions • Evaluating evidence (Faulds, 1996:8)
South Africa	Learning Outcome 1 (Grade 10-12) Scientific inquiry and problem solving skills The learners are expected to be able to use scientific inquiry skills like planning, observing and gathering information, comprehension, synthesizing, generalizing, hypothesizing and communicating with results and conclusions. (Department of Education, 2002)

The important features of Table 1 are, one that in all the four countries scientific inquiry is put first: standards A, Strand 1, Attainment target 1 and Outcome 1. Second, the table reflects the similarity of the skills that the learners need to acquire, which are mostly higher order skills. There seems to be an assumption that learners need to learn science concepts together with the scientific skills in order to meet the demands of the work place.

Employment of investigative laboratory work has a number of advantages. To illustrate this we revisit the studies discussed earlier, the work of Crawford (2000) and Jita (1998). The lessons observed by Crawford (2000) seemed to have all three elements of science learning as proposed by Hodson (1992):

1) Learning Science: learners acquired conceptual knowledge about the ecosystem and environmental quality. For example, the learners counted the coliform bacteria in Mary's River and found that it was dangerous for children to swim in the river. They were solving an authentic problem in their own context which helped them to understand the concepts.
2) Learning about science: understanding the nature and method of science, sampling and grabbling with data, interaction between science and society. Learners were given opportunity to experience the complex nature of scientific methods as oppose to following procedures: verifying laws and science principles.
3) Doing science: learners were doing research from its initial stages to reporting to the public. They were planning and designing their experiment in collaboration with the educator, and they presented their findings in conferences.

Jita (1998) observed that learners enjoyed Mrs Sally's extra lessons, the investigative laboratory work, more than the regular, traditional lessons. From both reports it is evident that, as opposed to observing demonstrations or following procedures, learners were following real scientific methods. There were chances to learn high order skills because their investigations were challenging, they were both hands-on and minds-on. The environment during investigative lesson is more conducive for learners to take intellectual risks. The situation during practical work is less formal and learners are more free to ask questions or to contribute to discussions. Another advantage is that these lessons provide good opportunity for assisting learners, and for continuous assessment because the educator interacts with the learners more regularly.

The importance of the investigative or inquiry approach does not suggest that there shall be no demonstrations and simple hands-on experiment. It is reasonable to assume that not all the concepts can be investigated in a school laboratory. One of the reasons can be the time constraints and lack of resources. This however is not intended to support the educators old habit of resorting to transmission of knowledge because they are used to or because of the desire for an easy classroom life (Nott and Wellington, 1995).

2.4 ASSESSMENT

In the past assessment has been dominated by psychometrics in such a way that assessment was the same as measurement and limited to testing and examination. It can be argued that testing was fit for the purpose, which was to assess memorization of factual knowledge. With the kind of learning that we wish to achieve - application of knowledge, higher order skills, attitude and values, assessment has to reflect these aims (Gipps, 1994; Doran, Lawrez and

Helgesons in Gabel, 1994). For the purpose of this discussion assessment will therefore be considered

> "as occurring whenever one person, in some kind of interaction, direct or indirect, with another, is conscious of obtaining and interpreting information about the knowledge and understanding or abilities and attitudes of that other person. To some extent or other, it is an attempt to know that person" (Rowntree, 1987:4).

Assessment according to this definition is not limited to what learners know, it includes the skills (abilities) and attitude. Another point which is raised by Rowntree (1987) is the interaction of the assessor and the assessee which can be direct (fact to face) or indirect through the use of tests, assignments etc. Rowntree's definition of assessment is broader than the notion of assessment as measurement. It includes testing and other methods of assessment such as discussion, oral, interviews, observation and projects.

2.4.1 Contemporary Issues in Assessment

Assessment can serve different purposes including diagnosing, guidance, ranking, selection, promotion and certification. But it seems as if the new policy on assessment puts more emphasis on monitoring progress and supporting teaching and learning (Gipps, 1994; NRC, 1996; DoE 1996; Malcolm, 1994). In order to achieve this aim assessment is integrated with learning and teaching. "Learning, teaching and assessment are inextricably linked" (Department of Education, 1996:20). Assessment does not come at the end of teaching, it deals with the process and product of learning. It is an ongoing process and hence the use of the term "continuous" assessment.

The USA assessment standard B (NRC, 1996) states that "assessment should assess achievement and opportunity to learn science" (NRC, 1996:79). This suggests an assessment which is prospective – that is, assessing the capability of the learner, what he/she can do in

future. What is assessed is more than what the learner knows. We assess the learner's competence, which are the learner's inner abilities to do things irrespective of the context (Lubisi, 1999). The fact that these are inner abilities means that they cannot be observed. Therefore, competence cannot be directly assessed but can be inferred from learner's performance (Lubisi, 1999; Malcolm, 1999). This has the following implications: firstly, it means that learners need to be assessed whilst performing a task. This is, on top of pen and paper there has to be some activity with which a learner can express his/her abilities. What he/she can do in terms of knowledge, skills, values and attitude. Secondly, assessment relies on the collection of sufficient evidence of suitable quality for reasonable inferences of an individual's competences to be made (Mitchell, 1989, cited in Lubisi, 1999:133; DoE, 2002). This calls for a variety of assessment methods, modes (forms); media (oral, practical, written, behaviour) and different techniques. The learners must be assessed in a variety of contexts (Bray 1986).

Thirdly, assessment in a contrived situation (situation which is made formal) is not adequate for making inferences about the learners competences. The international community (USA, UK, Australia including South Africa) emphasize assessing learners doing activities which are related to the activities that they will do in real life, this is, assessment needs to be authentic (NRC, 1996; DoE, 1996). Authentic assessment is concerned with the assessment of those learning outcomes which value what people do in real life - authentic human activities (Lubisi, 1999:57; NRC, 1996). It is said that authentic assessment originated in USA to designate assessment which moves away from the standarized multiple choice questions type (Gipps, 1994). In South Africa the present assessment practice is often referred to as holistic outcomes based assessment. It is argued that this assessment is holistic in at least three senses: firstly, it requires that learners be assessed in multiple integrated outcomes, outcomes

located in a variety of knowledge, skills and values. Secondly, it requires educators to use a variety of modes, media, and techniques for assessment. Thirdly, it focuses on the whole not the parts of learners' performance (Lubisi, 1999).

The difference between authentic assessment and holistic outcomes based assessment lies in the emphasis. The former emphasizes real life activities and the latter on integration. Common to both is the assessment of learners performing in order to make some inference on their competences, hence the notion performance assessment. In this discussion, the three terms are going to be considered as equivalent terms, meaning the recommended assessment system. In most cases I am going to use performance assessment, since this is used by many authors internationally. Performance assessment can take many different forms including: writing an extended essay; presenting an oral argument; assembling a portfolio or representative work; planning and conducting an investigation (Doran, Lawrez and Helgeson in Gabel, 1994). The form of assessment must be appropriate for the learning outcomes being measured (Ibid). Bray (1987) calls this "fitness for purpose", that is assessment must be fit for the purpose it serves. This, she argues means that an assessor should make a right choice of modes (form), media and assessment instruments.

2.4.2 Assessment of Higher-Order Skills

One of the principles informing the South African curriculum is development of critical and creative thinking. It is emphasized that "learning programmes should promote learners ability to think logically and analytically as well as holistically and laterally" (Department of Education, 1996:14). This poses a big challenge to assessment since it must reflect this goal (Doran, Lawrez and Helgeson, 1994; Gipps, 1994). The challenge is even more since the researchers are beginning to accept that assessment drives the curriculum. Bellis (1998)

argues that decisions about what successful learning may look like come before decisions about what content should be learned, such decisions also precede how such learning opportunities may be delivered. Therefore it is not incorrect to affirm that assessment drives the curriculum (Bellis, 1998). Advocates of this idea assert that formative assessment is a tool to facilitate curriculum planning and teaching (Murphy, 1996; Gipps, 1994). This suggests that assessment must be instrumental in achieving these high order skills. There seems to be an agreement that high order skills can be achieved when learners are engaged in investigations or inquiries (NRC, 1996; DoE, 2002, AEC, 1994). One of the advantages of conducting an investigation is that it creates opportunities for interactions, the interactions among learners and interaction between educator and learner. The educator guides, focuses, challenges, promotes enquiry by asking questions, motivates and encourages the learners. It is easy to assess and assist learners while they are busy with the investigation. In making inference about the competences of the learners the focus is not on the right or wrong answer but the extent to which a learner performed close to perfection. It becomes necessary to use a scoring rubric which describes different levels of achievement. A scoring rubric gives a level of achievement or marks together with a short description which says a learner obtained a particular level.

2.4.3 Some Assessment Constraints

The scoring which is influenced by measurement is limited to right or wrong answers. Since most questions are often closed, scoring is easy and more objective. However, the assessment of competence is inferred from learners performance in a variety of contexts. Malcolm sees this as complex, and he argues that assessment as inference is "always tentative in its claims" (Malcolm, 1999). Ruiz-Primo and Shavelson (1996) concur with this idea and they claim that it needs an expert to make an appropriate judgement. Lubisi (1999) is also not comfortable

with how we make the final decision about the competence of the learner. He asks the following question:

> *"To what extent does a students' performance indicate competence in a particular domain?*
> *To what extent does a student's poor performance indicate a lack of competence?"*
>
> (Lubisi, 1999 unpublished paper)

Lubisi's main concern is about the validity of the performance assessment. In supporting his argument Lubisi quotes Wood (1987) who uses the notion of false positive and false negative errors of judgement. The false negative error is said to refer to a case when a student is judged to be without competence when she/he in fact does have competence. Similarly false positive error refers to when a student is judged to have competence when she/he in fact does not have competence (Ibid). The only advice that is given by Lubisi (1999) is for the educator to be extra-cautious not to readily infer competence from performance.

Ruiz-Primo and Shavelson (1996) report on the study of the important claims about science performance assessments. It was observed that performance assessments require more work before, during and after the test (task). Performance assessment needs thorough preparation since its effectiveness depends on the quality of the task. Daxter, Glaser and Raghavan (1993) argue that "performance assessments may not necessarily lead to higher-order thinking, characteristics of the assessment task hold the key" (cited in Ruiz-Primo and Shavelson, 1996:1055). The tasks should have well stated outcomes with clear assessment criteria, and must be challenging but not too difficult. It is also demanding to design a good performance task.

An educator plays a number of roles during performance of the task (Crawford, 2000). Most of the performance tasks are often time consuming, more especially the investigations. During the activities, learner can display a number of skills which need to be assessed and developed. In as much as there is teaching to the test, educators may be tempted to limit the learners to a particular skill or skills. Performance assessment requires more work even after assessment. Recording and reporting must be informative. The assessor need to describe or give reasons for his/her judgements.

The challenges are not only on the assessor even the assessees encounter problems. Liftig (1992) observed that students often lack experiences and skills on responding to open-ended interpretive, applied and higher order essay questions. Another potential obstacle is the linguistic demands of authentic assessment. For example a learner may be required to describe, discuss, explain or argue using a second language. Cultural and linguistic issues may lead to what Wood (1987) calls "false negative error of judgement".

2.4.4 Assessment of Declarative Knowledge

The focus on skills or procedural knowledge has raised concerns among researchers that the declarative knowledge may be sacrificed (Marzano, 1992; Gott, Rice, Ryan and Samson 1998). According to the policy (DoE, 1996, 1998) assessment should integrate knowledge, skills, value and attitude. However, the dominance of performance tasks shift the focus to skills assessment. Ruiz-Primo and Shavelson (1996) observed that "to many educators performance assessment means that students should use their hands to manipulate materials". As an attempt to counteract this tendency, Rice, Ryan and Samson (1998) suggest the employment of the concept map as an alternative assessment. A concept map is defined as "a combination of a task, response format and a scoring system" (Ruiz-Primo and Shavelson, 1996:573). Rice et al argue against viewing the traditional and performance assessment as competing. They suggest that the two must be seen as complementary strategies. The

assessment of higher order skills has to be supplemented by the assessment of factual knowledge. The facts, terms or concepts serve as building blocks or a vocabulary for more complex cognitive operations. Rice, Ryan and Sampson (1998) identified the following strengths of concept map:

- The technique can be used with large groups with minimal assistance from educators.
- Concept maps produced by learners provide a rich source of information about their understanding and misunderstanding of concepts.
- It is easy to develop a qualitative sense of where instruction had been unsuccessful, because learners will fail to link those particular concepts.

(Rice, Ryan and Sampson, 1998:1106).

2.5 SUMMARY

Teaching style in science education can be educator-centred or learner-centred, but a learner centred style is preferred (NRC, 1996: Australian Education Council, 1994; DoE, 1996). In order to learn the learner should be an active participant. It is assumed that learners construct their own understanding. The current system of education in South Africa is intending to promote higher-order thinking - creative and critical thinking. It seems as if investigative teaching method or inquiry-based teaching is considered as a strategy that can help to achieve this goal.

The work of Roth, McRobbie, Lucas and Boutonné (1997); and Hart, Mulhall, Berry, Loughran and Gunstone (2000) revealed that demonstrations and hands-on experiments are not sufficient for deeper understanding. Doing something does not mean understanding something (Lederman, 1999). Learners may not learn from demonstrations or through following procedures. The assumption is that learners will learn better when they are challenged to construct knowledge by solving problems as scientists do in real life.

There are significant changes in assessment approaches internationally. The view is assessment must assist learning and is thus integrated with learning and teaching and hence has to be continuous. What is assessed is what the learner knows and can do. In other words what we need to figure out is the competence of the learner. Competence is inferred from the performance of the learner in a variety of contexts. Lubisi (1999) warns that competence should not be readily inferred from performance.

2.6 SOME GAPS IN THE LITERATURE

The literature reviewed in this chapter clarified the concepts and issues related to the critical questions posed in this study. However, most of the work emanates from developed countries such as USA and UK. There is still a dearth of literature in South Africa on science teaching in general and Physical Science teaching, in particular. A lot can be learned from the developed countries but not all the findings can be generalised to our situation, because of contextual differences. There is a dire need for literature on studies done locally, investigating the situations as they are in South Africa. It is hoped that the present study, which looks at the classroom practices of Physical Science educators will contribute to the filling of this gap.

During the past few years, the National Department of Education implemented new curriculum development policies (DoE, 1996, 1997, 1998). We need to know how educators are coping with these changes. We also need to understand the gap between the expected and the reality, and distinguish between rhetoric and reality. For instance, literature reveals some cases where investigative or inquiry teaching method has been successfully employed in Biology (Crawford, 2000; Jita, 1998). However not much is said about the employment of this teaching method in Physical Science. We also need to know the status of the resources in

schools, whether they (resources) are meeting the requirements of the investigative learning and performance assessment. Little research has been done on the utilization of available resources. No research was found on development of resources.

In the past assessment was limited to measurement of learners' achievement. The present education system in South Africa has a broader view of assessment. Assessment is now playing important roles, some authors argue that it drives the curriculum (Gipps, 1994; Broadfoot, 1995; Murphy, 1996). However, there seems to be little research in this field in South Africa. More research is needed for the curriculum developers to make informed decisions, and to inform practice. Not long ago the Department of Education showed some uncertainty on assessment policy issues. In 1999 the Department of Education and Culture (KZNDEC, 1999d, 1999e) stipulated that the final senior certificate final mark will be constituted by the year-end examination 50% and school based "continuous assessment" 50%. This was later changed to 75% examination and 25% school based continuous assessment (year mark). What informed the changes is not known, however it signalled some uncertainty about policy implementation.

At present, the National Department of Education is implementing an "intervention programme" to the schools which are not performing well, obtaining below 50% pass rate. The learners from these schools are expected to write external papers (common tests) in March, June and September (ie. quarterly tests). In KwaZulu Natal, the grade 11 learners also write external tests in June and September. Whether this helps to improve the achievement of learners remains to be seen. But what seems to be a concern is that the wish to inculcate high-order skills is likely to be hindered by the faith in the external examinations (testing). The common tests keep the educators on their toes trying to cover the syllabus.

CHAPTER 3

RESEARCH METHODOLOGY AND DESIGN

3.1 INTRODUCTION

The value of classroom research cannot be underestimated. It is through classroom research that the conditions of learning and teaching, and the teaching strategies can be improved. Although classroom research is important, it remains a difficult study. Our familiarity with the classroom situation makes it look simple. Anderson and Burns (1989) remind us that:

> *"Classrooms are settings in which:*
> - *Teachers and groups of students engage in activities with frequent verbal exchange and academic work;*
> - *The intended result of these activities, student learning, occurs gradually over time, and is largely unobservable, and;*
> - *Decisions made during instructional planning and teaching are also unobservable"*
>
> (Anderson and Burns, 1989:16).

In this chapter, I am going to outline the theoretical framework and the research methodology. Under research methodology I will describe the framework of research design, and how data were collected and analysed.

3.2 A THEORETICAL FRAMEWORK

I decided to choose symbolic interactionism as the main component of the theoretical framework for this study. The choice of the research approach and the design are based on the principles of this theory.

3.2.1 Selecting a Theoretical Framework

The term "symbolic interactionism" has come into use as a label for a relatively distinctive approach to the study of human group life and human conduct (Blumer, 1969:1). The

proponents of symbolic interactionism consider Herbert Mead as its ancestral progenitor (Joas, 1985). Some authors agree that the theory was shaped and developed by Herbert Blumer, one of the Herbert Mead's students (Prus, 1996; Charon, 1979; Denzin, 1992). There are a number of schools which used the label "symbolic interactionism", Mead and Blumer belong to the so-called Chicago-style symbolic interactionism. The other schools include California School, Iowa School of Symbolic Interactionism; Dramaturgical Sociology, Labelling Theory, and the New Sociology of Science (Prus, 1996; Denzin,1989; 1992; 1994). This study is going to consider the Chicago School version of symbolic interactionism.

The symbolic interactionism is said to be based on the following three principles:

> The first premise is that human beings act toward things on the basis of the meaning that the things have for them. The second premise is that the meanings of such things is derived from or arises out of, the social interaction that one has with one's fellows. The third premise is that these meanings are handled in, and modified through, an interpretative process used by the person in dealing with the things he encounters
>
> (Blumer, 1969:2).

In the first premise, Blumer (1969) uses the word "things" to mean physical objects, categories of human beings, institutions guiding ideals, activities of others and situation and individual encounters in his/her daily life. Blumer is concerned that the meaning of "things" is often ignored when studying human behaviour. His assumption is that people act on account of the meaning those things have for them. He is against the view that human behaviour is the result of factors such as stimuli, attitude, motives, perception, cognition and

other sociological factors. The focus on the above factors only undermines the role played by the "meaning".

The second premise deals with the source of meaning. Traditionally, it is assumed that meaning originates from the intrinsic nature or make-up of the "thing" or is brought to the thing by the observer in the form of sensations, feelings, ideas, memories, motives and attitudes (Blumer, 1969). But the symbolic interactionism claims that meaning arises during the process of interaction between people.

> *...[Symbolic interactionism sees meanings as social products, as creations that are formed in and through the defining activities of people as they interact.* (Blumer, 1969:5).

Blumer is arguing that meaning is not passively received, for example, by mere observing an object but is created during an active process of interaction.

According to the third premise the derived meaning is not used as it is, but it goes through a process of interpretation. A group of people, for example, is characterised by a series of action among the members of the group. Each member of the group derives meaning from objects and other members of the group by interacting with them. The derived meaning is interpreted. The interpretation of the meaning guides the action of the member towards the other members or objects. Blumer (1969) emphasises that to understand the "group life" one needs to be "close to this life" (p.38). At this point, it is explicit that Blumer is arguing for qualitative research and participation observation in particular. Blumer (1969) insist that the researcher needs to achieve "intimate familiarity" with the group he/she is researching (Prus, 1996).

> *"No theorizing, however ingenious, and no observance of scientific protocol, however meticulous, are substitutes for developing a familiarity with what is actually going on in the sphere of life under study.*
>
> (Blumer, 1969 cited in Prus, 1996:73).

This statement leads us to the method of data collection in symbolic interactionism. This statement suggests a presence of the researcher in the field to be studied. Blumer argues that the empirical world of symbolic interactionism is the natural world of such a group of people.

> *It lodges its problems in this natural world, conducts its studies in it, and derives its interpretation from such naturalistic studies.*
>
> (Blumer, 1969:51).

For data collection, Blumer (1969) emphasizes a "direct examination" of the empirical world. However he seems to doubt that the accounts given by the observer is sufficient. He is asserting that the

> *"accounts should be subjected to probing and critical collective discussion by a group of well-informed participants in the given world. ... To guard against the admitted deficiencies of individual accounts"*
> (Blumer, 1969:52).

Blumer seems to be advocating the use of "multiple views" of a case, a concept which is also raised by Stake (1995). Stake (1995) argues that "the interview is the main road to multiple realities" (p.64). In this study, I will use observation, interviews, and review of documents for data collection. This will be discussed later in this chapter.

3.3 RESEARCH APPROACH

Research can be broadly classified as quantitative or qualitative. The distinction between the two approaches lies in the aim, role of the researcher, and how data is collected. The aim of a quantitative research is to explain the cause and effect of a relationship. On the other hand the qualitative research seeks to understand human experiences. Quantitative research tries to limit the role of personal interpretation in order to satisfy the need for "value free" data. Stake (1995) considers the period from research design through data collection up to analysis

of data as "value free" period for quantitative researcher. A qualitative researcher must be in a field making observation, interpreting, analysing and synthesizing data. Interpretation is central to a qualitative research (Stake, 1995). Data collection in a quantitative research is dominated by formal measurement and statistical analysis. A qualitative researcher tries to describe the situation as it is, including interrelationships.

It is important to note that the quantitative and qualitative approaches are related. While quantitative approach can emphasize measurement, there will be some description and interpretation of the numbers. The narrative in qualitative research can state the sizes and amounts in numbers (Stake, 1995). The choice of the research approach is informed by the nature of the critical (research) questions (Yin, 1984). Stakes (1995) suggests that the qualitative research questions should orient the cases or phenomena, seeking patterns of unanticipated as well as expected relationships. The present study seeks to understand the learning and teaching phenomena, and its critical questions could only be answered by employing the qualitative research approach.

3.3.1 The Qualitative Research Approach

A qualitative research is considered as a "study of the way of life of a group of people" (Prus, 1996:103). Qualitative research can assume different forms, it can be ethnographic, naturalistic, phenomenological, hermeneutic, holistic, participative or non participative (Stake, 1995). The present study is naturalistic, holistic and participative in the sense that the researcher was present in the research sites, but the researcher did not take part in the actual teaching. One can identify the following characteristics of qualitative research:

- Qualitative researchers seek to understand the complex interrelationship among all that exist
- Naturalistic observation has been the primary medium of acquaintance

- The primary characteristic of qualitative study research is the centrality of "interpretation" (Frederick Erickson, 1986).
- Qualitative research tries to establish an empathetic understanding for the reader through description, sometimes "thick description" (Geertz, 1973; Denzin, 1989).
- Qualitative inquiry is distinguished by its emphasis on "holistic" treatment of phenomena (Schqandt, 1994).

The aim of this study is to understand the classroom practices of the educators. It could be meaningless to be told about the educator practices by using a posted questionnaire, for example. In order to understand, the researcher had to be as "close" as possible to the situation, derive meaning of the interaction taking place in the classroom, interpret those meanings and arrive at some conclusions. However, to keep the situation natural, I had to avoid intervention and hence he did not take part in the teaching process. For better understanding, everything pertaining to the teaching and learning of Physical Science viz: classroom; documents; resources; school profile; and the immediate environment was considered. This will be discussed later in this chapter and in Chapter 4.

3.3.2 Ethical Issues

A qualitative research like any other social activity should be undergirded by ethical principles such as fairness, honesty, justice, privacy and confidentiality. These ethical issues are important for legitimacy and authenticity of the research. However during the course of the research I was often faced with dilemma. Hitchcock and Hughes (1989) provide the following examples or dilemma:

- *What lengths can research go to in investigating their subjects?*
- *What rights do the subjects of a piece of research have?*
- *How can trust be established or confidentiality and anonymity be guaranteed?*

Hitchcock and Hughes (9189:198).

The problem of ethical dilemma starts in the early stages of a research. When the researcher negotiates access to the research setting, he/she needs to give a clear explanation of what he/she intends to do in the field; describe the purpose of the study, why he/she decided to choose the particular setting; discuss what he/she is going to do with the findings. Sometimes, when the participants are aware of what is being observed, they start to give a performance, this is, they act unnatural. This disturbs the naturalistic character of qualitative research. On the other hand if a researcher decides not to disclose some of the information, that is regarded as deception.

The nature of qualitative research demands that the researcher should be as "close" as possible to the situation and have an "intimate familiarity" with the participants (Blumer, 1969). The problem may be how close should the researcher be, without interfering with the privacy of the participants. During interaction with the participants a researcher may touch sensitive issues while trying to do justice to the study or to the audience of the study.

The essence of qualitative research is that it provide a "thick description" of the observed phenomena or situation (Geertz, 1973). Such a thick description should also include the context for example, the description of the classroom, the school and the immediate environment. Whilst giving such a detailed description the researcher must also observe anonymity and confidentiality. The question is, how much description should a researcher give without exposing the research setting or the participants?

One of the dilemmas that I experienced in the present study was to disclose the purpose of the study. It was difficult because the study is assuming that educators are not doing what they

are supposed to be doing. Nevertheless, I gave the detailed description of the purpose of the study. Unfortunately one of the educators took the advantage, and decided to give me a performance. Educator B repeated a lesson which she taught the previous day. The educator was revisited for a new lesson, the first lesson was not considered.

3.4 THE CASE STUDY METHOD

As indicated above the choice of the approach employed in this study is a qualitative approach, and the method adopted is a case study method. The definition of a case study which is going to be considered in this study is the one given by Yin (1984). He (Yin) gives what he calls a technical definition:

> *A case study is an empirical enquiry that:*
> - *Investigate a contemporary phenomenon within its real-life context, when*
> - *The boundaries between phenomenon and context are not clearly evident; and*
> - *Multiple sources of evidence are used*
>
> (Yin, 1984:23).

Yin (1984) sees the ability to use a variety of evidence, for example, observation, documents, artifacts and interviews as a unique strength of case studies. Hopkins (1993) considers the following as the advantages of using a case study method:

- *A relatively simple way of plotting the progress of a course or a pupils or groups reaction to teaching methods.*
- *Information yielded by case studies will tend to give a more accurate and representative picture*

(p. 43)

In the following paragraphs, I shall discuss the techniques used for data collection in this study.

3.4.1 Observation

Qualitative case study uses a variety of methods for data collection and observation is the most important method. Cohen and Manion (1994) asserts that "... at the heart of every case study lies a method of observation" (p.107). Some authors believe that observation can either be participative observation or non-participative observation (see for example Cohen and Manion, 1994). According to this view, a participative observation takes part in the activities that he/she observes. The other participants might consider the observer as one of the members of the group. In other words, his/her observation may be covert. A non-participant observer does not take part in the activities, he/she can sit at the back of a classroom writing down his/her observations.

Other authors consider observation as a continuum (see for example Burgess 1004 and Gold 1958). At one extreme of the continuum is a "complete participant observer" followed by a "participant-as-observer" then an "observer-as-participant" and on the other extreme is a "complete observer" (Lubisi, 2000:117). A complete observer is a non-participant observer. It is said that the difference between a complete-participant observer and a participant-as-observer is that the former observes "covertly" and the latter observes "overtly". Whilst a participant-as-observer develops relationships with other participants the observer-as-participant does not develop long-term relationships with other participants (Lubisi, 2000). In this study, I was a participant-as-observer since I developed relationships with the participants but I was not taking part in the teaching process and my observation was overt.

Hopkins (1993) gives four methods of undertaking classroom observation: structured, systematic, focussed and open observation. A structured observation is said to be a collection of information by either using a tally system or a diagram. Closely related to this method is

the systematic observation, which uses coding scales. An example of systematic observation is the Flanders Interaction Analysis Categories (FIAC) (Flanders, 1970). In the third type, the focussed observation, an observer focuses on a particular teaching technique, for example, questioning The details of these methods of observation is beyond the scope of this study. The observation method which was found to be suitable for this study is the open observation. In this method an observer records his observation including the interactions of the participants, description of the activities, the action and gestures of participants. These records form what is called the field notes. The field notes are raw data which form the initial stage of preliminary analysis. Hitchcock and Hughes (1989) suggest that writing field notes should follow a sequence of stages starting from the scribbled notes with key words or key phrases up to development of themes, patterns and recurring features. Hopkins (1993:116) has this to say about field notes:

- *Field notes can reflect general impressions of the classrooms, its climate or incidental events.*
- *The field notes should be descriptive rather than speculative, so that a broad picture amenable to interpretation can be built up.*

3.4.2 Interview

Interviews are often categorised into at least three types: structured, semi-structured and unstructured interview. These categories are determined by the degree of control over the interview exercised by the interviewer. For a structured interview, the interviewer prepares a questionnaire which often comprises of short and direct questions. The questions are usually looking for convergent answers - yes or no or short answers. As a result the structured interview is regarded as a "formal" or "controlled" interview (Gidden, 1993; Hitchcock and Hughes, 1989). In a structured interview a researcher strives to be objective by eliminating the human factor. Structured interviews are therefore appropriate for quantitative research.

Stenhouse (1984) concurs with this idea, "structured interviews are avoided in qualitative research" (Stenhouse, 1984 cited in Burgess, 1985:67).

A semi-structured interview is more flexible than the structured one. It is flexible in the sensed that the interviewer is able to ask more questions beyond the planned questions or to probe for deeper understanding and the respondent (interviewee) can expand his/her responses (Hitchcock and Hughes, 1989). In the so-called "unstructured" interview the degree of flexibility is even more. It is sometimes called a "interview-as-a-conversation" (Burgess, 1984). Whyte (1982:11) cited in Hitchcock and Hughes (1989:86) warns us that "unstructured" interview is a misnomer, since even the so-called "unstructured" does have a plan, "a genuinely non-directive interviewing approach is simply not appropriate for research".

In the present study, I employed both the semi-structured and unstructured interviews. But the interview was dominated by the semi-structured questions. Most authors suggest that a qualitative researcher should establish a rapport with the respondents (Yin, 1994; Hitchcock and Hughes, 1989). It is assumed that if the interviewer can develop good relationship with respondents, he/she can get a deeper and more meaningful information.

3.4.3 Documents

Documents which can be reviewed in a classroom research include educator's daily or weekly preparation, year planners, assessment records, learners' activities, notebooks, test books and other official documents. It is not possible to observe all the classroom activities, especially during a small project like the present study. Stake (1995:85) asserts that "documents serve as substitute for records of activities that the researcher could not observe directly". There

seems to be a common understanding that documents provide a context for understanding a particular curriculum or teaching method (Hopkins, 1993; Thernstrom, 1965; Woods., 1983 and Burgess, 1985). The documents will depict what is taught and how it is taught and also what is assessed and how it is assessed. What is assessed often determine the valuable knowledge. Eisner (1993:184) cited in Lubisi (2000:120) summarizes the importance of documents and the following statement "documents provide a kind of operational definition of what teachers value".

3.4 RESEARCH DESIGN

Yin (1984) defines a research design as "an action plan for getting from here to there". By "here" he (Yin) means the "initial set of research questions to be answered", and "there" is "some set of conclusions about these questions" (Yin, 1984:28). Research design deals with the logical sequence that connects the steps from the questions through the collection and analysis of data to interpretation of the findings.

3.5.1 Research Questions

It was stated in Chapter 1 that the aim of this study is to understand the classroom practices of Physical Science educators in order to find out whether it does influence the performance of learners. In the same chapter the status of the performance of learners in recent years was described. If there is a link between classroom practice and the performance of learners, the next step will be to suggest (based on the findings and literature) how the classroom practices could be improved in order to improve the performance of learners.

The research questions are:

(a) What are the actual classroom practices of Physical Science educators with respect to:

- Teaching styles
- Development of resources
- Use of resources
- Learner assessment

(b) How do the classroom practices or educators examined in (a) above influence the performance of learners in matriculation?

(c) In view of (a) and (b) above what practical measures will enhance the teaching of Physical Science and improve the matriculation results?

3.5.2 Selection of Cases

This section deals with the selection of the cases (the schools). These cases are not going to be regarded as samples since it is not the intention of this study to generalize to a certain population. A sample is defined as a "subset of the whole population which is actually investigated by a researcher and whose characteristics will be generalised to the entire population" (Bless and Higson-Smith, 1995:86).

Four schools were selected following some criteria which are going to be discussed below. The four cases have major similarities with some minor differences. Basically the four cases can be considered as what Yin (1984) calls "literal replication" the multiple-case studies which are carefully selected so that they produce similar results (Yin, 1984:48). This choice was made so that the result can be convincing to the readers but not necessarily for generalization.

For the school to be selected, it had to be offering Physical Science up to Grade 12. This could sound as a trivial condition, however in the African communities not all the schools

offer Physical Science because of the shortage of educators who specialised in the subject. This condition excludes junior secondary schools and primary schools.

Secondly, the school has to be one of those schools which were designated for African students under apartheid. These schools have some common problems. The schools were previously disadvantaged, for example, they were underfunded as a result lacked physical resources. Learners in these schools were receiving inferior education in the form of Bantu Education. The majority of the educators received a 3-year College Diploma which is also regarded as inferior compared to a 4-year Diploma (for the other races) or University education. In the past these schools were also affected by political violence.

The third criteria was that the school had to be a functioning school. This was to avoid unnecessary delays, or waste of time due to absenteeism of educators or learners, or school starting late and closing early. There was a school which had such problems and it was deliberately excluded from the study.

The schools selected were given Pseudonyms to ensure anonymity and confidentiality and in order to further enhance cooperation of the educators. They were designated as School A, School B, School C and School D.

3.5.3 Access Into Schools

I did not have any difficulty in gaining physical access into the four schools, since I was acquainted with the Physical Science educators of the selected schools. I had been teaching Physical Science in one of the schools in the Pietermaritzburg area for about 8 years. During these years I attended a number of in-service courses and workshops with almost all the

educator of the selected schools. I actually started to negotiate access to educators during the Physical Science workshops. I was also not a stranger to two of the four principals.

The hierarchical structure of education at lower levels is roughly as follows: District Manager; Circuit Manger; Principals then the educators. I decided to start negotiating from bottom up the hierarchy, this is, from the educators through the principal up to the District Manager. The main reason for doing this, was to gain the trust of the educator and to confirm his/her status in the research, as the main actor. The top down negotiation could cause resentment from educators.

The formal negotiation started with phone calls to set appointments to meet the educators. At these initial meetings I described the topic and the purpose of the research, assuring confidentiality and anonymity. The educators were happy to participate in the research. The following day, I phoned the principals setting appointments to meet them. At the meetings with the principals, I brought the official letter seeking permission to do research in their schools (Appendix C). The topic, purpose and other details were explained to the Principals. the last part of negotiation was with the District Manger. I handed an official letter asking for a permission to do research in schools under his jurisdiction. The District Manager did not have any problem since he knew the researcher as one of the educators in his district.

3.6 DATA COLLECTION

3.6.1 Educator Profile and School Profile

I needed information about the educators and their schools. I decided to design two sets of questionnaires. The questionnaires had to be short and simple. The educators' questionnaire required educators to give information related to their ages, qualifications, teaching

experience, academic and extra-curricular responsibilities and involvement in the professional organisations. This information was considered important for the general understanding of the educators, it will also help in the analysis of findings.

The principals were requested to provide information about the human resources, the physical resources, supporting inputs, relationships and school climate. This information was going to help in describing the contexts in which the educators are teaching.

3.6.2 Observation Guide

The classroom observation was done by writing down some field notes. I needed some guide to help him to focus my attention. The observation schedule could not serve the purpose since I could not predict what was going to happen in the classrooms. What I could do was to design an open-ended observation guide.

Most of the critical questions could be answered by observation of the classroom activities. The teaching styles can be judged from observing how the educator: introducers his/her lessons; interact with the learners, and use the resources. Similarly how the educator assesses will be determined by the nature of the questions he/she asks, the nature of the activities and how they are monitored and the variety of assessment methods employed. Those categories which could not be observed were going to be reviewed from the documents. The review of the documents is discussed below.

3.6.3 Designing Interview Schedules

The researcher designed two interview schedules, one for educators and the second one for the learners. The learners interview schedule took the form of a semi-structured interview.

The educators' interview schedule was divided into two sections: the first section was a semi-structured and the second section was an unstructured interview, preferable interview-as-conversation (Burgess,1 984: Yin, 1984).

Questioning in the interview schedule was guided by the research questions. Thus the questions were about the teaching style, development and use of resources and assessment of learners. The questions emanated from classroom observation. As a result, most of the questions were supplementing observation obtained from observation. When qualitative researchers "cannot see for themselves, they ask others who have seen" (Stake, 1995:44). The semi-structured interview questions were different for each educator. Two learners were selected for interview in each school, and they were asked the same set of questions. For the interview-as-conversation, I designed some probing questions around certain questions.

Although the questions for the educators were almost different but they served the same purposes. Some questions were seeking clarity about certain observation. For example, in two cases the desks in the classroom were arranged in straight rows. I had to ask whether it was always the case and what was the attitude of the educators towards the employment of group-work as a teaching strategy. Apparently the educators employed group-work for certain activities. At times the questions were asked to find out the reasons why educators were doing what they were doing. Other questions were asked to confirm or correct the perception of the researcher. A ... "qualitative researcher want those who are studied to speak for themselves" (Sherman and Webb, 1988:5).

The learners were also asked a variety of questions which were also guided by the critical questions. This included questions with which I wanted to find out whether the learners

understood what was taught. The other set of questions was used to determine the teaching style which was often employed by the educator, for example, a narrative method, how often the practical work was done. I was also able to determine the frequency and the nature of assessment.

The interview-as-conversation was organised around the following topics: development and use of resources, continuous assessment and problems experienced by educators. The first topic was addressing the perceptions of the educators about the use of resources and whether they (educators) do develop some teaching materials. With the second topic I wanted to know whether the educators were clear about their role in continuous assessment - the integration of teaching, learning and assessment. In the last topic I was looking for the "native point of view" Malinowski, (1922) cited in Hitchock and Hughes, (1989:52). The important issue here was: what prevents the educators from doing what they want to do. I was looking for genuine constraints not excuses, in this regard.

3.6.4 Documents

There were tow sets of documents which were reviewed, the educators' documents and the learners' documents. From the educators' documents I was able to obtain year planners, preparations, tests and memoranda, and mark schedules. The year planners contained some topics to be covered during that particular academic year. The year planner and daily preparation seemed to be less important compared to the mark schedules. In some cases the daily preparations were not up to date.

The learners' documents which were collected included the notes, test books, assignments, exercises, class work and homework. The notebooks were important documents because they

contain all the concepts discussed during contact sessions. The exercises and other activities seemed to be the work an educator viewed as important. It was used to drill certain concepts or practice some operations or formulae. From the text books, I was able to determine the nature and level of the questions asked by the educator. Lastly the mark schedule showed the variety of summative assessment and the frequency of each type of assessment methods or instruments, for example the number of tests. The records also reflect the performance of the learners.

3.7 DATA ANALYSIS

Data analysis is one of the important components of the research process. It almost takes place throughout the research. Whilst the researcher is making an observation, he/she also examines the part and relates it to the other parts (Stake 1995). Data analysis can be regarded as a process during which the researcher interacts with evidence with the aim of constructing meaning. "Data analysis consists of examining, categorizing, tabulating or otherwise recombining the evidence"... (Yin, 1984:99). The researcher separates data in order to find patterns and consistencies and then reorganise it to form categories or themes. Data analysis is often accompanied with synthesis (Stake, 1995).

It was mentioned in paragraph (3.6.1) above that I collected information about the educators and schools. This information was tabulated to make it easy to read and to make comparisons. The data such as age, experience and qualification say something about the educator. For example, it is that the educator's experience is accompanied with increase in his/her knowledge. It is also asserted that experienced educators are likely to resist changes. Van driel, Beijaard and Verloop (2001:141) pose the following argument in this respect:

> Although experience contribute to an increase in the extent of a teacher's practical knowledge, at the same time the variety within this knowledge decreases. This phenomenon is known as knowledge concentration: people gradually feel more at home in an area that becomes smaller

It was argued earlier in this chapter that at the heart of a case study lies a method of observation (Cohen and Manion, 1994). Because of the importance of observation a bulk of information was collected with the aid of fieldnotes. The writing of fieldnotes followed a sequence of steps as suggested by Hitchcock and Hughes (1989), see paragraph (3.4.2) above. During classroom observation I scribbled key phrases, key words and some important quotes. The raw field notes were then developed into legible notes. During this stage, I added some comments to the notes. This marked the beginning of the preliminary analysis. The later stages of developing notes constituted the real analysis of data. The researcher was sorting out key issues, noting patterns, recurring features, classifying and re-organizing information.

The interviews and document review provided data about visible and invisible evidence. Visible evidence included information about the classroom interactions. Such information was collected for triangulation purposes. The responses of the educators and learners together with the data from documents were compared with the observations made by the researcher. The aim was to confirm or discard certain findings. The invisible evidence include the educators' beliefs, their perceptions, plans, feelings and what I could not observe, for example, the work which was done earlier before the commencement of the study.

The recurring features and patterns were used to develop some themes. The themes were developed within the framework of the research questions. The issues which were covered include: the classroom organization and management, interactions, roles of educators, development and use of resources, use of resources, use of variety of assessment methods,

integration of teaching, learning and assessment, how the results were used for feedback and feedforward, questioning, monitoring of classroom activities, and the role played by learner in their learning.

3.7.1 Validation

To ensure the quality and the rigor of the research the findings need to be validated. Validity is about the trustworthiness of the findings. Hammersely (1992) cited in Altheide and Johnson (1994:487) asserts that "an account is valid or true if it represents accurately those features of the phenomenon that it is intended to describe, explain or theorize. The concept validity is a continuum, we talk of the extent to which the findings are valid. Validity also depends on the interpretation of the audience, which can be a researcher or academic audience (Altheide and Johnson 1994). There are a lot of arguments about the criteria of validity within the ethnographic or qualitative research. This has led to the so-called "radical qualified or hyphenated validities" (Altheide and Johnson, 1994). These criteria are related to culture, ideology, gender, language and relevance. The arguments on these criteria are beyond the scope of this study.

In this study I used the common technique for establishing validity, that is, triangulation. Triangulation involves gathering accounts of a teaching situation from three quite different points of view, namely those of the teacher, his pupils and a participant observer (Elliott and Adelman, cited by Hopkins, 1993). At the three vertices of the triangle is an educator, the learner and the researcher. The educator is an actor and his actions influence learning of the learners and the researcher is an observer. In a situation where I was not satisfied with the views of the other two (educator and learners) I could review the documents for more data.

After using triangulation another technique which was considered is "saturation". Becker (1958:563) defines this as "the check on the frequency and distribution of phenomenon". A particular observation was tested repeatedly against the available data. This was done by revisiting the documents, field notes and interview responses. Yin (1984:103) calls this "playing with the data".

CHAPTER 4

PRESENTATION AND ANALYSIS OF CASE STUDIES

4.1 INTRODUCTION

This chapter will provide a description and an analysis of each case study. The presentation of each case study starts with description of the context in which the educators are working. This includes the immediate surrounding of the schools and the description of the schools. Some important information about the educators will be discussed.

4.2 PRESENTATION OF THE CASE STUDIES

4.2.1 Case Study of School A

4.2.1.1 Context and Profiles

School A is a co-educational school, located in the Edendale area about 6 km from Pietermaritzburg city centre. This area is urban but was reserved for the Africans according to the Group Areas Act enacted by the apartheid regime in 1950. The families in this area range from working class to middle class. School A was built in 1994 and the buildings are still new. There is a triple storey, a double storey classroom block, and an administration block.

During the time the data was collected, the school had 894 learners, 26 educators and 3 members of the non-teaching staff. All the learners attending in this school were Africans and their home language is IsiZulu. The teaching staff of 26 was made up of the Principal, one Deputy Principal, 4 Heads of Department, and 20 permanent and qualified educators. The matriculation pass rates and pass rates of learners in Physical Science are given below.

Table 4.1 Matriculation and Physical Science Pass Rates of School A

Year	1997	1998	1999	2000
Matriculation	05%	18%	27%	47%
Physical Science learners	2%	28%	31%	67%

The pass rate of School A started very low both in matriculation, as a whole, and in Physical Science. However, in both cases there is an improvement. One of the reasons could be the fact that, the school was still new by 1997. They had their first matriculation in 1996, so the educators were still adapting themselves to the conditions. What is reflected in the table is that the Physical Science pass rate is always better than the overall matriculation pass rate. In 2000, there was a drastic change in both matriculation and Physical Science pass rate. This could be the influence of, among other factors, the introduction of the year mark system in 2000.

The school has 35 classrooms each with a maximum capacity of 50 learners. The classes had an average of 37 learners. There is a library which is not well stocked, and a Physical Science laboratory. The materials that MR A had in his Physical Science laboratory is displayed in photograph 1 Appendix H. The educator said that he was able to do most of the chemistry experiments, but he could not do some of physics experiments. According to Mr A the grade 12 learners had adequate Physical Science textbooks. Stationery was bought by parents. The school had one duplicating machine and one photocopier.

Mr A is a married man between the age of 45 and 54. He has the following qualifications: BSc (Agric) Honours, Secondary Teachers Diploma (STD), and a Computer Diploma. His major subjects are Economics and Animal Husbandry, and he has Physics I and Chemistry II. Mr A had more than 16 years teaching experience. He had taught Physical Science for seven (7) years. During the time of data collection, he was offering English in Grade 8A and 8C,

Physical Science from Grade 10 to Grade 12. He had a teaching load of 41 periods a week. Mr A was the Head of the Department of Science, responsible for academic development of the staff. He also assisted with soccer. During the period 1999 and 2000, he had attended three professional development courses:

(i) Science Education Empowerment Development Course (SEED)

(ii) Chalkboard Optics and Mechanics

(iii) Assessment Grids for Practicals, Projects and Assignments.

4.2.1.2 Mr A's Teaching Style

Mr A's classroom was a traditional classroom, in the sense that there was a clear front with rows of desks. The front of the classroom had a chalkboard and a demonstration bench which is elevated to form a platform. Mr A was actually using a laboratory as his classroom. The back of the classroom had a bulletin board on which there was a learner's timetable and a cleaning roster. The roster had only the names of the girls who clean the classroom from Monday to Friday. This says something about the gender equality in Mr A's classroom.

In the following discussion, I describe what was happening in Mr A's classroom. The information was obtained through lesson observation, interviews and document review. I visited the school five times for data collection. The analysis will deal with all five lessons.

Mr A's lessons were characterized by the following sequence of steps: discussion of homework or a summary of the previous lesson, reading of the notes followed by the educator's explanation. The rounding off of the lessons involved the instructions for homework.

Mr A was able to link the lesson with the previous one by summarizing the previous lesson or by revising the homework. On the first day (16/08/2000), it took the educator about 10 minutes to discuss the homework. Learners were required to balance the following two equations:

1. $C_6H_{14} + O_2 \rightarrow CO_2 + H_2O + E$
2. $C_7H_{16} + O_2 \rightarrow CO_2 + H_2O + E$

It was observed that the educator did not check whether the learner did the homework or not. Secondly, the discussion was dominated by the educator. The following illustrates what happened:

Educator: *Let us balance the equation. We start by balancing the number of carbons. So we put a 6 in front of* CO_2.

Next, we balance the hydrogen by putting 7 in front of H_2.

To balance oxygen we can write 9½ in front of O_2. *So the equation becomes:*

$C_6H_{14} + 9½\ O_2 \rightarrow 6\ CO_2 + 7\ H_2O + E$

But in chemistry we don't use fractions, so we multiply by 2

$2\ C_6H_{14} + 19\ O_2 \rightarrow 12\ CO_2 + 14\ H_2O + E$

The equation is now balanced. Who got it right?

The educator went through the balancing of the equation without asking for learners' contributions. It seems as if the educator was trying to emphasize the procedure or the rules of balancing an equation. He did the same thing with the second problem, he balanced the equation and told learners to copy the solution.

Mr A had prepared notes for his learners. He would sacrifice some of the periods to write notes on the chalkboard for his learners and at times use extra time such as afternoons to write the notes. During the lessons he let the whole class read a sentence or two in chorus form (in

unison) and then gave explanations. When he was asked why he allowed his learners to read in chorus form, his response was

> *I want all of them to read so that they can correct their mistakes. You know these kids can't copy something from the board without making mistakes. So when they read, they are able to correct their mistakes (interview 23/08/200).*

The problem with the reading was the noise, one could not follow what they were reading. It looked as if it was a language class reading a novel. However, in his explanation, the educator used simple language and concrete examples. The new terms were clarified, for example, under the properties of halo-alkanes, terms such as "anaesthetic", and "toxicity" and "flammability" were explained using concrete examples. Anaesthetic substance was described as "a substance which can put a patient into sleep during an operation". A non-flammable substance like tetrachloro methane was described as "a substance that can be used to extinguish a fire" (field notes, 16/08/2000). When emphasizing something the educator raised his voice, and asked the learners to repeat after him.

When the educator asked questions, he did not give learners enough time to answer, his waiting time was very short. He was too hasty to wait for answers. In case he did, he would let the whole class answer, in a chorus form. The following illustrate the interaction between the educator and his learners. They were busy with the substitution reactions of alkanes.

Educator: *Suppose we have a cylinder of methane and another cylinder of chlorine gas and we allow these to react (he wrote the equation on the board)*

$CH_4 + Cl_2 \xrightarrow{\Delta} CH_3Cl + HCl\ (g)$

Educator: *What is the name of the compound CH_3Cl ?*

Whole class: Chloromethane

Educator: *What will happen if we pump more chlorine gas (Cl_2)?*

(Without any delay he continues)

Educator: *If we pump more chlorine, another hydrogen will be replaced*

(he wrote the equation)

$CH_3Cl + Cl_2 \rightarrow CH_2Cl_2 + HCl$

Educator: *What is the name of the compound (CH_2Cl_2)?*

Class: *Dichloromethane*

(it was observed that the learners were reading the answers from their note books)

Educator: *What will happen if we continue to pump in chlorine gas?*

Class: *More hydrogen will be replaced.*

The addition of chlorine gas continued.

$CHCl_3 + Cl_2 \rightarrow CCLl_4 + HCl$

Educator: *What is the name of the compound $CCLl_4$?*

Class: *Tetrachloromethane*

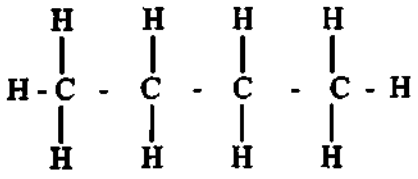
Educator: *Repeat! Tetrachloromethane (He paused for a while and he said)*

Educator: *Read the next sentence.*

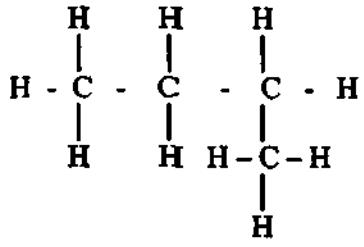
This kind of interaction between the educator and the whole class was very common in Mr A's classroom. On very rare occasions, the educator would point to individual learners. During the five days of observation, I do not remember him calling a learner by his/her name. It was also observed that Mr A's questioning focused on the names of compounds. He solved more difficult problems such as balancing the equations without allowing the learners to try them. His questioning did not seem effective since the learners were referring to their notebooks. It can be argued that his questioning was only limited to drawing the attention of the learners to listen to the educator delivering factual knowledge.

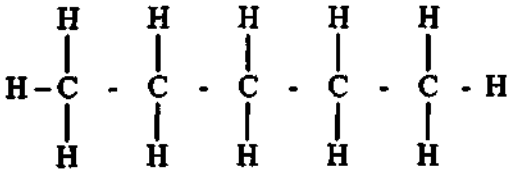
It seems as if Mr A wanted to cover a lot of work at the same time. For example, on the first day he covered: reaction of alkanes with oxygen; substitution reactions of alkanes; properties

of halo-alkanes; and alkanes with branch structures. On the fourth day, he discussed four different compounds: alkynes, alcohols, carboxylic acids and esters. He actually covered the work which is supposed to be done in three weeks, in four days, according to the Grade 12 syllabus (Department of Education and Culture, 1995). During his rush to complete topics Mr A even made some mistakes. He treated the following pairs of structures as different isomers:

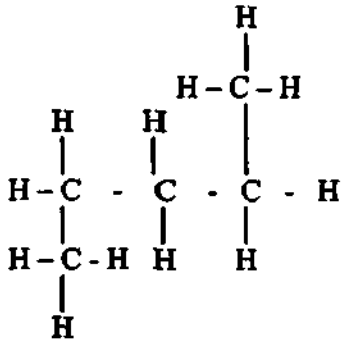


and





and



It is not very easy to tell whether this was caused by being hasty or it was the lack of preparation.

None of the lessons that were observed was based on activities or practical work. However, it should be mentioned that the nature of organic chemistry does not demand lots of experiments. According to the Grade 12 Physical Science Syllabus (Department of Education and Culture, KZN 1996:31), there is only one examinable practical work in this section - the preparation of esters. That might give the reason why the educator did not give learners experimental work. When the educator was asked whether learners were given a chance to perform hands-on experiment, he said that he often does demonstrations.

Educator: *I often do demonstrations for them. You know, when you allow these learners to perform an experiment, they waste a lot of time. Another thing, they break the apparatus, the beakers, test-tube, you name it (interview 23/08/2000).*

4.2.1.3 Assessment of Learners

Mr A's assessment had a formative component and a summative component. The formative assessment comprised of informal questioning, classwork, homework and assignments. The educator used these forms of assessment mainly to facilitate learning. Mr A's questioning seemed to be less effective because of the following reasons: firstly, the learners were reading answers from their notebooks. They were not engaged in any kind of thinking or reasoning. Secondly, the educator allowed the learners to answer as a class, in unison. As a result only the more confident and assertive learners were participating in the discussion. The rest of the learners were passive. Thirdly, the educator did not give the learners enough time to answer. Lastly, his questions were not challenging. He solved most of the more difficult problems. It was as if he had low expectation of his learners.

Mr A selected the classwork and homework from the exercises which are found at the end of each chapter of the textbook. These exercises are structured so as to give learners a practice of the application of the formulae. The educator also included previous examination questions for classwork. For example, on the 18th.08.2000 (3rd visit), he brought a 1998 standard grade question paper, and they discussed the following questions:

5.2 Explain the difference between a saturated and unsaturated hydrocarbon (4)

5.3.1 Write down a chemical equation for the hydrogenation of ethane using structural formulae (3)

5.3.2 Write down the name of the product formed during the hydrogenation of ethane (2)

5.4 Draw the structural formula for methyl propene.

(KwaZulu-Natal DoE, November 1998)

This seemed to motivate the learners. They were happy to see that they could answer some questions of the final examination.

For summative assessment, which is the assessment of learners in order to accumulate marks for promotion, Mr A used tests and assignments. In both cases, he used previous year examination questions. This is, the assignment questions were similar to the test questions. When he was asked about this he said:

I use the past examination question papers because I want my learners to practice answering the questions. I have realized that learners fail to answer the questions not because they don't know but because they are unfamiliar with the nature of the questions.

(Interview 23.08.2000)

After completing a section on electricity, Mr A gave his earners question 3 of a 1999 question paper (Higher Grade), as an assignment. That assignment was written on the 20th May 2000. He also took question 3 of 1998 question paper, standard grade and gave it to the learners as a test. One can agree that the use of previous examination question papers familiarized learners with the nature and the style of the questions, and how they must be answered. However, there is a risk of frustrating or boring the learners, if theses questions are used in all forms or instruments of assessment, especially because they do not relate to real world experiences.

4.2.2 Case Study of School B

4.2.2.1 Context and Profiles

School B is in Imbali Township outside Pietermaritzburg. It is about 4 km from the city center. Most families in the area are working class. Nearby there are other education

institutions: A Comprehensive High School, a College of Education, and a Technical College. In the eighties, the township was affected by political violence.

School B is a co-educational technical high school with Grade 8 to Grade 12. The school has 5 long classroom blocks and can accommodate about 1200 learners. During the time of data collection the enrolment was 918 learners. All the learners were Africans, their home language is Isizulu. There were 30 educators, including the Acting Principal, a Deputy Principal and 4 Heads of Department. The three non-teaching staff comprises of two secretaries and a security guard. The schools performance in matriculation is given below.

Table 4.2 Matriculation and Physical Science Pass Rate of School B

Year	1997	1998	1999	2000
Matriculation	54%	40%	33%	45%
Physical Science learners	31%	26%	23%	43%

The matriculation pass rate of 54% in 1997 was good compared to other schools during that period. After 1997 there was a sharp decrease in the pass rate. I was told that the school had some problems emanating from the so-called R and R, "restructuring and redeployment" programme. This led to the retirement of the Principal. This had a negative impact on the normal functioning of the school. The table also reflects that the pass rate of learners in Physical Science is always lower than the pass rate of the matriculation. There was an improvement in the year 2000, which seems to be the pattern in other schools.

The school has a hall, a library, physical science laboratories, biology laboratory, 1 technical drawing classroom, a metal workshop, an electronics workshop and 1 woodwork workshop. What Ms B had in her laboratory is displayed in Photograph 2, Appendix H. Her laboratory did not have adequate equipment but she said that she could do most of chemistry

experiments. According to Ms B, learners had adequate stationary and other writing materials. However, the school had a shortage of text books. The electrical system had been vandalized. Only the laboratories and the administration block had lights. The school has two duplicating machines and a photocopier.

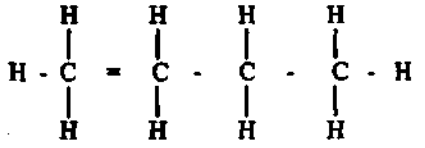
Ms B was between the age of 35 and 44 years. Her qualifications are a Secondary Teachers Diploma in Education. She had an experience of 12 years, and also 12 years teaching Physical Science. She was the Head of the Department of Science, and a class teacher. Ms B had a teaching load of 30 periods per week. Her other responsibilities included learner counseling, and administration duties as a member of the school management team. During the period 1999-2000, she attended 3 inset courses: a chemistry course, electricity and micro-chemistry course, and a science-expo course. She also took part in extra-mural activities. She is responsible for dance and ladies' soccer.

Ms B was visited twice for classroom observation. Unfortunately, in her first lesson she was repeating the lesson which was taught the previous day. Such a lesson was not appropriate for the purpose of this study which aimed at understanding what educators do in their everyday practices. Therefore, nothing much will be said about the first lesson.

4.2.2.2 Ms B's Teaching Style: "I always engage them, by asking more questions"

Ms B started her lesson by asking for a homework, but she did not check whether learners did it or not. They were required to draw a structure of butene. Without wasting time, she asked if anyone could draw the structure on the board. In the absence of volunteers, she asked one boy to draw it.

Ms B: *Mkhize came and draw it. (The boy moves to the board reluctantly and draw the following structure:*



(The structure was wrong, the first two carbons had 5 bonds instead of 4 bonds, three were two extra hydrogens. The educator began to correct the structure)

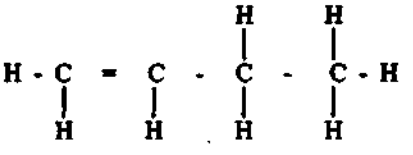
Ms B: *How many carbons are there in butene?*

Class: *There are 4 carbons.*

Ms B: *How many hydrogens are there?*

Class: *10 carbons.*

(That was wrong, but she decided not to correct it and she drew the structure)



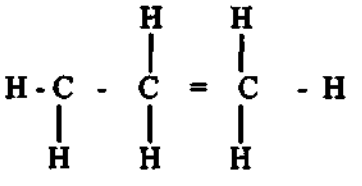
It was observed that the educator changed the structure without explaining why two hydrogens had to be removed. She continued with the lesson showing the differences among alkanes, alkenes and alkynes, giving one example, and a formula in each case. She then showed them how to write a molecular structure using formulae:

C_nH_{2n+2} ; C_nH_{2n} and C_nH_{2n-2}

She gave them two more examples for discussion:

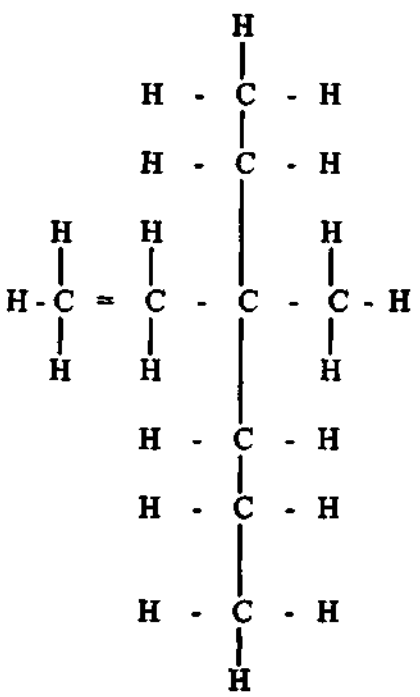
Ms B: *Chamane come and draw a structure of propene*

(the learners laughed, it seems as if Chamane is not a promising learner. He drew the following structure)



Chamane repeated the same mistake made by Mkhize. It might happen that he was not concentrating but the educator did not highlight the mistake or why the structures were changed. The educator asked another learner, Zikhele, to correct it. The structure was corrected but reasons why they were changing was not discussed.

When the educator wanted to introduce the branched structures, she used a big structure, a structure of nonane. Big structures often confuse learners, and this time it even confused the educator. She gave it a wrong name, she called it a butyl-hexane



The correct IUPAC (International Union of Pure and Applied Chemistry) name of this compound is 2-ethyl-2-methylhexane. This is complicated to serve as an introduction to a section.

From the above vignette, it is evident that Ms B was trying to involve her learners in the discussion. What was also observed was that she called her learners by their names or surnames. Ms B interacted well with the learners. There was an attempt to create a relaxed atmosphere. However, the learners especially the boys, abused the situation. The class was very noisy, and the boys were playful. During the interview a learner respondent confirmed this:

Our teacher is very kind and we like her but some learners disrespect her (interview 22.08.2000).

This had a negative effect because learners who were playful, not only missed lessons but they also disturbed those who were serious about their work. Even the educator was affected by the noise. She admitted that during an interview.

Interviewer: *I noticed that some learners are playful during the lesson, is this behaviour common in your classroom.*

Ms B: *Yes, boys are sometimes playful during the lessons but I always try to engage them, by asking more questions (Interview 22.08.2000)*

It seems as if this was the reason why she could not emphasize some important issues, such as the reason why the structures were incorrect. She was worried about the noise.

4.2.2.3 Assessment of Learners

Ms B used the following tools to assess learners: class tests, common tests (test set by the Department of Education and Culture), and assignments. From the beginning of the year up to June, they wrote two tests, one assignment and the June examination. Just like Mr A, Ms B used previous year examination questions for assignments and tests. For example, on the 19th July 2000, Ms B gave her learners a 1998 question paper as an assignment. The following extracts were taken from test 3, dated 20.04.2000.

2.2 The weight of a body of mass 80 kg on a certain planet is 144 N.

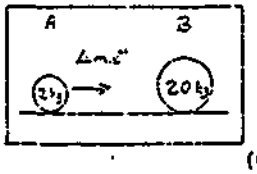
2.2.1 Calculate the magnitude of the acceleration of gravity on this planet. (3)

2.2.2 Calculate the final speed a stone will attain if dropped from a height of 10 m above the surface of this planet and allowed to fall freely. (6) (NSC)

3.2 A moving object A of mass 2 kg travels at 4 $m.s^{-1}$. It collides with a stationary object B of mass 20 kg. After the collision B travels at 0,5 $m.s^{-1}$ in the original direction in which A was travelling. Calculate

3.2.1 the velocity of A after the collision and (4)

3.2.2 the change in the momentum of A. (4)



(OFS)

Question 2.2 was taken from NSC (National Senior Certificate) and question3.2 was taken from OFS (Orange Free State Department of Education). This shows that Ms B used various sources to get suitable questions. It seems as if the educator was successful in familiarizing her learners with the standard of the questions and how to answer the questions. However, this seemed monotonous to the learners, answering similar questions in tests and in assignments. Most examination questions do not deal with the everyday life of the learners. For example question 2.2 above, is about "a body" and a "certain planet", and question 3.2 is abut a moving "object". These kinds of problems are not interesting to the learners.

To facilitate learning Ms B used questioning. She involves her learners by asking them questions. Her questions were not challenging. In addition, learners did not have to explain their answers. In most cases, she used questions to control learners. She would direct the question to the troublesome boys. For homework and classwork, Ms B selected exercises from those found at the end of the textbook. Some of these exercises are "search and find activities", - learners look for answers in the textbook. Some of the structured questions are phrased like the examination questions. Below is an example of an exercise taken from their prescribed book, Horn, Brink and Jones (1987:47)

'11. A 1 kg body moving east at 5 $m.s^{-1}$ hits a second body of unknown mass at rest. After the collision, the 1 kg body reverses its direction and moves west at 1 $m.s^{-1}$, while the second body moves east at 2 $m.s^{-1}$.
(a) What is the momentum of each body after the collision?
(b) What is the mass of the second body? (4.4)
Answers: (a) 1 $kg.m.s^{-1}$ west and 6 $kg.m.s^{-1}$ east *(b)* 3 kg.

The main aim of doing these exercises is to practice the application of the formulae. The exercises do not promote higher order thinking.

4.2.3 Case Study of School C

4.2.3.1 Context and Profiles

School C is in Imbali Township a about 8 km from Pietermaritzburg city centre. The school serves a working class community. The school is small, and was built to accommodate about 750 learners. I was told that the school was meant to be a primary school. A secondary school was going to be built somewhere else. Because that place as a "no go area" during political violence, they transformed the primary into a secondary school. The school accommodated learners from both the Inkatha Freedom Party (IFP) and United Democratic Front constituencies, during the eighties.

The school has Grade 8 to Grade 12. During data collection, there were 631 learners and 18 educators including 4 Heads of Department, a Deputy Principal and a Principal. There were 5 members of the non-teaching staff, 1 administration clerk, 1 cleaner and 3 security guards. The security guards were employed by the school governing body. The matriculation pass rate and Physical Science pass rate are given below.

Table 4.3. Matriculation and Physical Science Pass Rates of School C

Year	1997	1998	1999	2000
Matriculation	81%	50%	65%	67%
Physical Science learners	29%	33%	27%	61%

School C is one of the schools which is known for ist good performance in matriculation. This is confirmed by what is reflected in Table 3. Even though the school is doing well in matriculation examination but there seems to be a problem in Physical Science. The pass rate of learners in Physical Science was very low except in the year 2000. This shows that there is a problem in the teaching of the subject.

School C has two long classroom blocks and a short administration block. There are 20 classes, 1 class is used as a computer room, another one as a storeroom for the science equipment (see photograph 3, Appendix H). This means that there are 18 working classrooms. Each classroom can accommodate a maximum of 45 learners but each had an average of 38 learners. The school has no library, no laboratory, no school hall, no sports field. It has a duplicating machine, two photocopiers and 4 computers.

Mr C is a married man between the age of 25 and 35 years. He had teaching experience of 5 years, and had taught Physical Science for 5 years. When the data were collected, Mr C had a Secondary Teachers Diploma, and was not furthering his studies. He had a register class and a teaching load of 42 periods a week. Mr C was a Physical Science specialist, teaching the subject from Grade 8 to Grade 12. During the period 1999 to 2000, the educator attended 4 Physical Science INSET: 2 science expo courses, a school-net computer course and a general update course conducted by a Physical Science subject advisor. I visited the school two times for the purpose of collecting evidence.

4.2.3.2 Mr C's Teaching Style

In Mr C's classroom, I was fortunate to observe two different lessons. The first lesson was a practical lesson, and the second one was more narrative. The first lesson was a follow-up lesson, in the sense that they had discussed the properties of sulphuric acid, and they were demonstrating these properties practically. The first demonstration was about the dehydrating action of sulphuric acid on hydrous copper sulphate ($CuSO_4.5H_20$) and on sugar. The demonstration with copper sulphate went very well, the blue $CuSO_4.5H_20$ turned grayish white anhydrous copper sulphate ($CuSO_4$). The demonstration with sugar did not work. The educator used powdered glucose instead of sucrose (cane sugar). When the educator was asked about this he said:

Mr C: *I deliberately took a powdered glucose because I thought the reaction was going to be faster. I was trying to apply one of the factors affecting the rates of reactions: the state of division. You know that the finer the reactants, the faster the reaction (Interview 08/2000).*

In this particular case the "state of division" was not applicable because glucose and sucrose are different sugars. Glucose is a monosaccharide and sucrose a disaccharide of glucose had fructose. Sucrose is more likely to liberate more water than glucose because it has a bigger molecule.

The educator was successful in demonstrating the cleaning effect of sulphuric acid on metal surfaces. He cleaned a spatula and a spoon. The fourth demonstration was also a failure. Mr C was demonstrating the oxidizing action of sulphuric acid. He used a cold sulphuric acid instead of a hot one. That is, the reaction was supposed to be activated by heating the reactants. Though Mr C made an effort to do the demonstrations, it seemed as if he did not prepare thoroughly.

Unlike a demonstration lesson, which was a show and tell, in the narrative lesson (second lesson), the learners were more involved. In his second lesson ,the educator employed the question and answer method. The educator had completed two chapters of inorganic chemistry, sulphur and its compounds, and nitrogen and its compounds (Horn, Brink and Jones, 1987:239-262). Before starting a new chapter, the educator made a quick review. He drew a table such as the one below.

Process	*Contact*	*Haber*	*Ostwald*
Catalyst *Product* *Uses*			

Fig. 4.1 Processes

What is significant about this table is that it was the educator's idea, he did not get in from the book. Secondly, it is easy to read the table, and it is a better way of highlighting important concepts. The table was completed by learners, as follows:

Mr C: *Which catalyst is used in the contact process?*

Learner 1: *Vanadium oxide*

Mr C: *Which catalyst is used in the Haber process?*

Learner 2: *Iron*

Mr C: *And for the Ostwald process?*

Learner 3: *Platinum*

Mr C: *Which of the above catalysts is the most expensive?*

Class: *Platinum*

The lesson continued, with the educator leading them with questions. It was observed that the educator gave the learners enough time to answer and learners raised their hands in order to answer the questions. Their participation indicated that they had done the work.

The educator introduced the chapter on halogens and halides by asking questions about the groups of the periodic table until he reached Group VII. He then drew the orbital diagram of fluorine and chlorine atoms.

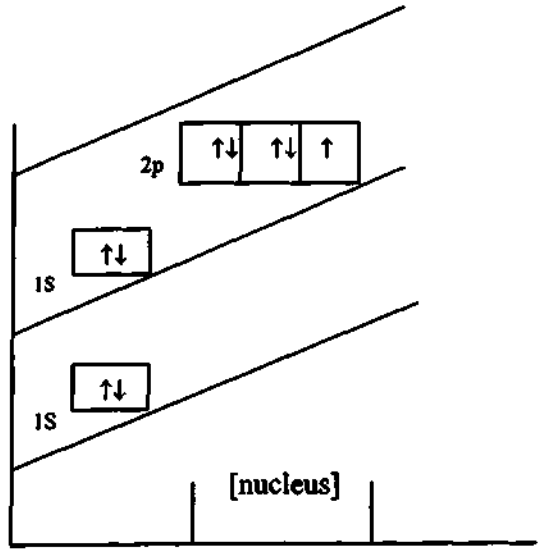


Fig. 4.2 Orbital Diagram of Fluorine

They then derived the valence electron configuration of fluorine and chlorine from the diagrams. The learners had to deduce the valence electron configuration of bromine and iodine from the pattern formed by the first two configurations.

F : $2S^2\,2p^5$

Cl: $3S^2\,3p^5$

From the electron configuration of the first two elements, learners had to deduce the electron configuration of the third and the fourth elements bromine and iodine.

The learners were able to do that, they wrote it as follows:

Br : $4S^2\,4p^5$

I : $5S^2\,5p^5$

What is important from this illustration is that, rather than telling the learners about the structure of group seven elements, the educator used patterns to help learners to deduce the

structures of bromine and iodine. This indicates that the educator gave so me thought to preparing the lesson.

In Mr C's classroom, the desks were arranged in groups. This allowed learners to interact. They were observed whispering, and confirming their answers amongst the members of the group before raising their hands. They were also able to share the 6 textbooks that they had on that particular day. On the first day (first visit), Mr C gave his learners some problems to solve. They were seen sharing ideas and the educator moved around helping them.

4.2.3.3 Assessment of Learners

Mr C used different forms of assessment such as assignments, classwork, homework, projects and tests. Like most educators, his main assessment instrument was a test. When setting tests, the educator used the format of a Grade 12 final examination paper, which consists of a multiple choice question and structured questions. The test questions were often taken from the textbooks: Horn, Brink and Jones (1987) or Pienaar, Walters, de Jager and Schreider (1985). In most cases, the educator set questions which had been discussed in class in the form of examples, classwork or homework. For example, in test 2, out of eight problems only one problem seemed to be new to the learners. The seven problems were in learners' notebooks, as examples, classwork or homework. It seems as if the purpose of Mr C's tests was to assess whether the learners were able to recall information or solutions of the problems. For example, in the abovementioned case (test 2), a learner could memorize the examples and classwork solutions, and get more than 80%. At its best, his test could assess the application of formulae. One could argue that those tests were not successful in assessing higher order skills.

Mr C's classwork seemed to be different from the practices of other educators, such as Mr A. From what was observed, the learners were working collaboratively helping one another. The educator also facilitated while learners were solving problems. Classwork seemed to be effective in Mr C's class. He also used homework as an assessment instrument which helped learners. Like other educators, Mr C had a problem with marking homework. When the homework problems were discussed, the learners marked their work and did corrections. Most learners do not like to do their homework. The learner respondents were asked about this:

Interviewer: *How many of you do their homework honestly without copying from others?*

Learner: *Most of us do the Physical Science homework. Hmm...m, I can say about 70% of us do try. The reasons is that we like Physical Science, and most of the learners respect our teacher (interview 28.8.2000)*

Mr C was introducing projects, where learners make models. Some of these models are displayed on photograph 4, Appendix H . The educator was also involved in the Science Expo competition. Some of his learners were participating in the competition. These projects led to a good relationship between the educator. When they work on a project they work as a team, including the educator.

4.2.4 Case Study of School D

4.2.4.1 Context and Profile

School D is situated in the urban area which was reserved for Africans, according to the Group Areas Act of 1950. The area is not a township. People build their own houses and the houses range from shacks to big houses. The area is about 10 km from the city. Most of the people in the area are unemployed. The area is very "rough" in terms of political violence

and gangsterism. During the political violence, the area was an ANC stronghold, and a "no go" area for the other political parties.

School D is a co-educational school, and has Grade 8 to Grade 12. The school is small, built to accommodate about 700 learners. However, there were 790 learners when the data was collected. The staff of 22 was made up of the Principal, Deputy Principal, 3 Heads of Department and 18 permanent educators. There were 6 non-teaching staff members, including an office clerk, a cleaner and 4 security guards. The security guards are employed by the school governing body. According to the principal, they sometimes have problems with people who steal the school property. That is the reason they employed many security guards. The matriculation pass rate and Physical Science pass rate are given in Table 4.4 below.

Table 4.4. Matriculation and Physical Science Pass Rates of School D

Year	1997	1998	1999	2000
Matriculation	35%	26%	22%	47%
Physical Science learners	15%	28%	19%	40%

The school has 20 classrooms which are large enough to accommodate 50 learners. There are two offices, for the Principal and the Deputy Principal. The school does not have a hall, a library, a laboratory, and there is no sports field. According to the principal, the school has a shortage of text books. Stationary was bought by the parents. Only the Grade 12 learners were supplied with textbooks. The school has only one duplicating machine and one typewriter. There is no photocopier and no computer. The school has a telephone, and electricity in the offices only.

Ms D was a young educator between the age of 25 and 34 years, and she was single. She had a College Diploma, Secondary Teachers Diploma. She was studying a computer course when the data was collected. Ms D had 5 years experience and 5 years teaching Physical Science. She was acting as a subject head and had a register class, Grade 11 "A". She had attended 5 inset courses during the period 1999 to 2000.

It seemed as if Ms D was not comfortable with being observed teaching, but initially she was willing to help. When I wanted to visit her, she kept canceling appointments. As a result she was only observed once. During the observation, she showed some resentment to being observed. At some stage, I had to correct her, when she linked by visit to the "Educator Appraisal Programme".

4.2.4.2 Ms D's Teaching Style

Ms D was observed teaching Grade 11. There were 43 learners, 20 boys and 23 girls, five learners were absent. According to Ms D, they had already finished the syllabus and they were busy with revision. The educator was intending to do revision by asking questions, however, she did not prepare a set of questions. She took a learners' notebook, she used the notes to ask questions. Her first question was:

Ms D:	*What is a vector?*
	(About five hands were up and she pointed to one boy).
Learner 1:	*A vector quantity is a physical quantity which has a magnitude only.*
Ms D:	*Correct yourself, it is the other way round.*
Learner 1:	*Magnitude and direction.*
Ms D:	*What is a scalar quantity?*
Learner 2:	*A scalar quantity is a physical quantity which has a magnitude only.*
	(The learner is reading from his notebook. The other learners are looking at their notebooks).
Ms D:	*Give me an example of a scalar quantity.*

(The learners are not responding and the educator decided to continue).

Ms D: *Examples are distance, time, mass etc.*

Ms D: *What is a distance?*

Learner 3: *A distance is the path actually travelled.*

The educator continued asking lower order questions. These questions are often asked to assess the recall of information. But in Ms D's case the questions did not serve that purpose because the learners were referring to their notebooks. They did not have to recall the information. It seemed as if the educator was highlighting important concepts to be internalized by learners for examination purposes. Some of these questions had appeared in a test written on the 15th March 2000. The following extract is taken from this test:

Physical Science Test No. 1 Grade 11

Question 1

Define the following terms and give one example where possible

1.1.1 Vector

1.1.2 Scalar

1.1.3 Displacement

1.1.4 Distance

1.1.5 Acceleration 3 x 5 = [15]

It was observed that during revision, the educator did not give adequate feedback. She allowed learners to guess, for example, the first learner did not know the difference between a vector and a scalar. It was also noticed that Ms D's class was not active. As this was a revision exercise, it was not unreasonable to expect a more interactive lesson or active participation of the learners.

Ms D took about 25 minutes asking questions, then she gave her learners some work to do. The educator moved around facilitating and marking the work. As she moved from desk to desk she discovered that five boys were not doing their work because they had left the exercise books at home. The educator did not do anything about it, and the boys remained seated for the rest of the period. Ms D seemed to be a disciplinarian educator. However, that prevented her from creating a relaxed atmosphere.

4.2.4.3 Assessment of Learners

Ms D used a variety of assessment instruments: tests, assignments, classwork, homework and projects. The tests remained the most important assessment instrument for Ms D. All the test marks were recorded, and they contributed towards the promotion mark of the learner. The educator also recorded some of the classwork and few homeworks. The analysis of the test questions reveals that the questions were selected from the examples, classwork exercises and homeworks For example, in test 1 all the questions were taken from the learners notebooks, examples, classwork and homework. This means that a learner who could memorize the problems could get 100%. The implication is that Ms D could not distinguish between a learner who understands the concepts and a learner who is able to internalize or memorize information.

CHAPTER 5

DISCUSSION OF FINDINGS

5.1 INTRODUCTION

The last chapter presented an analysis of the findings with respect to each of the case studies examined. This chapter serves the purpose of discussing and interpreting the results of the analysis. In doing this I will work with literature reviewed in Chapter 2.

5.2 DISCUSSION

This section discusses the key findings of the present study. Important issues that emerged will be examined.

5.2.1 The Challenge of Effective Classroom Interaction

Classroom interaction can take any form from educator – whole class interaction, educator and a small group of learners, educator and an individual learner, and interactions amongst learners. As to which interaction the educator prefers depends on the aim of the activity, and the situation surrounding that particular activity. The analysis of the data suggests that the educator – whole class interaction was very common in all the four classes. Most of the class activities involved the whole class. Mr A is a typical example of this type of interaction. In his class, learners answered in chorus form and they also read in unison. The problem with the whole-class interaction is that it is based on the false assumption that the class is a homogeneous group of learners whose abilities are the same. Thus, it is deduced that learners reach the same understanding at the same time.

When an educator asks a question, learners volunteer to contribute to the discussion by raising their hands. The most active learners will participate in the discussion. Those who are withdrawn or less active usually get away with it, and they can be silent the whole day. It was also observed that feedback was educator-led discussion. During these discussions individual learner's problems and mistakes were not addressed. Feedback involved general discussions aiming at giving answers.

It was noticed that the Grade 12 educators Mr A and Ms B were not in favour of group work, and learners working collaboratively. Their learners were seated in straight rows. In Grade 11 classes, Mr C's class and Ms D's class, learners were sitting in groups. It seems as if when educators are under pressure, they revert to traditional methods. Mr A and Ms B were under pressure of completing the syllabus in preparation for the final examination. However, it must be mentioned that Ms D and Mr C groups were not functioning properly. No particular activity was done in group. In Mr C's class learners discussed before answering the questions.

Learning in small groups has a number of benefits. In small groups learners learn to think as a team that "sinks or swims" together (Adams and Hamm, 1990). This motivates learners to help one another as members of a team would do. It is argued that there is a mutual benefit when a successful learner helps a less academically talented one. The more competent learner organizes his/her thinking when he/she explains to a less competent leaner.

The interaction between the educator and individual learners were very poor. Learners were not assisted on a one-on-one basis. The assumption was that they were old enough to stand on their own. Educators also cited the problem of large classes. But it seems as if educators

actually lacked the strategies for handling large classes. In some cases (from my experience) educators divide the class into small groups, then they deal with the groups. Other educators deal with individual learner in turns. That is, they assist a few learners at a time until they finish the whole class.

Assisting individual learners, so-called "individualization" is not a new teaching strategy. It only gained more attention after Vygotsky (1978) proposed the notion of Zone of Proximal Development (PZD). The Zone of Proximal Development is defined as:

> *The distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers* (Vygotsky 1978:85).

The ZPD indicates the difference between what the learner can do on his/her own and what he/she can do when assisted by an adult or a more competent peer. Vygotsky argues that when assisted an eight-year-old (by mental development) can solve problems that can be solved by a twelve-year-old child. It should be emphasized that for this kind of assistance, there need to be a dynamic interaction between a learner and an adult or more capable peer. In order to assist a learner, one has to understand how the child learns rather than what the child has already learned.

5.2.2 Questioning for Understanding Versus Control

Informal classroom questioning is one of the important instruments of interaction in a classroom situation. It plays an important role in integrating teaching-learning and assessment. The fact that it is informal and not threatening to the learners allows them to express their ideas, thoughts, reason and ask questions. This helps the educator to understand his learners. The interaction is direct, learners can get feedback at the same time, and the educator can also probe learners' knowledge by follow up questions (Wragg, 1993).

However, the data reveals that the educators could not use questioning effectively. In most cases, the questions were not used to assess learners' understanding. But educators used questions to draw the attention of the learners. In other words questioning served the purpose of controlling learners.

5.2.3 Creating an Environment to Support Meaningful Learning

One of the major observations was that all the Physical Science classrooms of the four schools were poor learning environment. All the classrooms had bulletin boards but there were no displays. The displays that one can expect to find in a classroom include: classroom rules, charts, newspaper and magazine cuttings, learner work, models, and photocopied materials. Clearly any school can afford to have some of these materials, irrespective of the financial conditions. Muijs and Reynolds (2001) concur with this argument:

> *An aspect of a pleasant classroom that the teacher has a large amount of control over is creating attractive and pleasant displays* (Muijs and Reynolds 2001:60).

By control Muijs and Reynolds (2001) seem to suggest that besides being easily accessible, physical resources can be manipulated easier than other factors, such as psychological and social factors in a classroom. It is argued that the environment influences the behaviour and attitude of the learners. Moos (1976), for example, has this to say:

> *"The environment exerts considerable influence on human behaviour and constitutes a major determinant of effective functioning and satisfaction among milieu inhabitants"* (Moos, 1976 cited in Fraser, 1981:3).

The environment may play an aesthetic effect which can influence the attitude and disposition of the learners. Colourful and bright displays can cheer-up the classroom and make it more pleasant environment while also giving the educator the opportunity to allow peripheral learning to occur (Muijs and Reynolds, 2001). It is argued that pleasant learning environment can motivate learners and improve the attitude of the learner and enhance learning.

Another issue that emerged in the study is that schools lack a "culture" of resource development. The use of the word "culture" suggests that this lack of creativity to develop resources is something that educators inherited from their teachers. In the past, during the time of Bantu Education, educators were forced to stick to the syllabus and prescribed textbook. Creativity was discouraged. They had to teach the factual knowledge that was required for examination purposes. Development of resources in this study means development of textual material and other artifacts such as teaching aids, charts, models, worksheet, development of more context based exercises for class work and assignment, and raising funds in order to buy laboratory equipments.

It was evident that educators were still relying on prescribed textbooks. The only thing they developed were the notes which was a summary of the textbook. The exercises which are found at the end of each chapter were recycled from examples, through class work exercises, assignments, tests and examination. Educators did not design their own problems for assignments and tests. Anyone who completed a teacher-training course would have used a teaching aid or/and a chart during training. But once the educators become qualified they forget about the teaching aids. The four educators were no exception. There was no evidence to indicate that they do use teaching aids.

With respect to laboratory activities, data revealed that learners were not given a chance to do practical work, laboratory activities were limited to demonstrations. It was found that There were a number of reasons for this. firstly, there was a shortage of resources. In one case (School D) the educator could not even do a demonstration, because there was no apparatus. School C had very little equipment, but the educator borrowed some from a College of

Education, some few kilometers from school. School A and school B had apparatus but not adequate for individual learners. However, learners could have hands-on-experience if working in groups. Secondly, data revealed that educators took responsibility to do demonstrations because of security reasons. Educators were saying that learners break apparatus when they do experiments. The third reason was the pressure to complete the syllabus and prepare learners for examinations. Educators argued that when learners are given a chance to do an experiment they wasted time. This was self-defeating, because learners were supposed to practice in order to gain experience. The findings revealed that the most important reasons for this lack of initiative is related to educators' beliefs and assumptions about science learning and science teaching. Educators viewed science curriculum in terms of the content covered. They believed that teaching science is about delivering the subject content in a clear and logical way only.

There seem to be a wide gap between what is expected, according to policy, and what was happening in the four schools as far as laboratory activities are concerned (DoE, 1996b). The following illustrates the situation.

Table 5.1 Nature of "Laboratory" Activities in the Four Classrooms

Activity	Mr A	Ms B	Mr C	Ms D
Investigation	0	0	0	0
Hands on (following procedure)	0	0	0	0
Demonstration	1	1	1	0
Teacher talk	3	3	3	3

Rating scale: The numbers 0, 1, 2 and 3 in the table are used in the following sense:
0 = no presence 1 = minimal presence
2 = moderate presence 3 = strong presence

It has already been pointed out that educators dominated their lesson with educator talk. However, they did some demonstrations on rare occasions. In Chapter 2 it was shown that countries such as USA, UK and Australia are opting for investigative experiment and they criticize "recipe" type experiment (see Hart et al, 2000). However, in the case studied, learners could not do even a "recipe" type experiment. In Ms D's case not even a demonstration was performed.

5.2.4 Assessment Methods: Same Make Different Blend Name

Data suggest that educators used a variety of assessment methods. These assessment methods can be broadly classified as formative and summative assessment. The formative assessment was defined earlier as those assessment methods which are concerned more with informing teaching and learning. Formal summative assessment is more concerned with the collection of marks for promotion. For formative reasons educators used informal classroom questioning, class work, homework and assignments. Tests and examinations remained the dominant formal summative assessment instruments. It must be mentioned that class work and assignment also contributed towards the summative assessment marks. This is what educators regarded as "continuous assessment". The structure and the use of these assessment instruments were almost similar in all the case studies.

It was discussed in chapter 4 that the informal classroom questioning lacked purpose. Educators were using questioning as a pedagogical method, that is, question and answer method. It was not used as an instrument for collecting evidence of what learners knew. This affected the quality of questions that educators asked. To draw the attention of the learners an educator would ask any questions. Educators did not build on to the responses of the learners to questions asked.

Data suggested that there were similarities amongst class work exercises, homework tasks and assignments. The slight difference between homework tasks and assignments was that an assignment was longer than a homework task and learners needed more time to complete an assignment. There was a difference between the assessment of the grade 12 educators (Mr A and Ms B) and the grade 11 educators. The grade 12 educators used previous year examination question papers as a source of questions for class work, assignment and tests. The grade 11 educators used their prescribed text book as a source. The educators cited problems of learners who seldom did their homework task and assignments. This was the concern of all the educators. It seems as if the educators did not have an explicit policy on discipline, as Ms B argues:

> *The (referring to the Department of Education) decided to ban corporal punishment and now we don't know how to punish these children. If you try to use these fancy punishments such as cleaning the toilets and verandas, they seem to enjoy it.*

Ms B was not advocating the return of corporal punishment but her point was that they do not seem to find an alternative to corporal punishment.

Tests remained the dominant assessment instruction across all four schools. They carried more weight than the other forms of assessment. Tests were considered as the most reliable form of assessment, since they reflected the unassisted performance of learners. Unlike the other assessment instruments, tests were inspected and signed by the Head of the Department before they were written.

The above discussion (and chapter 4) has revealed that the educators had some flaws in their assessment of learners. In addition, there are some other issues which where not considered when assessing. For example, educators focused on a pen-and-paper assessment i.e. written form: the classroom exercises, homework; assignment and tests. The different media of presenting evidence such as oral, practical and behaviour were not considered when assessing.

It is argued that learners should be assessed on what they know and can do. It is also assumed that not all learners are good at writing what they know, some prefer presenting it orally, and other learners are good at practical work (Bray, 1986 and Gardener 1983).

It has already been mentioned that educators promoted surface learning of the content. Even the problems which needed application of the formulae were solved and presented to learners to be rote learned. The analysis revealed that the tests were composed of problems which were already solved in examples, class work, homework, and assignments. That is, tests were assessing recall of information. It was also discovered that the variety of assessment methods were not authentic. The names of assessment methods were different but the composition was just the same: "same make but different blend names". This is one of the indications which show that educators are still stuck to the traditional approach to teaching. The national policy on assessment (DoE, 1998b) emphasize the assessment of learners' competences, the inner abilities of learners, and their potential to learn. This demands employment of a variety of assessment methods and in different contexts. The aim of assessment is to collect sufficient evidence in order to make reasonable inferences about the learners' competences. In order to assess learners abilities, it is recommended that learners should be assessed performing activities (NRC 1996, DoE 1998b). In addition such activities should be related to the activities that learners will do in real life, the authentic activities. However, the data suggested that in all the four cases learners were not assessed performing activities. In fact, there were no activities which were performed by the learners.

5.3 SUMMARY

It was observed that all four educators were enthusiastic and dedicated educators. This observation was supported by the fact that educators sacrificed their time to give learners extra lessons, it was also indicated by the volume of work covered and most of them

completed the syllabi in August. However, they seemed to have a problem about how learners learn. It looked like educators assumed that learners learn by listening to the educators explaining concepts, by observing educators solving problems on the chalk board, by observing demonstrations and by being drilled with questions. Though the educators articulated that learners are not empty vessels, their actions did not seem to confirm that. The methods employed by educators could not promote understanding and they dealt with surface features of the content and frequently did not probe to the depth necessary for learners understanding (Tobin, Tippins and Gallard, 1994). This was evident from the poor performance of learners in homework, assignments, and tests. When a learner fails to do a piece of homework, that is often associated with laziness and other affective factors. However, some learners do not do their homework and assignments because they do not know how to start. "Putting learners first" (DoE, 1996) means inter alia, understanding learners problems and assisting them accordingly.

Poor performance in the matriculation examination is not something that comes as a surprise to the educators. It starts with those homework tasks and assignments which are not done, and the class tests which are failed. In essence, it is a chain of poor performances. In the previously disadvantaged communities, learners do experience socio-economic problems that create a barrier to learning. However, the educators need to reflect on how they teach.

CHAPTER 6

CONCLUSION

6.1 INTRODUCTION

Before I conclude the study, I will discuss the implications of the findings on policy, practice and on INSET. This will be followed by reflections on the study, which include limitations of the study and issues for further research. The chapter ends with a conclusion.

6.2 IMPLICATIONS OF THE FINDINGS

6.2.1 Implications for Policy

It was indicated in Chapter 1 that after the 1994 democratic elections the Department of Education and Training put forward a number of policies to guide educators' practices (Department of Education, 1996b, 1997a, 1998b). One of the key principles proposed in the curriculum framework for general and further education and training, is the principle of learner-centredness (DoE, 1996b). This principle suggests how learners are viewed (not as tabula rasa), roles of the learner in his/her learning and role of the educator as a facilitator of learning. This principle can be viewed as a point of departure from the traditional teaching approach. However, evidence suggests that educators were still employing traditional teaching methods. It was not clear whether the educators were not aware of the "new" policies. However, data suggested that educators' practices were more influenced by their beliefs and perceptions. Educators seemed to believe that traditional methods are "quicker" and more "reliable". For example, laboratory activities were viewed as a waste of time and tests were viewed as more reliable than other alternative assessment methods. This poses a threat to the implementation of policy, and it is a challenge for the INSET.

6.2.2 Implication for Practice

The results of the present study suggest that the educators' practices promoted rote learning and memorization of facts. This is far from the goal of the national education policy, which is to produce critical thinkers (DoE, 1996b). It was also acknowledged that there are factors which aggravate these practices. For example, the issue of resources, the pressure of the final examination and the problem of large classes. Concerning the resources, educators will have to utilize the available resources, schools need to fund-raise in order to buy resources, and schools can work as clusters to share resources. The problem of large classes is often minimized by dividing learners into small groups. This is not an attempt to provide solutions to the above problems, but it is an indication of the fact that something can be done. It is the role of the INSET to assist educators (see 6.2.3 below).

6.2.3 Implications for INSET

During the time when data were collected no educator was up-grading his/her qualifications. This means that they only relied on departmental circulars and INSET for information and policy documents. This poses a challenge for INSET to make the educators aware of changes and developments in science teaching and learning. Unfortunately, this does not end there, educators need the support of the INSET when implementing the new policies. Educators are required to teach, not the way they were trained. For example, educators were not trained to perform investigative experiments and they were allowed to use corporal punishment in the past. Educators need to learn new skills, which will not be gained by accident. It is a challenge for INSET.

6.3 LIMITATIONS OF THE STUDY

The first limitation of the study was the time during which the study was carried out. Class observation could only commence during the third term owing to commitments on the M. Ed programme. By this time some of the educators had already completed the syllabi, for example, Mr C and Ms D had completed the Grade 12 syllabus. As a result, they had to be observed teaching Grade 11. Ms D was engaged in revision with her Grade 11 learners. According to the initial plan all the educators were to be observed in Grade 12. However, the change of plan turned out to result in a better combination, that is, observation in two Grade 12's and two Grade 11's.

Another limitation could be caused by the fact that I, the researcher am a physical science educator. This could cause subjectivity and bias in the interpretation of the findings. For example, this could have expressed itself in the form of empathizing with fellow colleagues, or adding some general insights from my own experiences which were not revealed by the study.

Lastly, since the study was about educator practice inside the classroom, one would argue that school discipline acted as an extraneous variable. For example in school B, the standard of discipline was very low, and in school C learners were well disciplined. The learners in school B were almost unteachable. It becomes unfair to compare educator practices under different situations.

6.4 ISSUES FOR FURTHER RESEARCH

During the analysis and the discussion of the results in chapter 4 and earlier in this chapter, there were some issues and questions which emerged that could not be answered in the present study. These issues are highlighted below and are recommended for further research.

The present study was conducted with the schools in the urban areas. There is a general assumption that schools in urban areas are better resourced than the schools in rural areas, yet some schools in rural areas perform better than the schools in urban areas. A replication of this study involving schools in rural areas can give further insights into the issue.

The second issue is the authenticity of continuous assessment and the year mark system. There are some concerns among many sectors that the year marks are manipulated. A quantitative survey is required to investigate this matter.

Thirdly, a survey is needed to determine educators' awareness of the "new" policies on education and what they are supposed to be doing. During informal discussion, it was evident that educators were not aware of some of the changes in science teaching.

The final question is: how effective is in-service training programme in developing educators?

6.5 CONCLUSION

In concluding this study, it suffices to remind the reader of the purpose of the study. The purpose of this study was to:

- Examine the teaching practices of Physical Science educators with respect to teaching styles, development and use of resources, and learner assessment.

- Analyze how these practices influence deep conceptual learning and understanding on the part of the learners.
- Propose measures for enhancing the teaching of Physical Science with the view of improving the matriculation results.

The classroom practices of educators were predominantly traditional. The practices were characterized by educator dominance, non-interactive teaching, memorization, and passive participation of learners. Such practices are not effective for deeper understanding, higher-order thinking and problem solving (Anderson, 1997; Darling-Hammond, 1996).

The schools did not have adequate resources, however, it looked like the bigger problem was with the beliefs and perceptions of educators about how children learn best. Educators did not value activities, they seemed to be more concerned with the content to be covered. The teaching aids, textual material and library books, laboratory equipment did not play any significant role.

Evidence from the case studies suggests that there was a shift towards a variety of assessment methods, but this needed some improvement. On integrating teaching, learning and assessment, educators seemed to have problems. The assessment instruments such as class work exercises, homework, and assignments seemed to contribute more to the summative assessment and very little to assisting learners in their learning. Another problem was the focus on the assessment of lower-order skills.

There are some factors which need to be addressed in order to improve the situation. Firstly, educators need INSET support in order to change their beliefs about science and science teaching. They view science as knowledge to be transferred from educator to learners.

Secondly, educators had very low expectations of their learners. This was evident in the way they tried to simplify things for their learners, including the assignments and test questions. Thirdly, is the issue of resources, the schools were very poor in terms of resources. It seems as if only the educators and their principals will solve this problem, since the government no longer provides hand-outs. The fourth factor relates to the pressure of completing the syllabus and the final examination. Educators assume that when they follow more active methods of teaching, time is wasted. However, the findings were that the drill methods demand extra time: afternoon sessions and Saturday classes. As has been mentioned, educators will need professional development in order to change this situation.

REFERENCES

Adams, D.M. and M.E. Hamm (1990). Cooperative Learning: Critical Thinking and Collaboration Across the Curriculum. Springfield: Charles C. Thomas Publisher.

Anderson, L.W. and R.B. Burns (1989). Research in Classrooms: The Study of Teachers, Teachers and Instruction. Oxford: Pergamon Press.

Anderson, O.R. (1997). A neurocognitive perspective on current learning theory and science instructional strategies. Science Education, 81, 67-89.

Altheide, D.L. and J.M. Johnson (1994). Criteria for Assessing Interpretive Validity in Qualitative Research. In: Denzin, N. and Y. Lincoln (eds), Handbook of Qualitative Research. 485 – 499.

Australian Education Council (1994). A Curriculum Profile for Australian Schools. Carlton: Curriculum Corporation.

Ausubel, D.P. (1968). Educational Psychology: A Cognitive View. New York: Holt, Reinhart and Winston, Inc.

Bellis, I. (1998). Outcomes and Competences and Their Assessment. Paper presented at ASSEESA Conference 30 September 1998.

Bless, C. and C. Higson-Smith (1995). Fundamentals of Social Research Methods: An African Perspective. 2nd Ed. Cape Town: Juta and Co., Ltd.

Blumer, H. (1969). Symbolic Interactionism: Perspective and Method. Englewood Cliffs: Prentice Hall, Inc.

Bray, E. (1986). Fitness for Purpose. In: R. Lloyd-Jones; Bray, E.; Johnson, G.; Currie, R. (ed). Assessment from Principles to Action: 17-28. London: Macmillan.

Broadfoot, P. (1995). Performance Assessment in Perspective: International rends and Current English Experience. In: H. Torrance (ed)., Evaluating Authentic Assessment. 1 – 43. Buckingham: Open University Press.

Burgess, R. (1985). Issues in Educational Research: Qualitative Methods. London: Falmer Press.

Charon, J.M. (1979). Symbolic Interactionism: an Introduction, an Interpretation, an Integration. Prentice-Hall.

Christie, P. (1985). The Right to Learn: The Struggle for Education in South Africa. Cape Town: Galvin and Sales (Pty) Ltd.

Cohen, L. and L. Manion (1994). Research Methods in Education (4th ed). London, Routledge.

Crawford, B.A. (2000). Embracing the Essence of Inquiry: New Roles for Science Teachers. Journal of Research in Science Teaching. 37, 917 – 937.

Darling-Hammond, L. (1996). The Right to Learn and the Advancement of Teaching: Research, Policy and Practice for Democratic Education. Educational Research, 25, 5-17.

Denzin, N.K. (1989). Interpretive Interactionism. Newbury Park: Sage.

Denzin, N.K. (1992). Symbolic Interctionism nd Cultural Studies. Englewood Cliffs, N.J.: Prentice-Hall.

Denzin, N. and Y. Lincoln (eds) (1994). Handbook of Qualitative Research. Thousand Oaks: Sage.

Department of Education (1995). White Paper on Education and Training. Pretoria: Author.

Department of Education (1996b). Curriculum Framework for General and Further Education and Training. Pretoria: Department of Education.

Department of Education (1998b). Assessment Policy in the General Education and Training Band Grade R to 9 and Abet. Pretoria: Department of Education.

Eisner, E. (1993). Reshaping Assessment in Education: Some criteria in search of Practice. Journal of Curriculum Studies, 25(3), 219 – 233.

Elliott, J. and C. Adelman (1976). Innovation at the Classroom Level: A Case Study of the Ford Teaching Project. Unit 28, Open University Course E203: Curriculum Design and Development. Milton Keynes: Open University Press.

Flanders, N.A. (1970). Analyzing Teaching Behaviour. New York: Addison Wesley.

Floden, R.E., M.E. Goertz and J. O'Day (1995). Capacity Building in Systemic Reform. Phi Delta Kappa, 77: 19-21.

Foulds, K. (ed) (1996). Teacher's Resource File. London: John Murray.

Fraser, B.J. (1981). Learning Environment in Curriculum Evaluation: A Review. Sydney: Pergamon Press.

Freire, P. (1970). Pedagogy of the Oppressed. New York: Continuum Publishing Co.

Gabel, D.L. (ed). (1994). Handbook of Research on Science Teaching and Learning. 49-80. New York: Macmillan.

Geertz, C. (1973). The Interpretation of Culture. New York: Basic Books.

Giddens, A. (1973). Sociology. Cambridge: Polity.

Gil-Perez, D. (1996). New Trends in Science Education. International Journal of Science Education. 18(8) 889-901.

Gipps, C. (1994). Gipps, C. (1994). Beyond Testing: Towards a Theory of Educational Assessment. London: Falmer.

Gold, R. (1958). Roles in Sociological Field Observation. Social Forces 36(3) 217-223.

Gott, R. and S. Duggan (1996). Practical Work: Its Role in the Understanding of Evidence in Science. International Journal of Science Education. 18(7) 791-806.

Gruender.C.D. and K. Tobin (1991). Promise and Prospect. Science Education, 75(1) 1-8.

Hammersley, M. (1992). What's Wrong with Ethnography? London: Routledge.

Hart, C.; P. Mulhall; A. Berry; J. Loughran and R. Gunstone (2000). What is the Purpose of this Experiment? Or Can Students Learn Something from Doing Experiments? Journal of Research in Science Teaching. 37(7) 655-675.

Hartshorne, K. (1992). Crisis and Challenge: Black Education 1910-1990. Cape Town: Oxford University Press.

Hatch, T. and H. Gardner (1990). If Binet had Looked Beyond the Classroom: The Assessment of Multiple Intelligences. International Journal of Educational research 14(5): 415-429.

Hitchcock, G. and D. Hughes (1989). Research and the Teacher. London: Routledge.

Hodson, D. (1992). In Search of a Meaningful Relationship: An Exploration of Some Issues Relating to Integration in Science and Science Education. International Journal of Science Education, 14(5) 541-566.

Hodson, D. (1993b). Re-Thinking Old Ways: Towards a More Critical Approach to Practical Work in School Science. Studies in Science Education, 22: 85-142.

Hofstein, A.; B. Eylon and G.J. Giddings (1995). Science Education: From Theory to Practice. Rehoudt: The Weizmann Institute of Science.

Hopkins, D. (1993). A Teacher's Guide to Classroom Research. 2nd ed. Buckingham: Open University Press.

Horn, L.; B. du P. Brink and R.C. Jones (1987). Physical Science in Action (Standard 10). Kenwyn: Juta and Co.

Horrell, M. (1964). A Decade of Bantu Education: Johannesburg. South African Institute of Race Relations.

Jita, L. (1998). The context and Practice of Science Teaching in Secondary Schools in KwaZulu Natal. Durban: Education Policy Unit, University of Natal.

Jita, L. (1998). The context and Practice of Science Teaching in Secondary Schools in KwaZulu Natal. Durban: Education Policy Unit, University of Natal.

Joas, H. (1985). G.H. Mead: A Contemporary Re-Examination of his Thought. Cambridge: Polity Press.

KZNDEC (2001). December 2000 Examiner's Reports KwaZulu-Natal Senior Certificate Examination. Unpublished Internal Document.

Lederman, N.G. (1999). Teacher's Understanding of the Nature of Science and Classroom Practice: Factors that Facilitate or Impede the Relationship. Journal of Resarch in Science Teaching, 36(8) 916-929.

Liftig, I.F., B. Liftig and B. Eaker (1992). Making Assessment Work: What Teachers Should Know Before They Try It. Science Scope 15, 4-5.

Louisell, R.D. and J. Descamps (2001). Developing A Teaching Style: Methods for Elementary School Teachers. Illinois: Wadeland Press.

Lubisi, C. (1999). Assessment in Education: Principles, Practice and Critique. Pietermaritzburg: University of Natal Press.

Lubisi, C. (2000). An Investigation into Mathematics Teachers' Perceptions and Practices of Classroom Assessment in South African Lower Secondary Schools. Ph. D. Thesis. Notitngham: University of Nottingham.

Malcolm, C. (1999). Outcomes-Based Education has Different Forms. In Jansen, J. and P. Christie (eds), Changing Curriculum: Studies on Outcomes-Based Education in South Africa. 77-111.

Malherbe, E.G. (1977). Education in South Africa. Vol. 2. Cape Town: Juta.

Marzano, R.J. (1992). A Different Kind of Classroom. Alexandria, VA: ASCD.

McNaught, C.M. (1994). Learning Science at the Interface Between Zulu and English. Ph. D. Diss. Pietermaritzburg: University of Natal.

Miles, M.B. and A.M. Huberman (1994). Qualitative Data Analysis. London: Sage Publishers.

Mintzes, J.J.; J.H. Wandersee and J.D. Novak. (1997). Meaningful Learning in Science: The Human Constructivist Perspective. In Phye, G.D. (ed). Handbook of Academic Learning Construction of Knowledge. 405-440. San Diego: Academic Press, Inc.

Mitchell, L. (1989). The Definition of Standards and their Assessment. In: J. Burke (ed). Compency Based Education and Training. London: Palmer Press.

Moll, I. (2002). Clarifying Constructivism in a Context of Curriculum Change. Journal of Education. 27, 1-32. Pietermaritzburg: School of Education, University of Natal.

Mossom, F.Y. (1989). Science Teaching by means of the Process Approach in the Primary School. M. Ed. Thesis. Pretoria: University of South Africa.

Muits, D. and D. Reynolds (2001). Effective Teaching: Evidence and Practice. London: Paul Chapman.

Murphy, P. (1996). Integrating Learning and Assessment – The Role of Learning Theories? In. P. Wood (ed). Contemporary Issues in Teaching and Learning. London: Routledge.

Muwanga-Zake, J.W. (2001). Is Science Education in a Crisis? Some of the Problems in South Africa. Science in Africa. (2) 1-14. East London: Casem Rhodes University.

Nott, M. and J. Wellington (1996). When the Black Box Springs Open: Practical Work in Schools and the Nature of Science. International Journal of Science Education. 18(7) 807-818.

Novak, J.D.(1979). The Reception Learning Paradigm. Journal of Research in Science Teaching. 16: 481-488.

NRC (1996). National Science Education Standards. Washington, DC: National Academy Press.

Parker, B.P., (1994). Democracy, Power and the Organization of Education Projects. Ph.D. Thesis. Pietermaritzburg: University of Natal.

Prus, R. (1996). Symbolic Interaction and Ethnography Research. Albany: Suny Press.

Rice, D.; J. Ryan and S. Samson (1998). Using Concept Maps to Assess Student Learning in the Science Classroom: Must different Methods Compete? Journal of Research in Science Teaching. 35(10). 1103-1127.

Rice, J.; C. Saunders and T. O'Sullivan (1996). Successful Group Work. London: Kogan Page.

Roth, W.; C.J. McRobbie; K. Lucas; S. Boutonne (1997). Why May Students Fail to Learn From Demonstrations? A Social Practice Perspective on Learning in Physics. Journal of Research in Science Teaching. 34(5) 509-533.

Rowntree, D. (19987). Assessing Students: How Shall we Know Them?. London: Kogan Page.

Ruiz-Primo, M.A. and R.J. Shavelson (1996). Rhetoric and Reality in Science Performance Assessment: An Update. Journal of Research in Science Teaching. 33(10) 1045-1063.

Shange, G.D. (1996). A Study of Factors Affecting Teaching and Learning with Special Reference to Standard Ten Physical Science in Selected African Schools in Rural

Areas of KwaZulu Natal. M. Ed. Thesis. Pietermaritzburg, Univesrity of Natal Pietermaritzburg.

Sherman, R.R. and R.B. Webb (1988). Qualitative Research in Education: Focus and Methods. London: The Falmer Press.

Slavin, R.E. (1994). Educational Psychology theory and Practice. Massachusetts: Allyn and Bacon.

Spillane, J.P., G.L. Thompson, C. Lubienski, L. Jita and C. Reiman (1995). The Local Government Policy System Affecting Mathematics and Science Education in Michigan: Lessons from Nine School Districts. Lansing: Michigan Statewide Systemic Initiative Policy and Program Review Component (MSU).

Stake, R.E. (1995). The Art of Case Study Research. Thousand Oaks: Sage Publications, Inc.

Staple, A.D. (1980). A Critical Comparative Review of Evaluation Criteria Employed in Senior Certificate of Education Examinations and Their Effect Upon Teaching Methods Employed in the Presentation of Physical Science in Selected Schools in Natal and England. M. Ed. Thesis. Pietermaritzburg: University of Natal.

Steffe, P. and J. Gale (ed) (1995). Constructivism in Education. Hillsdale, N.J.: Erlbaum.

Stenhouse, L. (1975). An Introduction to Curriculum Research and Development. London: Heinemann.

Stuart, J.F. (ed). (1987). Didactics: An Orientation for First-Year Students. Johannesburg: Macmillan.

The South African Schools Act of 1996.

Tobin, K.; M. Espinet; S.E. Byrd and D. Adams (1988). Alternative Perspective of Effective Science Teaching. Science Education, 72, 433-451.

Tobin, K. and M. Espinet (1989). Impediments to Change: Application of Peer Coaching in High School Science. Journal of Research in Science Teaching. 26, 105-120.

Tobin, K., D. Tippins and A.J. Gallard (1994). Research on Instructional Strategies for Teaching Science. In: D.L. Gabel (ed)., Handbook of Research on Science Teaching and Learning. 45-94. New York: Macmillan.

Treagust, D.F., R. Duit and B.J. Fraser (1996). Improving Teaching and Learning in Science and Mathematics. New York: Columbia University, Teacher College Press.

Woods, P. ((1983). Sociology and the School. London: Routledge and Kegan Paul.

Van Driel, J.H.; D. Beijaard and N. Verloop (2001). Professional Development and Reform in Science Education: The Role of Teachers Practical Knowledge. Journal of Research in Science Teaching. 38(2) 137-158.

Vygotsky, L. (1978). Mind in Society. Cambridge, Mass: Harvard University Press.

Wragg, E.C. and G. Brown (1993). Questioning. London: Routledge.

Yin, R.K. (1984). Case Study Research: Design and Methods. Beverly Hills: Sage Publications.

KWAZULU-NATAL DEPARTMENT OF EDUCATION AND CULTURE

ORMAL STATISTICS

YEAR: 1999/11

ENIOR CERTIFICATE (FULLTIME)

UBJECT: PHSCH PEYSICAL SCIENCE HG

ERCENTAGE DISTRIBUTION:

MAXIMUM MARK: 400

		H	H	G	FF	F	E	D	C	B	A	MEDIAN	CANDIDATES
		00-09	10-19	20-29	30-33	34-39	40-49	50-59	60-69	70-79	80-100		
UPPLIED NORM		1.92	20.75	23.12	6.84	10.07	13.00	10.18	7.40	4.21	2.51	32.46	14,479
	RAW MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1994/11													
	ADJUSTED MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	RAW MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1995/11													
	ADJUSTED MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	RAW MARKS	5.47	29.44	21.30	5.37	7.23	9.52	7.96	6.17	4.22	3.32	27.08	13,344
1996/11													
	ADJUSTED MARKS	0.53	9.94	24.43	10.06	11.23	12.60	12.76	10.80	4.31	3.32	36.69	13,344
	RAW MARKS	1.25	23.16	25.85	7.60	9.18	11.93	8.49	5.98	3.71	2.85	29.90	16,350
1997/11													
	ADJUSTED MARKS	1.25	14.84	19.60	7.35	10.69	15.73	13.23	9.68	4.79	2.85	37.91	16,350
	RAW MARKS	2.10	27.81	27.34	7.65	8.56	10.05	7.05	4.67	2.66	1.90	27.35	17,355
1998/11													
	ADJUSTED MARKS	1.85	17.04	21.26	7.33	10.22	15.76	10.52	8.82	4.68	2.52	35.48	17,355
	RAW MARKS	2.42	34.30	24.67	5.35	7.94	9.22	6.64	4.69	3.05	1.72	25.38	17,265
1999/11													
	ADJUSTED MARKS	2.10	20.54	23.50	6.49	10.40	12.88	10.04	7.26	4.27	2.50	32.37	17,265

FOR STATISTICAL PURPOSES, CANDIDATES WHO WERE ABSENT FOR THIS SUBJECT WILL NOT BE INCLUDED IN THE CALCULATIONS.

ENTRY STATISTICS FOR THIS SUBJECT:

ENTRIES	OUTSTANDING	ABSENT	% CANDIDATES OGIVED
17861	16	580	99.91 %

APPENDIX A 3 KWAZULU-NATAL DEPARTMENT OF EDUCATION AND CULTURE

RVAL STATISTICS YEAR: 1999/11

NIOR CERTIFICATE (FULLTIME)

BJECT: MATHS MATHEMATICS SG

RCENTAGE DISTRIBUTION: MAXIMUM MARK: 300

		H	H	G	FF	F	E	D	C	B	A	MEDIAN	CANDIDATES
		00-09	10-19	20-29	30-33	34-39	40-49	50-59	60-69	70-79	80-100		
PPLIED NORM		27.85	23.56	15.82	4.96	6.75	8.31	6.09	3.72	2.01	0.93	19.40	29,267
994/11	RAW MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	ADJUSTED MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
995/11	RAW MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	ADJUSTED MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
996/11	RAW MARKS	22.15	24.80	17.51	5.42	7.12	9.21	6.34	4.23	2.28	0.93	21.74	24,207
	ADJUSTED MARKS	11.01	18.04	17.90	7.35	10.15	12.54	10.82	6.59	3.69	1.90	31.66	24,207
997/11	RAW MARKS	23.41	33.42	17.90	4.95	5.93	6.32	4.03	2.38	1.23	0.43	17.96	32,723
	ADJUSTED MARKS	14.00	18.82	15.52	6.13	12.60	13.75	8.30	5.59	3.38	1.92	31.08	32,723
998/11	RAW MARKS	52.91	21.93	11.29	3.03	3.34	3.46	2.15	1.20	0.49	0.21	9.45	43,041
	ADJUSTED MARKS	40.67	21.28	12.89	5.30	5.99	6.36	3.46	2.15	1.20	0.70	14.38	43,041
999/11	RAW MARKS	41.57	25.18	14.85	3.51	5.33	5.05	2.72	1.25	0.42	0.13	13.35	46,871
	ADJUSTED MARKS	30.18	21.16	16.10	5.14	9.01	8.84	5.05	2.72	1.25	0.54	19.37	46,871

R STATISTICAL PURPOSES, CANDIDATES WHO WERE ABSENT FOR THIS SUBJECT WILL NOT BE INCLUDED IN THE LCULATIONS.

TRY STATISTICS FOR THIS SUBJECT:

NTRIES	OUTSTANDING	ABSENT	% CANDIDATES OGIVED
9850	110	2869	99.77 %

APPENDIX A 4 KWAZULU-NATAL DEPARTMENT OF EDUCATION AND CULTURE

RMAL STATISTICS — YEAR: 1999/11

NIOR CERTIFICATE (FULLTIME)

BJECT: MATHH MATHEMATICS HG

RCENTAGE DISTRIBUTION: MAXIMUM MARK: 400

		H	H	G	FF	F	E	D	C	B	A	MEDIAN	CANDIDATES
		00-09	10-19	20-29	30-33	34-39	40-49	50-59	60-69	70-79	80-100		
PPLIED NORM		24.23	19.97	14.24	4.50	7.14	10.40	7.98	5.28	3.76	2.50	24.07	17,342
	RAW MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
94/11	ADJUSTED MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	RAW MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
95/11	ADJUSTED MARKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	RAW MARKS	28.22	25.54	14.69	4.22	5.16	7.29	5.76	4.26	2.93	1.93	18.53	16,777
96/11	ADJUSTED MARKS	2.84	20.31	20.31	6.18	10.88	17.31	7.29	5.76	5.80	3.33	34.20	16,777
	RAW MARKS	39.39	22.23	12.20	3.45	4.54	6.14	4.57	3.16	2.55	1.77	14.77	20,916
97/11	ADJUSTED MARKS	8.50	30.89	19.84	3.83	5.43	11.40	7.95	4.68	4.47	3.02	25.35	20,916
	RAW MARKS	36.54	21.83	11.91	3.77	4.47	6.35	4.48	3.64	2.57	2.44	15.25	18,628
98/11	ADJUSTED MARKS	27.64	19.48	13.25	5.27	6.64	8.25	6.48	6.04	4.33	2.61	22.17	18,628
	RAW MARKS	35.94	19.72	12.91	3.75	5.80	7.79	5.43	3.70	2.80	2.16	17.13	16,961
99/11	ADJUSTED MARKS	27.09	17.37	14.03	4.30	7.24	10.33	7.84	5.32	3.88	2.60	23.95	16,961

R STATISTICAL PURPOSES, CANDIDATES WHO WERE ABSENT FOR THIS SUBJECT WILL NOT BE INCLUDED IN THE LCULATIONS.

TRY STATISTICS FOR THIS SUBJECT:

NTRIES	OUTSTANDING	ABSENT	% CANDIDATES OGIVED
7707	21	725	99.88 %

APPENDIX B

Sobantu Secondary School
P O Sobantu
3210
29 May 2000

The District Manager
Education Department
Pietermaritzburg
3200

Dear Sir/Madam

PERMISSION FOR CLASSROOM OBSERVATION

This is to request your office to grant me permission to visit some schools in the area of your operation for the purpose of observing physical science lessons during the months of July/August. This classroom observation is part of the research project which is conducted under the auspices of the University of Natal.

The purpose of the study is to examine the classroom practices of the physical science educators. This project will in now way disrupt the schools' programmes. I also give you an undertaking that strict ethical standards will be adhered to with regard to confidentiality. At no stage will the names of the schools, nor the participants be divulged. The findings of this project will not be published.

Should you require any further information I will gladly supply it.

I thank you in advance for your support.

Yours faithfully

Office stamp:

G.G.B. Ndlovu
(033) 3902542 (W)

Permission granted/~~Not granted~~ on consultation with the principal.

(CSEM)
Designation

DISTRICT MANAGER FOR EDUCATION & CULTURE
PIETERMARITZBURG DISTRICT
PIETERMARITZBURG

APPENDIX C

Sobantu Secondary School
P O Sobantu
3210
28 April 2000

The Principal

Dear Sir/Madam

PERMISSION FOR CLASSROOM OBSERVATION

I hereby ask for permission to conduct classroom observation in your school. This observation is part of the research project which is conducted under the auspices of the University of Natal.

The purpose of this project is to examine the classroom practices of the physical science educators. I have already spoken with the educator, he/she seems to be willing to assist me.

The project will in no way disrupt the school programme. Strict ethical standards will be adhered to with regard to confidentiality. At no stage will the name of the school nor the participants be divulged. The findings will not be published..

I thank you in advance for your support.

_____

G.G.B. Ndlovu
(033) 3902542 (W)

APPENDIX D

Sobantu Secondary School
P.O. Sobantu
3210
02/04/2000

The Director
Examination Section
Private Bag X9044
Pietermaritzburg
3200

Dear Sir/Madam

Requesting for Matric P. Science Pass Rate Statistics

This is to request your office to grant me permission to have an access to the Matric Physical Science pass Rate Statistics. When I contacted my subject adviser Mr Moodley, I was made to understand that he cannot release the statistics without your permission.

The statistics will help me in my research project. The project is conducted under the auspices of the University of Natal. I give you an undertaking that strict ethical standards will be adhered to with regard to confidentiality. At no stage will the names of the schools be divulged.

I thank you in advance for your support.

Ndlovu

~~B.B.G~~. Ndlovu (Mr)
G. G. B

UNIVERSITY OF NATAL
SCHOOL OF EDUCATION
3 -4- 2000
PRIVATE BAG X01
SCOTTSVILLE 3209

Permission granted / ~~not granted~~

Designation Chief - Examinations & Curriculum
30/05/2000

Office stamp

APPENDIX E

INTERVIEW SCHEDULE (EDUCATOR A - 1)

1.1 I saw the desks arranged in straight rows, do you allow your learners to work in groups"

. . . . . .

1.2 If yes, what activities do you give to you learners?

. . . . . .

. . . . . .

. . . . . .

1.3 If your answer is no, what is your attitude towards co-operative learning (group work)

. . . . . .

. . . . . .

. . . . . .

2. Since you give your learners notes before hand don't you think it can be a good idea to let them discuss and report back, at times?

. . . . . .

. . . . . .

3. I noticed that you allow your learners to read in unison even if they answer questions they answer together as a class not individuals. Is there any particular reason why you do that?

. . . . . .

. . . . . .

. . . . . .

4.1 When you give your learners problems to solve you encourage them to write on any piece of paper. Do you have any particular reason for doing that?

. . . . . .

. . . . . .

. . . . . .

4.2 Would you say that you give them enough time to solve those problems?

.....

.....

5.1 How often do you give your learners homework?

.....

5.2 Out of 46 learners how many learners do their homework sincerely and honestly without copying from others?

.....

5.3 How do you deal with those who don't do their homework?

.....

.....

.....

6. How is the rate of:

6.1 Absconding? .....

6.2 Absenteeism? .....

7. How do you deal with such behaviour?

.....

.....

8. What other resources (teaching materials) do you use besides the prescribed textbooks?

.....

.....

9.1 What did the learners lean in terms of:

9.1 Knowledge

. . . . . .

. . . . . .

9.2 skills . . . . . .

. . . . . .

9.3 values; attitude ? . . . . . .

. . . . . .

10.1 Did your learners enjoy your lessons?

. . . . . .

10.2 If yes, how could you tell?

. . . . . .

10.3 If not, why not?

. . . . . .

11. If the answer in 10.1 is no, what must be done to make your lessons more interesting?

. . . . . .

. . . . . .

. . . . . .

12.1 Did the learners experience any problems?

. . . . . .

. . . . . .

. . . . . .

12.2 If yes, how did you solve it?

. . . . . .

. . . . . .

. . . . . .

Category 2: Making inference from the present practice to the past

1.1 Did you teach this material in the same way last year?

. . . . . .

1.2 If not, what changes have you made this year?

. . . . . .

. . . . . .

. . . . . .

1.3 Why did you make them?

. . . . . .

. . . . . .

. . . . . .

2.1 Would you say your teaching has changed in the last three (3) years?

. . . . . .

2.2 If yes, what tangible changes have you made?

. . . . . .

. . . . . .

. . . . . .

2.3 What has influenced these changes?

. . . . . .

. . . . . .

Category 3: Inferring future practice from the present

1.1 Did you experience any difficulties in (when) presenting these lessons?

. . . . . .

1.2 If yes, what were they?

. . . . . .

. . . . . .

. . . . . .

1.3 How might these obstacles be removed?

. . . . . .

. . . . . .

. . . . . .

2. Is there anything that you might do differently next time (in future)?

. . . . . .

. . . . . .

. . . . . .

. . . . . .

INTERVIEW SCHEDULE (EDUCATOR B - 1)

1.1 I noticed that some learners are playful, is it always the case?

.....

1.2 If yes, how do you deal with them?

.....

.....

2. What is the attitude of the learner towards physical science as a subject?

.....

.....

3. Roughly, what is the percentage of learners who do their homework honestly?

.....

4. How do you deal with the learners who do not do their homework?

.....

.....

5. What is the rate of absenteeism and absconding?

.....

6.1 Estimate the numbers of days that you have lost this year (for what ever reason)

.....

6.2 Would you say that the number of days lost affect the performance of the learners at the end of the year?

.....

.....

.....

7. Would you describe your relationship with your learners?

.....

8.1 The desks in your classroom are arranged in rows, do you allow your learners to work in groups?

.....

8.2 If yes, what learning activities do you give them?

.....

.....

9. What other resources do you use besides the prescribed text book?

.....

.....

10 What do your learners learn in terms of

10.1 knowledge .....

.....

10.2 skills .....

.....

10.3 values; attitude and disposition? .....

.....

11. Do your learners enjoy your lessons?

.....

11.1 If yes, how could you tell?

.....

11.2 If not, why not?

. . . . . .

11.3 If the answer in 11 is no, what must be done to make your lessons more interesting?

. . . . . .

. . . . . .

12. Would you say that your teaching has changed in the last three (3) years?

. . . . . .

12.1 If yes, what tangible changes have you made?

. . . . . .

. . . . . .

. . . . . .

12.2 What has influenced these changes?

. . . . . .

. . . . . .

. . . . . .

13. Is there anything that you might do differently next year?

. . . . . .

. . . . . .

. . . . . .

14.1 Do you experience any problems with your learners?

. . . . . .

. . . . . .

. . . . . .

14.2 How can these problems be solved?

. . . . . .

. . . . . .

. . . . . .

INTERVIEW SCHEDULE EDUCATOR D - 1

1.1 I understand you have covered both the Grade 11 and Grade 12 syllabus. What strategies do you employ which helps you to complete both syllabi this early?

. . . . . .

. . . . . .

. . . . . .

1.2 Would you say that the learners catch up with the pace?

. . . . . .

. . . . . .

. . . . . .

2. What is the attitude of your learners towards physical science?

. . . . . .

. . . . . .

3. How is their participation during lessons?

. . . . . .

. . . . . .

4. Do they ask questions when they don't understand?

. . . . . .

5.1 How often do you give your learners homework?

. . . . . .

5.2 What percentage of learners do the homework honestly and sincerely?

. . . . . .

5.3 How do you deal with those who don't do their homework?

. . . . . .

6.1 How is the rate of absconding and absenteeism?

.....

6.2 How does the school deal with such misbehaviour?

.....

.....

7.1 Since you don't have a laboratory how do yo teach sections like inorganic chemistry?

.....

.....

7.2 What other resources do you use besides the prescribed textbook?

.....

.....

8. What do your learners learn in terms of:

8.1 Knowledge .....

.....

8.2 Skills .....

.....

8.3 Values; attitudes and disposition .....

.....

.....

9.1 How often do you allow the learners to work in groups?

.....

9.2 What learning activities do you give them?

.....

.....

10. Do the learners enjoy your lessons?

.....

10.1 If yes, how could you tell?

. . . . . .

. . . . . .

10.2 If not, why not?

. . . . . .

. . . . . .

10.3 If the answer in 10 is no, what must be done to make your lessons interesting?

. . . . . .

. . . . . .

. . . . . .

11. Would you say that your teaching has changed in the last three (3) years?

. . . . . .

11.1 If yes, what tangible changes have you made?

. . . . . .

. . . . . .

. . . . . .

11.2 What has influenced these changes?

. . . . . .

. . . . . .

. . . . . .

12.1 Do you experience any problems with your learners?

. . . . . .

. . . . . .

. . . . . .

12.2 How do you solve these problems?

. . . . . .

INTERVIEW SCHEDULE (LEARNERS A- 2 & 3)

1. How many organic compounds have you dealt with so far? Name them.

.....

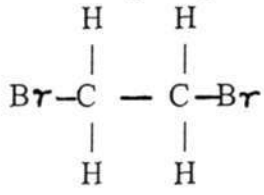
.....

2. Explain the difference between an unsaturated and a saturated hydrocarbon.

.....

.....

3. Name the following compounds:

3.1 

3.2 $CH_3C\ell$

4.1 Your educator usually give you problem to solve during the lessons, would you say that you get enough time to solve them? .....

.....

4.2 You are also allowed to write on any piece of paper, don't you lose those papers or those solutions? .....

.....

5. I have noticed that your educator use previous year question papers, does he always do that?

.....

6. When the educator asks questions you all answer as a class, not individually, even when you read notes - you all read simultaneously. Does your educator like it that way? .....

.....

7. Your educator does not speak Zulu, how does that affect you? .....

.....

8.1 The desks in your classroom are arranged in rows, do you get a chance to work in groups?

.....

8.2 If yes, do all the members of the group participate in the discussions? .....

.....

8.3 Do you find group discussions beneficial? .....

Explain .....

.....

9. Do you do practical work (real hands on experience) .....

.....

10.1 Do you find the practicals (demonstrations) useful? .....

.....

10.2 If yes, how do the practicals enhance your learning? .....

.....

.....

11. How would you describe your educator's teaching style: .....

(a) Narrative (lecture method)

(b) Direct reading from the book

(c) Question and answer method

(d) Problem posing method

(e) A variety of teaching methods

12. How many tests have you written so far? .....

.....

13. How many have you passed? (Give %) .....

.....

14. What is the average pass rate of the class? .....

.....

15. What contribu tes towards continuous assessment? .....

.....

16. In your own opinion does continuous assessment help you in learning physical science?

.....

.....

17. As far as you are concerned does continuous assessment give a true reflection of the learners work? .....

.....

INTERVIEW SCHEDULE (LEARNERS D: 1 AND 2)

1. Distinguish between a vector and a scalar quantity

. . . . . .

. . . . . .

. . . . . .

2. What is meant by a resultant of a number of vectors?

. . . . . .

. . . . . .

. . . . . .

3. What will be the resultant of the following two vectors?

50m in the direction of 90°

30 m towards the east

. . . . . .

. . . . . .

4.1 Do you enjoy physical science lessons?

. . . . . .

4.2 If your answer is no, explain why

. . . . . .

. . . . . .

. . . . . .

5. Would you say that you all understand your educator?

. . . . . .

6.1 How often do you get homework?

. . . . . .

6.2 How many learners do their homework honestly and sincerely? (This is, who don't copy from others)

. . . . . .

. . . . . .

7. What is the relationship between the learners and the educator?

. . . . . .

. . . . . .

. . . . . .

8. Is your educator approachable?

. . . . . .

. . . . . .

9.1 The desks in your classroom are arranged in groups, do you actually work in groups?

. . . . . .

9.2 What activities do you do in groups?

. . . . . .

. . . . . .

9.3 If your answer in 9.1 is yes, do you find group discussions helpful? (Explain)

. . . . . .

. . . . . .

. . . . . .

10.1 Do you do the practical work (real hands on experience)?

. . . . . .

10.2 If not, why not?

. . . . . .

. . . . . .

10.3 If yes, do you find the practical (demonstrations) useful? Why?

. . . . . .

. . . . . .

. . . . . .

11. How would you describe your educator's teaching style?

(a) Narrative (lecture method)

(b) Direct reading from the book

(c) Question and answer method

(d) Problem posing method

(e) A variety of teaching styles

12. How many tests have you written so far?

. . . . . .

13. How many have you passed (give %)

. . . . . .

14. What is the average pass rate of the class?

. . . . . .

15. What counts as continuous assessment?

. . . . . .

. . . . . .

16. In your own opinion does continuous assessment help you in learning physical science? Explain.

.....

.....

.....

INTERVIEW SCHEDULE (LEARNERS C: 1 AND 2)

1. What were you learning in Physical Science today?

   .....

2. How many experiments did you do today?

   .....

3. The experiment with H_2SO_4 and Copper did not work, what was the reason?

   .....

4. What happened with $CuSO_4 \cdot 5H_2O$ and H_2SO_4

   - The colour changed from ..... to .....
   - What do we call the water ($5H_2O$)

     .....

5. What do you ~~after~~ do if you don't understand your educator?

   .....

6. Would you say that learners understand your educator?

   .....

7. I saw the desks arranged in groups, do you learn in groups (do you do group discussions)?

   .....

8. If yes: do all the members of the group participate in the discussions?

   .....

9. How does the educator ensure that all members participate?

   .....

10. Compared to other subjects, do the learners like Physical Science?

    .....

11. What makes them more/less interested in Physical Science? Is it:

- The way it is presented?
- Because they value it?
- Because of the parental influence?
- Because of its nature?
- Any other reason.

.....

.....

12. Do you do practical work? (real hands on experience)

.....

13. If yes: how do the practicals enhance your learning?

.....

14. If no: do you find it difficult to understand Physical Science concepts or it is just like any other subject?

.....

15. How many tests have you written so far?

.....

16. In your own opinion does continuous assessment help you in learning Physical Science?

.....

17. As far as you are concerned does continuous assessment give a true reflection of the learners work?

.....

APPENDIX F **STANDARD GRADE: 150**
SCHOOL A

No	Names	Test 1 50	Classwork 20	Assignment 1 30	Test 2 150	Classwork 20	Assignment 300	Total 300
1								
2	Boyce S	34	13	16	30	17	11	121
3	Dlamini BF	21	10	18	20	10	09	88
4	Dlamini MW	31	10	23	90	11	14	179
5	Gabbed M	21	15	18	90	18	07	169
6	Gambu MSC	28	10	18	20	11	08	94
7	Gumede Z	19	13	16	20	25	07	100
8	Khanyile EM	23	13	18	15	11	08	88
9	Khoza ND	18	13	16	15	17	10	89
10	Khumalo TP	16	13	16	45	0	03	113
11	Luthuli BI	36	10	23	24	16	10	119
12	Madondo E	13	13	16	36	20	22	100
13	Magwenyane K	44	15	18	108	20	18	205
14	Mbanjwa SA	28	10	23	54	11	10	136
15	Mdletshe IN	40	10	16	20	06	23	115
16	Mgubungu G	26	13	16	24	11	15	105
17	Mthembu OZ	27	10	23	78	16	13	167
18	Mthembu XI	28	13	16	33	11	17	118
19	Mthethwa ZE	28	13	16	30	18	09	114
20	Mnguni N	18	10	16	72	12	06	134
21	Ngubane NZ	18	13	16	27	16	04	94
22	Nyide HM	18	1	16	51	10	1	115
23	Nyide MD	13	10	16	36	12	13	100
24	Phosile FM	22	10	18	-	-	-	50
25	Phungula S	36	15	18	45	18	20	152
26	Sibiya BL	17	10	16	18	20	09	90
27	Sithole EH	1	15	18	18	20	07	89
28	Sithole XPT	32	15	18	66	18	17	166
29	Shezi LB	15	10	16	12	20	09	82
30	Vilikazi ZPS	17	15	18	51	20	09	130
31	Vezi PG	20	15	16	99	18	09	177
32	Zondi R	26	10	18	69	06	10	139
33	Zumgu TW	23	15	18	69	20	16	161

APPENDIX F **PHYSICAL SCIENCE GRADE 11**
SCHOOL C

	Names	Prac/assign 1	Prac/assign 2	Classwork	Class test	Test 1	Test 2		Total
1	Bhengu Monica	25	8	20	-	50	48	151	46
2	Busani Themba	31	--	14	38	60	90	238	73
3	Chauke Dephney	30	15	19	35	80	87	266	81
4	Dladla Siyabona	37	7	10	33	8	43	143	44
5	Dladla Zibuyile	36	11	11	42	60	23	198	60
6	Dlamini Zamani	23	11	10	-	53	-	101	34
7	Duma Octavia	32	9	9	41	36	40	158	48
8	Dumakude Schelele	27	12	20	45	77	42	273	83
9	Hlatswayo Samukelisiwe	36	11	19	26	06	82	130	55
10	Hlela Stembiso	21	14	20	37	40	15	147	45
11	Jali Fortunate	35	21	17	38	53	60	215	66
12	Khumalo Samkelo	39	14	20	-	93	55	221	67
13	Kunene Khulekani	25	-	20	30	83	18	176	54
14	Kweyama Blessing	10	12	20	15	60	63	185	56
15	Ma---so Nkosikhona	30	13	13	39	55	68	213	67
16	Mdunge Khanyisile	30	8	20	30	23	-	111	34
17	Mdunge Muzi	38	10	20	-	53	-	121	37
18	Mkhize Sibohiso	20	8	10	18	58	-	114	35
19	Mkhize Skhumbuzo	37	-	20	32	33	25	147	45
20	Mntambo Duduzile	21	-	20	28	63	50	182	55
21	Mthalane Zamo	36	14	-	0	26	-	76	23
22	Ndlovu Precious	28	13	19	40	67	86	253	77
23	Ndlovu Sthembiso	43	16	20	48	87	92	302	92
24	Ndlovu Thuthukile	25	-	17	22	77	42	133	56
25	Nene Philile	11	12	20	38	63	73	217	60
26	Ngidi Kwenzekilo	33	13	19	39	33	68	205	63
27	Ntshangase Skhumbuzo	33	10	20	45	83	92	233	86
28	Shange Zandile	23	10	6	33	43	46	161	50
29	Vilakazi Aurel	29	13	20	5	63	37	242	74
30	Vilakazi Zanele	36	-	20	45	70	92	263	80
31	Zondi Khethukuthula	37	-	-	42	33	25	137	42
32	Zondi Thembelihle	16	9	-	-	54	35	124	38

APPENDIX F **PHYSICAL SCIENCE GRADE 11A**
SCHOOL D

		CW 10	HW 20	ASS 50	ASS 07	TOTAL 100	PRACT 50	CLASS TEST 50	C/TEST 50	PROJECT 100
1	Bhengy Midman	4	10	00	46	40	a	15	a	
2	Cele Rejoice	6	15	00	42	42	36	08	a	
3	Chili Monkululeko	5	10	20	40	50	40	22	12	76
4	Dlamini Nompilo	4	8	00	45	39	30	06	A	
5	Dlamini Prudence	4	7	25	70	43	30	28	18 ½	
6	Hlongwane Wellington	6	10	35	49	66	35	19	14	
7	Jili Nduduzo	5	10	00	32	31	32	06	10	
8	Khanyile Nomonde	5	7	38	39	59	38	15	16	
9	Khubisa Rosemary	7	12	30	37	57	30	10	16	
10	Leisa Sylvia	6	13	28	49	64	30	22	14	
11	Mahlaba Christina	3	-	00	34	25	31	10	16	
12	Mahlaba Sioho	6	10	00	21	25	a	07	14	
13	Mkhize Aretha	5	7	00	39	34	25	14	a	
14	Mkhize Parhoise	7	15	48	41	74	46	25	20	
15	Ngcobo Mxolisi	5	7	35	47	63	37	17	12	
16	Ngcobo Pinky	7	15	30	70	81	48	28	17 ½	
17	Ngcobo Ernest	5	7	00	42	36	30	09	12	
18	Ngubane Selby	5	10	00	37	35	28	09	12	
19	Ngwane Terrence	4	6	00	00	07	a	20	14	
20	Nxumalo Siyabonga	5	12	00	39	37	38	28	16	
21	Shezi Londiwe	6	10	00	28	29	28	13	08	
22	Shezi Nkosinathi	4	10	00	50	43	30	07	a	
23	Shezi Prince	5	14	00	43	41	36	21	02	
24	Sithole Doris	6	11	12	00	19	a	a	a	
25	Tshabalala Vusi	7	10		42	66	38	29	22	
26	Zondi Mamelis	5	12	00	00	11	30	12	14	
27	Suma Happy	7	16	46	39	72	46	34	26 1/2	85

APPENDIX G OBSERVATION GUIDE

- School's immediate environment
- School demography
- School resources
- Classroom physical environment
- Classroom relations
- Organisation of lesson
- Classroom management
- Resources used
- Teaching methods
- Different assessment methods
- Documents

APPENDIX H **THE RESOURCES THAT THE EDUCATORS HAVE IN THEIR LABORATORIES**

Photograph 1: **School A's Resources**

Photograph 2: **School B's Resources**

Photograph 3: **School C's Resources**

Photograph 4: **School C Learners' Projects**

Photograph 5: **School D Learners' Projects**