FACTORS INFLUENCING THE CHOICE OF PHYSICAL SCIENCE AT SECONDARY SCHOOLS IN THE NORTHERN PROVINCE

by

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SUMMARY

This study investigates variables that influence choice of Physical Science as a secondary school subject. The variables are *pupil, home environment, teacher* and *school environment*. A questionnaire was administered to 849 grade 9 pupils. The following findings are recorded:

The better pupils achieve in Science the more likely that they will further their studies in Science. If pupils have positive self-concepts, beliefs about, attitudes and interest in Science and enjoyed Science at primary school they are inclined to choose Science as a subject. Pupils who choose Science view it as a valuable subject for daily life, have parents who evaluate Science favourably and come from better socio-economic backgrounds than those who do not choose Science. These pupils also view the attitudes, personalities, competencies and methods of assessment of their Science teachers positively. Finally, they perceive the Science curricula and textbooks as beneficial.

KEY TERMS

Physical Science; Choice; Secondary school pupils; Attitude; Self-concept; Interest; Achievement; Gender; Beliefs; Socio-economic status; Cultural background; Teacher's personality; Teacher's competence; Teacher's assessment; Teacher's methods; School management policy; Science curriculum.

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DEDICATION

This study is dedicated to my parents, Rirhandzu Maria and Hlupheka Willie Nukeri.

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CHAPTER 1

INTRODUCTORY ORIENTATION

1. INTRODUCTION

The world we are living in today is growing faster than ever before, particularly in the field of science and technology, especially since the advancements in computer science. This sudden growth has brought the added need for qualified personnel such as engineers, medical doctors, technicians, pharmacists, scientists and other related professionals in order to cope with and address the needs of our communities. This statement is supported by House (1988:634) when she maintains that:

> *Futurists tell us that the twenty-first century world will be characterised, above all else, by exponential growth and ever accelerating change, by a society built on information technology ..., by connectedness within the world community, and by a myriad of new realities and new problems only vaguely imagined today. The children we educate for life in that world will need new coping skills if they are to live as productive citizens.*

South Africa, as a developing nation, should also prepare itself to survive and cope successfully with the demands of human developments in this coming century. For South Africa to be called a successful and competitive nation capable of facing the challenges of the twenty-first century and beyond, love and pride of Physical Science as a school subject should be instilled in all our primary and secondary school pupils.

A strong background in Physical Science will open career opportunities for our pupils and make them marketable in this increasingly technological and competitive society.

The author has noted that since the first democratic elections in South Africa in 1994, parents as well as community organisations with an interest in education have expressed concern and have continuously and constantly questioned the low numbers of pupils who register for Physical Science as a subject after standard seven. In the

Sunday Times (29 June, 1997:7) it was indicated that Physical Science is one of the least popular subjects at matric level in South Africa. It is further indicated that "only 23 in 100 full-time candidates wrote Science last year, i.e. (1996) compared with almost 80 in 100 who did Biology". Popularity of certain subjects over others differ from province to province, but the situation in the Northern Province concerning the number of students who choose Physical Science in secondary schools is discouraging.

Another significant issue which needs attention is that of gender analysis of choice of Physical Science as a subject at secondary schools. Bosker and Dekker (1994:178-179) maintain that

> *... in most West-European countries, girls have recently caught up with boys in the achieved level of education. However, girls and boys still differ in making educational choices. Girls are still under represented in technical and science fields ....*

It was further found that more boys choose science (Physical Science) than girls. In the same study, it is also indicated that "Counselling based on the achievement of individual girls rather than on their attitudes leads more girls to choose science" (Bosker & Dekker, 1994:181). The low representation of women in scientific and technological careers in South Africa, and especially in the Northern Province, should be attended to with the urgency it deserves. In many countries "national policies aim to stimulate girls to choose science and technology-related subjects, not only for reasons of equal opportunity, but also for economic reasons" (Bosker & Dekker, 1994:179). Therefore, South Africa, and in particular the Northern Province, cannot be considered as an exception to this.

The importance of Physical Science as a subject is further highlighted by Smith and Gessler (1989:36) when they state that "Our nation will need at least four percent of its citizens to become design engineers and scientists. But each of these professionals will be supported by 10 percent or more technologists and up to 100 technicians". Hence there is a need to prepare all our youth, irrespective of gender, to live and cope in this highly technological world during the twenty-first century. To achieve this, our secondary school pupils should develop positive attitudes towards Physical Science and be motivated to choose it at secondary schools and tertiary institutions as one of their subjects of study.

The Northern Province is regarded as the poorest in South Africa and recently considered a disaster area as far as educational provisions are concerned. This is further highlighted by a Sunday Times report (29 June, 1997:7) which indicated that the overall matric pass in 1996 was 38 percent compared to the national pass rate of 54,7 percent, placing the Northern Province at the bottom of the list. This is a matter of concern, because "the evidence is indisputable that in a world of multinational corporations and international markets, inventiveness in science and technology rather than abundance of labour or natural resources is the major asset ..." of any country and hence also of the Northern Province (Steen, 1988:88). The pass rate in Physical Science and the number of secondary school pupils that choose Physical Science as a subject are alarmingly small, and will be revealed in this study.

Technological development cannot be realised unless the factors that are related to the choice of Physical Science as a subject at secondary schools are identified as a matter of urgency, and therefore, feasible strategies and intervention programmes put in place to address the problem and encourage our secondary school pupils to choose Physical Science as a subject. It should be noted that Physical Science and Mathematics will help the government of the Northern Province to utilise the human resources at its disposal to be able to compete with other provinces in this regard.

Therefore, the main aim of this study is to identify and explore some of the factors which may positively or negatively influence secondary school pupils in their choice of Physical Science as a school subject. The study will make recommendations to the national and provincial government and relevant role players to improve the situation to the benefit of all citizens of South Africa.

1.2 ANALYSIS OF THE PROBLEM

1.2.1 Awareness of the Problem

South Africa, as a developing nation with its new-born democracy, has a role to play in Africa and internationally. To achieve this, South Africa should attain self-sufficiency in the field of science and technology. "The latest issue of the World Competitive Yearbook rates science and technology among the eight factors that determine competitiveness" and the development of mathematics, science and technology are regarded to have a distinct bearing on overall economic growth of any country (*Sunday Times*, 20 July, 1997:8).

House (1988:634) further emphasises the importance and the role of science in our everyday life when she refers to a 1983 report by the National Science Board entitled "Educating Americans for the 21st Century", which states:

> *These new bases are needed by all students ... not only tomorrow's scientists, - not only the talented and the fortunate - not only the few for whom excellence is a social and economic tradition. All students need a firm grounding in mathematics, science and technology.*

In a research conducted by Smith and Gesseler (1989:33) they maintain that one of the reasons why students select engineering as a career is because of good grades in Science and Mathematics. Thus failure to choose Physical Science as a subject can limit the career options of our youth. The above argument is supported by the Sunday Times (20 July, 1997:8) which indicates that matriculants "realised only in matric that they are stuck. They take Biblical Studies, Agriculture and Biology and all they can do at university is Social Work, Law or the Art". However, a matric pass with Physical Science may lead to various career options like engineering, medical science, etc, which are in high demand. Klebanov and Brooks-Gunn (1992:97) also indicate that these early educational choices have implications for the career options of our youth.

The urgent need for secondary school pupils to consider Science and Technology as career choices are supported by an article in the Sowetan (29 July, 1997:7) titled "Science as the road to wealth". In it the writer maintains that:

> *... the Medical Research Council is to use 1998 to educate the public about science and technology as a way of creating wealth in South Africa.*

It is further indicated from the same report that:

> *... the MRC would work with related organisations to achieve the goal of generating interest in the public in the areas of science and technology.*

The problem that we face in South Africa today, especially in the Northern Province, is the low enrolment of secondary school pupils in Physical Science from standard eight and the disappointing number of females amongst them. To substantiate and gain evidence of the problem stated above, the writer had used random sampling to identify eight secondary schools offering Physical Science in standard ten for the past five years in the Mamalulele district which is part of the Northern Province.

ANALYSIS OF STANDARD TEN ENROLMENT FOR PHYSICAL SCIENCE FOR THE PERIOD NOVEMBER 1992, 1993, 1994, 1995 AND 1996 IN MALAMULELE AREA (NORTHERN PROVINCE)

Table 1

YEAR	1992			1993			1994			1995			1996		
SCHOOL	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
A	125	14	11.2	192	18	9.4	182	29	15.9	304	41	13.5	361	58	16.1
B	-	-	-	130	9	6.9	153	19	12.4	163	26	6.0	119	20	16.8
C	220	16	7.3	221	17	7.7	224	18	8.0	193	27	14.0	153	19	12.4
D	131	37	28.2	189	29	15.3	214	35	16.4	209	35	16.7	153	31	20.3
E	180	26	14.4	225	93	41.3	233	13	5.6	251	95	37.8	154	15	9.7
F	90	15	16.5	117	16	13.7	114	20	17.5	123	25	20.3	144	37	25.7
G	324	55	17	304	64	21.1	330	69	20.9	N/A	N/A	N/A	124	21	16.9
H	108	12	11.8	92	17	18.5	106	13	12.3	136	16	11.8	128	12	9.4
TOTAL	1178	175	14.9	1470	263	17.9	1556	216	13.9	1379	265	19.2	1336	213	15.9

TOTAL ENROLMENT FOR THE PERIOD 1992-1996 = 6919, ENROLMENT IN PHYSICAL SCIENCE: 1132,% ENROL: 16.3 * 1992 Results for school B and 1995 Results for school G were not available. * School Names have been kept anonymous for reasons of confidentiality. * Roman figure : (I) Stands for total number of pupils in standard, (II) Total number for pupils who registered for Physical Science as a subject, (III) Percentage of pupils who registered for Physical Science.

1997 ENROLMENT FOR PHYSICAL SCIENCE IN SECONDARY SCHOOLS IN THE MALAMULELE AREA (NORTHERN PROVINCE)

Table 2

1997 ENROLMENT OF PUPILS IN SENIOR SECONDARY SCHOOLS

STANDARD	8			9			10		
SCHOOL	TOTAL ENROLMENT	ENROLMENT IN PHY. SCIENCE	% ENROL-MENT	TOTAL ENROLMENT	ENROLMENT PHY. SCIENCE	% ENROL-MENT	TOTAL ENROLMENT	ENROLMENT IN PHY. SCIENCE	% ENROL-MENT
A	195	53	27.2	184	37	20.1	297	41	13.8
B	170	70	41.2	145	56	38.6	211	39	18.5
C	192	56	29.2	159	28	17.6	179	30	16.8
D	200	63	31.5	147	44	29.9	164	37	22.6
E	163	16	9.8	173	17	9.8	179	19	10.6
F	91	39	42.9	118	54	45.8	104	42	40.4
G	160	45	28.1	107	40	37.4	110	34	30.9
H	145	46	31.7	175	37	21.1	138	20	14.5
TOTAL	1316	388	29.5	1208	313	25.9	1382	262	19

NB: School names have been kept anonymous on grounds of confidentiality

ANALYSIS FOR 1997 ENROLMENT IN PHYSICAL SCIENCE BASED ON GENDER IN THE MALAMULELE AREA (NORTHERN PROVINCE)
Table 3

STANDARD	SCHOOL	SCHOOL ENROLMENT IN PHYSICAL SCIENCE	MALES		FEMALES	
			NO.	%	NO.	%
8	A	53	27	50.9	26	49.1
	B	70	45	64.3	25	35.7
	C	56	24	42.9	32	57.1
	D	63	32	50.8	31	49.2
	G	45	33	73.3	12	26.7
9	A	37	18	48.6	19	51.4
	B	56	41	73.2	15	26.8
	C	28	14	50	14	50
	D	44	28	63.6	16	36.4
	G	46	27	58.7	19	41.3
10	A	41	23	56.1	18	43.9
	B	39	20	51.3	19	48.7
	C	30	15	50	15	50
	D	37	26	70.3	11	29.7
	G	34	23	67.6	11	32.4
TOTAL		679	396	58.3	283	41.7

School names have been kept anonymous for reasons of confidentiality

It is evident from Tables 1 and 2 that the number of secondary school pupils who choose Physical Science as a school subject after standard seven (grade nine) is disappointingly low. As indicated in Table 1, for the period 1992-1996, out of a total number of 6919 pupils, only 1132 registered for Physical Science as a school subject for standard ten (grade 12), which amounts to only 16,3 percent. Table 2 gives a clear picture of the recent scenario in secondary schools. Out of a total enrolment of 3906, only 963 pupils are doing Physical Science during 1997, which amounts to 24,7 percent of the population. In reference to Du Plessis, Du Pisani and Plekker (1990), Sirestarajah (1994:9) indicates that for the entire Black standard 10 pupil population in different subjects, "...in 1989 only 17,9% of pupils were enrolled for Physical Science, whereas 28,5% were enrolled for Mathematics and 89.0% for Biology". He further indicates that there is evidence that in the White population, the interest in Physical Science as a school subject is alarmingly decreasing since the early seventies. It is also evident from Table 3 that in almost all secondary schools, more boys choose Physical Science as a school subject than girls, thus 58,3 percent boys in comparison to 41,7 percent girls.

The revelations in Tables 1, 2 and 3 substantiates the statement that "Physical Science is one of least popular subjects at school. Only 23 in 100 full-time candidates wrote science last year" (*Sunday Times* 29 June, 1997:7).

Hence, the notable feature of South Africa and in particular, the Northern Province is the "... the low levels of Mathematic and scientific literacy among the general populace." (Sowetan 17 April, 1998:20).

STATISTICAL ANALYSIS OF PHYSICAL SCIENCE STANDARD 10 RESULTS (1992-1996) IN THE MALAMULELE AREA (NORTHERN PROVINCE)

Table 4

YEAR	1992					1993					1994					1995					1996				
School	No wrote	No pass	No fail	% pass	% fail	No wrote	No pass	No fail	% pass	% fail	No wrote	No pass	No fail	% pass	% fail	No wrote	No pass	No fail	% pass	% fail	No wrote	No pass	No fail	% pass	% fail
A	14	2	12	14.3	85.7	18	10	8	56	44	29	3	26	10	90	49	20	29	41	59	58	21	37	36	64
B	-	-	-	-	-	9	9	0	100	0	20	16	4	80	20	26	22	4	85	15	20	13	7	65	35
C	16	14	2	88	12	17	16	1	94	6	18	8	10	44	56	25	17	8	68	32	19	13	6	68	32
D	37	16	21	43	57	29	19	10	66	34	33	19	14	58	42	35	20	15	57	43	31	17	14	55	45
E	26	6	20	23	77	15	8	7	53	47	13	6	7	46	54	13	10	3	77	23	15	11	4	73	27
F	15	10	5	67	33	16	10	6	63	37	20	18	2	90	10	25	16	9	64	36	37	19	18	51	49
G	55	19	36	35	65	64	24	40	38	62	60	25	35	42	58	-	-	-	-	-	21	7	14	33	67
H	12	4	8	33	67	17	13	4	77	23	17	13	4	77	23	16	15	1	94	6	12	8	4	67	33
TOTAL	175	71	104	41	59	185	109	76	59	41	210	108	102	51	49	189	120	69	64	36	213	109	104	51	49

NB
(A) School names have been kept anonymous on grounds of confidentiality
(B) Percentages have been worked out to the nearest whole numbers
(C) 1995 results for school "G" were not available
(D) 1992 results for school "B" were not available

STATISTICAL ANALYSIS OF SYMBOLS OBTAINED FOR PHYSICAL SCIENCE, STANDARD 10, IN MALAMULELE AREA (NORTHERN PROVINCE)

Table 5

YEAR / SCHOOL	DISTRIBUTION OF SYMBOLS																													
	1992						1993						1994						1995						1996					
	C	D	E	F	G	H	C	D	E	F	G	H	C	D	E	F	G	H	C	D	E	F	G	H	C	D	E	F	G	H
A	-	-	-	2	3	9	-	-	6	4	3	5	-	-	1	2	25	1	-	-	9	11	15	14	-	-	7	14	10	27
B	-	-	-	-	-	-	-	-	4	5	-	-	-	1	10	5	3	1	-	4	7	11	3	1	-	-	5	8	2	5
C	-	3	10	1	1	1	-	1	9	6	-	1	-	2	1	5	1	9	-	-	3	14	4	4	-	-	5	8	2	4
D	1	1	6	8	11	10	-	1	4	14	4	6	1	-	6	12	5	9	1	-	5	15	5	9	-	1	4	12	3	11
E	-	1	1	4	2	18	-	-	4	4	1	6	-	-	1	5	4	3	-	2	3	5	1	2	-	2	3	6	2	2
F	-	1	3	6	3	2	-	1	3	6	6	-	-	2	4	12	1	1	-	2	4	10	6	3	-	-	5	14	6	12
G	-	-	5	14	11	25	-	-	4	13	10	37	-	-	8	17	4	31	-	-	-	-	-	-	-	-	4	3	5	9
H	-	-	1	3	5	3	-	-	7	6	2	2	-	-	4	9	3	1	1	1	8	5	1	-	-	-	2	6	2	2
TOTAL	1	6	26	38	36	68	0	3	41	58	26	57	1	5	35	67	46	56	2	9	39	71	35	33	0	3	35	71	32	72

NB: (A) School names have been kept anonymous on grounds of confidentiality
(B) Symbols A and B are not included in the table as there were no scores above 'C'
(C) 1992 results for school "B" were not available
(D) 1995 results for school "G" were not available

SUMMARY OF THE DISTRIBUTION OF SYMBOLS FOR STANDARD 10 RESULTS
PERIOD: 1992-1996 NOVEMBER
IN THE MALAMULELE AREA IN THE NORTHERN PROVINCE

Table 6

NUMBER	SYMBOLS							
WROTE	A	B	C	D	E	F	G	H
972	0	0	4	26	176	305	175	286
%	0	0	0.4	2.7	18.1	31.4	18.0	29.4

SUBJECT SYMBOLS:
A = 80-100%
B = 70-79%
C = 60-69%
D = 50-59%
E = 40-49%
F = 30-39%
G = 20-29%
H = 0-19%

School names have been kept anonymous on grounds of confidentiality

If students achieve well in Physical Science, they may be motivated to choose Science for study up to and beyond matric, and the corollary also is true. In this regard a shocking report (*Sunday Times* 24 November, 1996:1-2) indicates that South African school children rank amongst the worst in the world when it comes to performance in Mathematics and Science. This is based on the 1996 third International Mathematics and Science study in which standard 5 and 6 (grades 7 and 8) pupils in South Africa achieved worst in both Mathematics and Science out of 45 countries. This is further substantiated by this study in Tables 4, 5 and 6.

Furthermore, for those who passed standard 10 Physical Science during the period 1992-1996, only 2,7% obtained a score of 50% or above *symbol A-D), while 31,4% obtained symbol F (as indicated in Tables 5 and 6). During the same period (1992-1996), no pupil managed to obtain a symbol A or B (70% to 100%), while schools A and G did not get one D pass in Physical Science for the past five years as indicated in Tables 5 and 6.

Based on the stipulations above, it is clear that a small number of secondary school pupils choose Physical Science as a subject and with poor results. This is a problem that needs urgent attention, because:

> *... for us to feed our children, we must create wealth. We all know that the chief method of wealth creation in the modem world is through science and technology* (*Sowetan* 29 July 1997:7).

Hence, we need to address this issue urgently, and prepare our secondary school pupils for the twenty-first century as House (1988:640) highlighted:

> *In a world where we must educate students to solve problems as yet undreamed of, we only hope to impart to them germs of the attitudes and abilities that may someday enable them to find breakthrough solutions. Our mathematics and science classrooms can become the laboratories for this leaming.*

From the author's experience as a Physical Science teacher, head of the department in a secondary school for a number of years, lecturer at a college of education in the Northern Province and through active participation in enrichment programmes during winter holidays and weekends, it has also been noted that only a small number of students choose Physical Science as a school subject from standard seven. In addition, only a few of those who choose Physical Science as a subject pass it in matric, hence the serious concern about our future technical work force.

Based on the stipulations and the revelations above, for South Africa in general and the Northern Province in particular, to become a winning nation, secondary school pupils should be encouraged to do well in science and hence to choose Physical Science as a subject irrespective of gender. This calls for the need to identify and discuss various factors that may influence the choice of Physical Science as a subject in secondary schools.

1.2.2 **Examination of the Problem**

The research problem in this study manifests itself in the following forms:

(a) Secondary school pupils may have negative attitudes towards Physical Science and hence do not choose it as a subject.

(b) Less females than males choose and pass Physical Science as a subject in secondary schools.

From the author's experience, observations and informal interviews conducted with Physical Science teachers from several schools, it seems that the low numbers of pupils who register for Physical Science from standard 8 to 10 as indicated in Tables 1, 2 and 3 can be attributed to the negative attitudes of secondary school pupils towards Physical Science and subject streaming in schools. In most secondary schools, Physical Science is in the same stream with Mathematics. The interviewed teachers further indicated that Mathematics and Physical Science are regarded as too difficult by the secondary school pupils and the community.

House (1988:634) says:

> *But the truth that frequently eludes those who make a profession within either science or mathematics is that both disciplines have come to be viewed as the province, not of the masses, but of an intellectual elite. For most peoples, science and mathematics beyond the most rudimentary levels are the pursuits of a gifted minority.*

Furthermore,

> *... the most important school organisation variable has proved to be student ability group or curriculum-program assignment. A number of careful studies have shown that student placement exerts a powerful independent effect on achievements and attainments and explain part of the total effects of social class on these outcomes* (Hoffer 1992:205).

Based on the information above, South Africa, and in particular the government of the Northern Province, can no longer wait but should address this situation as soon as possible "... because in every country, Science and Technology and Engineering are the fields that make the population innovative and the country competitive" (*Sunday Times* 20 July, 1997:8). Hence the government of the Northern Province has introduced some bridging programmes for Physical Science and Mathematics in the rationalised colleges of education, e.g. a college of education near Pietersburg have been assigned with preparing future teachers in the teaching of Science, based on hands-on laboratory learning.

In order for the Northern Province to improve it's people's competitive edge locally and internationally, the government should prepare its human resources, particularly that of it's youth. Secondary school pupils should be prepared for careers in Science and Technology by encouraging the pupils to choose Physical Science as a subject. It should be noted that "Scientific and technological knowledge currently increase by 13 percent per year, thus doubling every 5,5 years, and the rate is soon expected to jump to 40 percent per year" (House 1988:634). This points to the need to identify these variables which influence the attitude of secondary school pupils towards Physical Science. Pupils should develop positive attitudes towards Physical Science and they should believe that they can learn and pass Physical Science in matric. In addition House (1988:637) maintains that

> *We must, every day, help our students to see the applications of science and mathematics all around them in their own lives. Students need to learn how to view the world through maths- and science colored glasses,*

which will automatically influence and motivate pupils to choose Physical Science as a subject.

While it is discouraging to find that a very low percentage of our pupils register for Physical Science in secondary schools, it is more disappointing to find that only 51 percent of our standard 10 pupils passed Physical Science in 1996 compared to 64 percent of standard 10 pupils who passed the same subject nationally in the same year (see Table 5).

1.3 STATEMENT OF THE PROBLEM

From the aforementioned sections, it is evident that choosing and passing Physical Science in secondary school will open career opportunities for our youth. This is possible because Physical Science is one of the cornerstones and a prerequisite for the careers mentioned in section 1.1. In the light of the role and importance of Physical Science in the technological era, and the current poor achievements and negative attitudes towards Physical Science, the researcher feels that the problem should be researched. The researcher further feels that it has become expedient for a study to be conducted in the South African context in general, and in the Northern Province in particular, to identify and discuss factors influencing the choice of Physical Science in secondary schools. This will enable the researcher to make recommendations on how pupils can be encouraged to choose Physical Science as a subject from standard 8.

Thus, the research problem is stated as follows: Which factors influence secondary school pupils in choosing (or not choosing) Physical Science as a subject?

1.4 AIMS OF THE STUDY

1.4.1 Specific aims

The research attempts to

(i) identify and discuss factors which significantly influence the choice of Physical Science by pupils in secondary schools, and
(ii) make recommendations on how the adverse influence can be minimised in the short as well as the long term.

1.4.2 General aims

The general aims of this study are as follows:

(a) To create awareness amongst the stakeholders of the influence of various factors that positively or negatively affect choice of Physical Science at school;

(b) To make a contribution to the government's plans to channel the country's resources in developing manpower in fields such as medicine, engineering, technology and other related ones, hence creating an opportunity for our country to compete internationally in the fields of science and technology;

(c) To guide the education planners, educators and curriculum developers to perform their duties effectively;

(d) To provide information to education specialists that will assist them with the implementation of Physical Science policies, teaching methods and strategies based on and beyond the envisaged Curriculum 2005.

1.5 DEMARCATION OF THE FIELD OF STUDY

As indicated in 1.4.1 above, this study attempts to identify and discuss the significant factors that may influence the choice of Physical Science as a school subject by secondary school pupils. It should also be noted that standard 7 (grade 9) pupils from randomly selected schools will be used as respondents in the empirical investigation. The choice of the above mentioned respondents is based on the fact that Physical Science is an optional subject from standard 8 (grade 10) and pupils make a decision to choose or not to choose Physical Science at the end of Standard 7 (grade 9).

1.6 DEFINITION OF CONCEPTS

1.6.1 Factor

The Concise Oxford Dictionary of Current English and The Readers Digest Oxford Complete Word Finder defines a factor as "... a circumstance, fact or influence contributing to a result". Longmans Dictionary of Contemporary English defines a factor as "... any of the forces, conditions, influences that act with others to bring about a result". The Random House Dictionary refers to a factor as "... one of the elements contributing to a particular result". In addition, Reber (1985:265) refers to a factor as:

> *... generally, anything that has some causal influence, some effects on a phenomenon. In this sense a factor is an antecedent condition, a cause.*

For the purpose of this study, a factor means any element, force, condition or circumstance that has a causal influence or can contribute to the attitudes of secondary school pupils towards Physical Science and hence influence/contribute to their choice of taking Physical Science as a school subject.

1.6.2 Choice

The Concise Oxford Dictionary of Current English refers to a choice as "... the act or an instance of choosing". However, The Oxford Paperback Dictionary defines choice as "... the right of choosing". Longmans Dictionary of Contemporary English refers to choice as "... an act of choosing or chance to choose". The Random House Dictionary refers to choice as "... the act of choosing or selecting an alternative". Vrey (1979:36) indicates that once objectives are known, and their implications considered, then a decision or final choice can be made.

Therefore, for the purpose of this study, choice means an act or instance of choosing Physical Science as a subject by secondary school pupils.

1.6.3 Attitude

Longmans Dictionary of Contemporary English defines an attitude as "... a way of feeling or thinking about someone or something, especially as this influences one's behaviour". The Concise Oxford Dictionary of Current English defines an attitude as "... a settled opinion or way of thinking" and an attitude of mind as "... a settled way of thinking". The Random House Dictionary refers to an attitude as "... manner, feeling, etc., towards a person or thing". Van den Aardweg and Van den Aardweg (1988:26) refers to an attitude as a "... mental or neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related".

The South African Student's Dictionary states: "Your attitude to something is the way you feel about it or regard it". Mwamwenda (1994:509) refers to attitude as "A relatively stable and enduring predisposition to behave in a certain way towards persons, objects, institutions, or issues".

For the purpose of this study, attitude would mean a predisposition or manner which leads one to behave or react in a certain way towards an issue or object (Physical

Science) based on experience.

1.6.4 Physical Science

Science is defined by The Concise Oxford Dictionary of Current English as a "... branch of knowledge conducted on objective principles involving the systematized observation of an experiment with phenomena especially concerned with material and function of the physical world". Physical Science as a school subject is a part discipline of natural science which focuses on the study of the physical world. According to Curriculum 2005, this learning area "... will equip learners with the ability to understand our natural resources and to manage them effectively" (Department of Education, 1997:14).

Physical Science as a school subject is divided into two part disciplines, namely Physics and Chemistry. The Longmans Dictionary of Contemporary English defines Physics as "The science concerned with the study of the matter and the natural forces such as light, heat and movement". Fourie (1986:4) indicates that Physics is concerned with various forms of energy and their interaction with matter. Furthermore, the Concise Oxford Dictionary of Current English refers to Physics as "... the science dealing with properties and interactions of matter and energy".

The Longmans Dictionary of Contemporary English defines Chemistry as "... the science which studies the substances which make up the earth, universe, and living things, how these substances combine with each other, and how they behave under different conditions". Fourie (1986:4) defines Chemistry as a "... study of matter in respect of it's structure and the changes it undergoes". Furthermore, The Concise Oxford Dictionary of Current English refers to Chemistry as "... the study of the elements and the compounds they form and the reactions they undergo".

The Random House Dictionary defines Physical Science as "... the study of natural laws and processes other than those peculiar to living matter, as in Physics, Chemistry or Astronomy". The Concise Oxford Dictionary of Current English defines Physical Science as "... the science used in the study of inanimate natural objects, e.g. Physics, Chemistry, Astronomy, etc".

In summary, Physical Science is regarded as the science which deals with the study of the physical universe. It is divided into Physics and Chemistry, as its part disciplines.

1.6.5 Secondary School Pupils

Van den Aardweg and Van den Aardweg (1988:204-205) indicate that:

> *After primary school years, the child enters the secondary school. The junior secondary school usually runs from standard 5 to standard 10. In some cases, this is a theoretical position, but in practice, the secondary school caters for standard 6 to 10.* (This is now grades 8 to 12.)

Vrey (1979:165) confirms that:

> *... secondary school spans from standard 6 to 10. The standard 6 child is usually 13, the standard 10 child is about 17.*

The pupils who enter secondary school are of the age group 13 to 18 years. This stage of development is usefully identified by the term "adolescence". Mwamwenda (1994:63) indicates that "... the period of adolescence ranges from the age of about 12 to about 21 years". However, Louw (1991:377) refers to adolescence as the "... developmental stage between childhood and adulthood". Therefore, one can argue that our secondary school pupils are in early and mid adolescence which is regarded as "... a fascinating, interesting and challenging period of human growth and development" (Mwamwenda 1994:63), which will in turn have an impact on secondary school pupils' attitudes towards their education in general and to Physical Science in particular.

For the purpose of this study, the focus is on early and middle adolescence which covers the age group of 12 to 18 years, who are expected to be in standard 6 (grade 8) to standard 10 (grade 12).

Adolescence as a period of transition needs to be taken into consideration when studying secondary school pupils. The following are some of the developmental aspects of adolescence which may play a role to influence choice of Physical Science as a school subject:

1.6.5.1 *Social Development*

Van den Aardweg and Van den Aardweg refers to social development as the "... development of relationships and associations with others" (1988:214), which according to Gouws and Kruger (1994:10) "... encompasses the changes in relations with other people and the influence of society and specific persons on the individual". During the period of adolescence, the adolescent develops social relations with parents, teachers, the peer group, friends and the self. Van den Aardweg and Van den Aardweg (1988:216) and Gouws and Kruger (1994:10) maintain that

> *... the roles of parents and peer groups in the life of an adolescent are not in conflict but are used as guides in different areas, for example, where the future is concerned, adolescents value parental guidance, and where current status and identity decisions are involved, adolescents may rely on peers.*

This may indicate that parents play an important role in influencing adolescents to choose Physical Science and take related careers.

Vrey (1979:184-186) has this to say about the adolescent's relations with others:

(a) *Relations with the ideas in the school environment*
Adolescents have achieved considerable self-reliance in work involving problem-solving in most of their subjects and accept responsibility for their own lives (Vrey, 1979:185-186). Once the adolescent acquires problem-solving skills, this will have a significant influence on the choice of Physical Science as a school subject.

(b) *Relations with Parents*

Adolescents see their parents more realistically and form their own opinions on fundamental matters that may conflict with those of his parents. Adolescents "... who rely on parental love feels freer to take risks, to explore, find themselves, try out their abilities, develop decision-making powers and openly compare alternatives particularly as regards the choice of a career" (Vrey, 1979:174). Therefore, parents can play a significant role in the life of an adolescent and in the choices they make.

(c) *Relations with Peers*

"Following the peer group's demands for conformity, self identity develops in such a way that the person's uniqueness - his differences from the peer group - is accepted" (Vrey, 1979:185). The peer group gives the adolescent a sense of belonging and further helps the adolescent to become emancipated from parental control (Mwamwenda, 1995:70). It should also be noted that closer relationships within the peer group are formed, including heterosexual ones. Therefore, peers may also influence the choice the adolescent makes.

1.6.5.2 *Affective Development*

Gouws and Kruger (1994:94) and Van den Aardweg and Van den Aardweg (1988:16) maintain that affective development is based on the development of a number of manifestations or aspects of personality pertaining to emotions, feelings, passion, sentiments and whims. As a social being, adolescents experience many emotions when they relate to their parents, teachers, peers and community. According to Gouws and Kruger (1994:95) and Mwamwenda (1995:50) the adolescent can experience the following emotions: anxiety, anger, aggression, hostility, envy, jealousy, fear, worry, love, hate, disgust, desire for honour, empowerment and recognition. However, it should be noted that the adolescent is:

> *...no longer mastered by his emotions, but has learned their effects and has been able to handle them* (Van den Aardweg & Van den Aardweg

1988:13).

(a) *Relations with Values*

The adolescents' relations with values are based on their views of the world around them. Since the adolescents are in Piaget's formal operational stage, they are in a position to form their own opinions and decisions without compulsion from parents or teachers (Vrey, 1979:185-186). Van den Aardweg and Van den Aardweg (1988:13) indicate that since the adolescents are in the processes of framing their philosophies of life, they are more able to think in the abstract and assess various viewpoints as either exciting, boring or interesting. They are "... establishing a foundation on which to base their behaviour and has absolute freedom in doing this".

(b) *Relations with the Career World*

"At the end of his (her) school years, the adolescent chooses a career" (Vrey, 1979:186). It should be noted that a career is chosen as a matter of self-actualisation. The career is seen as the area within which self-actualisation can take place. Van den Aardweg and Van den Aardweg (1988:13) further indicate that the adolescent "... looks forward to his (her) future career with it's possibilities of further study or training, job satisfaction, ...". This aspect is one of the main focuses in this study.

It should further be noted that the emotions that are being experienced by adolescents, the relations that they form with values and career world, have some educational implications. These may influence the adolescents' choice of subjects and their achievements. Pupils who are worried, experience anxiety, disgust or lack of interest and who achieve poorly in Physical Science, develop negative attitudes towards Physical Science. This may impede learning, and influence pupils not to choose Physical Science as a subject. However, pupils who are happy, positive and rational by nature and love Physical Science, may perform well and hence develop positive attitudes towards Physical Science. Such pupils are motivated to choose science subjects in grade 10 and also at tertiary institutions. This leads us to the need to investigate whether some of the affective domain aspects can have an influence on the choice of Physical Science as a school subject by secondary school pupils.

1.6.5.3 ***Cognitive Development***

Cognitive development refers to the:

> *... continuous and cumulative development of the intellect and ... it concerns all that has to do with knowing, perception, conceptualisation, insight, knowledge, imagination, intuition and is closely allied to experience* (Van den Aardweg & Van den Aardweg, 1988:39).

Adolescents at secondary schools are at the age of 13 to 18 years, therefore, they fall under Piaget's formal operational stage. This stage is characterised by the tendency of the adolescent to think abstractly, solve problems logically and attain hypothetical and thinking skills (Gouws & Kruger, 1994:47). Clark and Starr indicate that adolescents move

> *... from a period of concrete knowledge to a more formal abstract knowledge. During this period they learn to work with the abstract, the theoretical and the hypothetical.*

Therefore, secondary school teachers should encourage and instil imagination and creativity in their daily interaction with their pupils in the teaching and learning situation. The attainment of the skills mentioned above will positively influence pupils to choose Physical Science as a school subject. However, Mwamwenda (1994:68) and Louw (1991:408) indicate that not all adolescents can attain the Piaget's formal operational stage. Amongst others, this is caused by limited intelligence, cultural deprivations and lack of exposure.

To understand the concepts used in Physical Science, it is necessary to attain the formal operational stage. Therefore, the direction of cognitive development of the adolescent can negatively or positively influence the choice of Physical Science by secondary school pupils, hence the need for this study.

1.6.5.4 ***Formation of Self-Identity and Self-Concept***

Vrey (1979:45) defines self-identity as congruent with an integrated whole made up of:

(i) *... the person's conceptions of himself (herself);*
(ii) *... the stability and the continuity of the attributes by which he (she) knows himself (herself);*
(iii) *... the agreement between the person's self-conceptions and the conceptions held of him (her) by people he (she) esteems.*

The central problem of adolescence as a period of stress is:

> *... establishing a sense of identity. For adolescents, this means a series of questions to clarify who they are and what their role in society should be. What work will I do? Will I be a success or a failure?* (Gane & Berliner, 1992:140).

Van den Aardweg and Van den Aardweg (1988:13), also mention that the adolescent "... looks forward to his (her) future career with its possibilities of further study or training in job satisfaction ..." which should be influenced by the types of subjects that they choose at senior secondary level. Mwamwenda (1995:354) maintains that self identity is of crucial importance during the period of adolescence and goes on to add:. "Failure to achieve a sense of identity may result in a person remaining at the adolescent level for longer than normal."

Mwamwenda (1995:372) defines self-concept as:

> "... the way a person perceives himself in terms of social, physical and intellectual attributes". Mwamwenda further indicates that the

development of self-concepts are affected by the way in which the adolescent is brought up, how he/she gives meaning to his/her own experiences. Hence the home and the school play a significant role in facilitating positive or negative self-concepts that may in turn influence the choice of Physical Science as a school subject.

In order to foster positive self-concepts in their pupils, science teachers should interact with pupils in a positive and non-threatening manner and give them tasks that are challenging, yet related to their abilities. Self-identity and self-concept are related because once a person becomes aware of the self, the conception of an own identity arises and the pupil concerned gets to know himself/herself. Self-concept "...comprises three mutually dependent components: identity, action and self-esteem. ... self-concept refers to a configuration of convictions concerning oneself and attitudes towards oneself that is dynamic and of which one is normally aware" (Vrey, 1979:47).

It should further be noted that on his/her search for identity, the adolescent is:

> *... forced into physical and psychological independence and this requires a separate identity. Three aspects are involved here: sexual orientation, a commitment to a philosophy of life and a vocational choice* (Van den Aardweg & Van den Aardweg, 1988:113).

Gouws and Kruger (1944:87) maintain that career identity takes place in two phases: during the first phase from approximately 14 to 18 years (correlates with secondary school pupils), the adolescent thinks in broad categories of work without taking any definite decision. The second phase is from approximately 18 to 21 years of age. During this period, the adolescent usually chooses a career that forms an important part of his/her identity.

From the stipulations above, it becomes clear that the search for identities and the formation of self-concepts enable adolescents to know what they want to do in life; what they are good at, and to decide on their career choices which will be influenced by the subjects they choose at secondary school level. For instance, pupils who want to be scientists, engineers, technicians, pharmacists and other related professions will have to choose Physical Science as one of their school subjects from grade 10 in secondary schools.

Therefore, if adolescents cannot form well-defined identities and self-concepts, this results in identity diffusion which is defined as "... uncenteredness, confusion about who one is, and what one wants" and a moratorium which is defined as "... identity crisis, suspension of choices because of struggle" (Woolfolk, 1995:70). This will, in turn, be characterised by the adolescent's inability to make meaningful subject and career choices with regard to Physical Science.

1.7 PROGRAMME OF STUDY

Chapter 2 deals with a literature review where factors related to pupil variables and home environment variables are identified and discussed. It also deals with the question of how these variables influence pupils' choice of Physical Science as a subject at secondary school.

Chapter 3 also deals with a literature review where factors related to teacher variables and school environment variables are identified and discussed, and how the above variables can influence pupils' choice of Physical Science as a school subject at secondary school.

In Chapter 4 the researcher explains the research design.

Chapter 5 deals with results and discussions based on the results.

In Chapter 6 conclusions and recommendations are made.

CHAPTER 2

PUPIL AND HOME ENVIRONMENT VARIABLES AND CHOICE OF PHYSICAL SCIENCE

2.1 PUPIL VARIABLES AND CHOICE OF PHYSICAL SCIENCE AS A SCHOOL SUBJECT

2.1.1 Introduction

As explained in the previous chapter, science, technology, and Physical Science in particular play a very significant role in our daily lives and in the development of any nation. The number of pupils who choose Physical Science at secondary school is alarmingly low in South Africa in general, and in the Northern Province in particular. This pinpoints the urgent need to explore the variables that may influence secondary school pupils in the Northern Province to choose Physical Science as a school subject.

Many researchers have identified a number of variables that influence pupils' choice of Physical Science as a school subject. Variables which are discussed in this chapter include the following:

(a) Pupil variables, namely: attitude, interest, achievement, career aspirations, gender and self-concept.

(b) Home environment variables, namely: exposure to role models, socio-economic and cultural background.

2.1.2 Pupils' Attitudes

Van den Aardweg and Van den Aardweg (1988:26), Chiappetta, Waxman and Sethra (1990:55) maintain that it is difficult to change attitudes, due to the complex nature of learning. Crawley and Koballa (1994:37) indicate that a relationship exists between attitudes and beliefs when they say:

> *... beliefs that an individual holds about the consequences of engaging in the specific behaviour, within subject effect or personal norm, help the person form an attitude towards engaging in the behaviour.*

They also indicate that a person making a behavioural choice will most probably select the alternative which leads to the most favourable outcome.

In order to take Physical Science as a school subject, pupils need to develop positive attitudes towards Physical Science. "They must feel a sense of ownership, a curiosity and a drive to learn more" (House, 1988:637). She further indicates that students should be enthusiastic about Science, i.e. they should think creatively, take risks, subject their ideas to screening by others, make decisions and accept the consequences and the challenge to help shape the future.

In his study, Lucido (1989:334) indicates that pupils walk into ordinary classrooms with preconditioned learning blocks that differ from one individual to another. He further indicates that all pupils are affected by four educational adversaries, namely:

(a) course difficulty or grade level;
(b) fear of the teacher;
(c) fear of the other students as competitors; and
(d) fear of the grading process.

The above stipulations show that pupils' attitudes are based on a number of variables, hence the need to review the literature based on pupils' attitudes that can influence the choice of Physical Science as a school subject.

2.1.2.1 *Attitude Towards Subject Content*

According to Aghadius (1995:130) scientific attitude is defined as the "... attitude exhibited by scientists in the course of their work", i.e. thinking as scientists do.

Chandavarkar, Doran and Jacobson (1991:391) maintain that almost all pupils who enrol for science seem to have a positive attitude towards it. However, according to Solomon (1987:414) and Milner et al. (1987:201) it is claimed that, on the whole, students/pupils perceive Physical Science content as very difficult, too Mathematical and too abstract. Furthermore, Solomon (1987:414) said that Physics in particular is considered by pupils to be difficult, "... so, to study it is to claim a kind of intellectuality", and a tendency to alienate one from the majority of the community. The above sentiments are also shared by Toews (1988:458) who found that 68,8% of subjects in his sample indicated that their reason for not taking Physics as a school subject is because Physics content is difficult for them, while "... just under 50% chose Physics because it seemed attractive" and "... interesting to learn". Rennie and Parker (1996:55) also refer to Malcom (1989) who indicates that Physics is regarded as the most difficult subject, hence it's low enrolment, particularly by females.

However, Kelly (1988:673) indicates that

> *... how easy or difficult pupils perceive a subject to be, had no effect on whether they choose to study it - with the exception of Chemistry where girls who saw Chemistry as more difficult than other science subjects seemed to be slightly more likely to study it than girls who saw it as easier than other subjects.*

These studies seem to be contradictory, because most researchers maintain the pupils view of Physical Science content being difficult can lead to poor enrolments while Kelly (1988:673) indicates that enrolments in science (Physical Science) is not influenced by the difficulty of the subject content.

2.1.2.2 *Attitude Towards the Teacher*

The attitudes of pupils towards the teacher who is regarded as a co-partner in the teaching and learning situation may also influence the choice of Physical Science by secondary school pupils. According to Wood and De Laeter (1986:288), after parents, the second most influential person in determining whether students choose Physical Science as a school subject is the science teacher. They also indicate that approximately 75% of the students signified that the science teacher had a positive influence on pupils' choice of Physical Science as a school subject by secondary school pupils.

In a study conducted in Holland for grade 9 pupils, Dickie and Farrel (1991:444) found that there is a significant correlation between student's liking for Physics and their perceptions of the teacher's behaviour as being friendly and helpful. These writers further observed that there is also a significant correlation between students' cognitive performance and their perceptions of the teachers as strict and leading. Crawley and Black (1992:586) also found that liking for the teacher is a strong attractant of pupils to register for science and in particular Physical Science. Therefore, this shows that significant others like Physical Science teachers can positively or negatively influence secondary school pupils to enrol for Physical Science as a school subject.

2.1.3 **Pupils' Interest**

The Random House Dictionary defines interest as "... one's feeling of concern or curiosity, as aroused by something or someone". The Concise Oxford Dictionary refers to interest as a "... concern or curiosity". Gunter (1982:275) defines interest as a "... preference for certain subjects or activities". He further indicates that "... in education, the term interest is usually used in connection with a subject, like interest in Physics" (Gunter, 1982:275). For the purpose of this study, interest in Physical Science means pupils' curiosity and preference to choose Physical Science as a school subject.

Ormerod and Bottomley (1982:42) state that the most dominant variable which influences the 14 year old secondary school pupils in their choice of Chemistry as a school subject is "... whether they like the subject or not". The same sentiment is supported by Kelly (1988:662) when she said "... liking for the subject is the most consistent predictor of enrolment in fourth year". Kelly (1988:672) further indicates that the only factor which is consistently related to choice for all science subjects (Physics, Biology and Chemistry) for both boys and girls is their interest/liking for the subject.

Toews (1988:458) also refers to Dietrich and Pella's study which indicates that pupils enrol in Physics because of personal interest in Physics and because it fits into their academic schedules. Milner, Ben-zvi and Hostein (1987:207) supported the above assertion when they say that students' attitudes and interest in science, and in particular Physical Science, is the most prominent and influential factor concerning pupils' enrolment in Physical Science courses. According to previous studies conducted in France and Nigeria by Tibergheim and Boyer (1989:304) and by Okpala and Onocha (1988:363) respectively, it was found that the low numbers of secondary school pupils who choose Physical Science as a subject is due to their lack of interest in Physical Science.

According to Trowbridge and Bybee (1990:64) it was found that pupils' interest in the learning task will increase the motivation to learn, hence most of the pupils who register for science have positive attitudes towards science. According to Hessley (1992:376) factors that most directly correlate with pupils' choice of the humanities or of a science career are the area(s) of interest/hobbies.

However, Crawley and Black (1992:585) indicate that, among secondary school pupils in the United States,

> *... interest in the study of Physics appears to be the lowest of all available introductory courses.*

Crawley and Black (1992:586) further assert that:

> *Girls' aversion for the study of Physics appears to be unrelated to interest. It was shown that even boys who dislike Physics take and complete the sequence, whereas girls who report that they like the subject tend to drop it at the end of year three of secondary education.*

The aforementioned studies seem to be inconclusive and is therefore researched in this study since some researchers maintain that pupils' interest in Physical Science can significantly encourage pupils to enrol for Physical Science as a school subject. This is even though Crawley and Black (1992:586) assert that interest/liking for the subject does not have an influence in the choice of Physical Science as a school subject amongst the females in particular.

2.1.4 **Pupils' Achievement in Physical Science**

2.1.4.1 *Introduction*

The Random House Dictionary defines achievement as "... to bring to successful end or to get by effort". The Concise Oxford Dictionary refers to achievement as "...reach or attain by effort". The Oxford Advanced Learners Dictionary of current English refers to achievement as success "... gained by effort and skills". Van den Aardweg and Van den Aardweg (1988:8) define achievement as a product which can be measured by means of achievement tests. Reber (1985:5) also defines achievement as "... accomplishment or the attaining of a goal".

For the purpose of this study, achievement means the performance of pupils in Physical Science as determined by the magnitude of the scores gained in Physical Science tests, assignments and examinations.

2.1.4.2 *Pupils' Achievement in Physical Science*

Toews (1988:458) refers to a previous research by Mclassy which indicates that those who choose Physics in senior secondary schools are regarded as "... intellectually elite, who find satisfaction in studious pursuits". The same sentiments are also shared by Wellington (1992:130) who indicates that only pupils who score a mark of 510 out of 650 (78%) and above, are the ones who are likely to choose Physical Science in senior middle school. Wood and De Laeter (1986:286) also indicate that only 25% of the top achievers enrol for science in grade 11 and grade 12.

Kelly (1988:670) states that

> *... the better the boys performed in Physics tests, the more likely they were to continue with the subject.*

However, for girls, this straight line relationship only occurred in the top half of the achievement range. "Very few girls scoring below average in their Physics tests choose to continue with the subject" (Kelly, 1988:670). Kelly (1988:670) further indicated that, in Chemistry, only few children of either sex continued with the subject if their performance was below average. In conclusion, Kelly (1988:672) found that in both Physics and Chemistry (Physical Science), achievement at the end of the year examination

> *... had the strongest relationship to subject choice. Estimated performance was also a highly significant determinant of whether or not these two subjects (Physics and Chemistry i.e. Physical Science) were studied in fourth and fifth year.*

The same sentiments are shared by Colling and Smithers (1983:14) when they mention that a good performance in Science may influence pupils to do Science, especially females. According to Crawley and Black (1992:586), pupils who study engineering and science related careers are high achievers in both Mathematics and

Physical Science in secondary schools.

Ayalon (1995:38) indicates that in Israeli secondary education, only the most able students are allowed to specialise in science subjects. George, Wystrach & Perkins (1987:32) and Erinosho (1992:247) state that the most important factor influencing pupils to choose Chemistry as a school subject is the student's recognition of his/her high aptitude/ability for science. Donaldson and Dixon (1995:31) share the above sentiment and further indicate that high marks obtained by pupils in tests, assignments and examinations contribute to pupils' high self-esteem, and low marks to pupils' low self-esteem.

There are some other studies that differ from the aforementioned. For example, according to Shanon, Sleet & Stern (1982:81) secondary school pupils "... who do study Chemistry and Physics are motivated by factors other than their abilities in the subjects" concerned. Furthermore, Ormerod and Bottomley (1982:42) maintain that "... boys are not influenced by low estimates of success in Chemistry examinations" as far as the choice of Chemistry in secondary school is concerned. The above sentiments are also held by Alters (1995:415) when he indicates that there is no statistically significant correlation between high-school Physics and university achievement. Furthermore, Koballa (1988:490) found that enrolment of the secondary school pupils in at least one elective Physical Science course is not related to academic ability, science grades or aptitude towards science. However, he has indicated that it is strongly related to attitude.

The aforementioned studies seem to be inconclusive/contradictory, because some researchers maintain that pupils' achievements in Physical Science influence their choice of Physical Science as a school subject. At the same time, a number of researchers maintain that pupils' achievements in Physical Science at lower levels do not influence their choice of Physical Science as a school subject in secondary schools.

2.1.5 **Career Opportunities**

In their study on Science Education. Crawley and Koballa (1994:36) state that, according to their theory of Reasoned Action, human beings are considered to be rational, to have the ability to control their behaviours and are also able to process all available information about pending decisions before taking any action. Based on the above theory, it was found that:

> *... pursuing a career in science or engineering ... represent a behavioural category which might include specific behaviours such as enrolling in advance, elective high school courses in ..., Physics, earning grades of A or B in mathematics and science courses....*

According to the study conducted by Shanon et al. (1982:81) on Australian secondary schools based on factors influencing pupils' selection of science subjects, it was found that:

> *... many of the students were studying Chemistry and Physics because they felt these subjects were relevant to their career goals and not necessarily because of their abilities in these subjects.*

The same sentiment is shared by Toews (1988:459) who indicated that 75% of pupils taking Physics in grade 11 or 12 intend to further their education in Physics or prepare themselves for future careers related to Physics. The same sentiment is also shared by George et al. (1987:432) and Milner et al. (1987:205) when they indicate that the main reason given by grade 11 pupils for choosing Physical Science as a subject is interest in science, followed by interest in science as a future career.

Wood and De Laeter (1986:287) and Chandavarkar et al. (1991:391) state that choice of vocation is the factor that most influences secondary school pupils to choose Physical Science as a school subject. Koballa (1988:484) further indicates that female pupils attending a junior high school are influenced to enrol for at least one elective Physical Science course because they feel that Physical Science will assist them to be more prepared for future careers in science.

According to Trowbridge and Bybee (1990:159), fewer pupils are interested in science because of economic reasons, while most pupils do not see job possibilities in science, hence they pursue other studies than science.

It is interesting to note that researchers such as George et al. (1987:432) and Tibergheim and Boyer (1989:305) indicate that while the possibility of a better future career can influence pupils' choice of Physical Science in secondary schools, it should be noted that it is not the most dominant factor. George et al (1977:432) found that pupils' future career aspirations as a factor that influences pupils' choice of Physical Science is rated fourth after students' aptitude in science, an inspiring or encouraging high school science teacher and enjoyment of laboratory work and experimentation. However, Tibergheim and Boyer (1989:305) found that 66% of the pupils who register for Physical Science do so because they express a need for the development of knowledge necessary to understand one's environment, while only 31% of the pupils indicate that their goal in learning science is a preparation for their future careers which will be science based.

While all previous studies agree that pupils' future career aspirations in science related careers influence secondary school pupils' choice of Physical Science, these studies seem to be inconclusive on the extent to which a future career can influence pupils' choice of Physical Science as a school subject.

2.1.6 **Pupils' Gender**

2.1.6.1 *Gender Roles and Choice of Physics/Chemistry/Biology*

In his study in Israel, Ayalon (1995:40) indicates that there is gender inequality in choice of courses in Israeli secondary education as "... lesser number of females are found in higher level courses in Mathematics and Sciences". Wellington (1992:133) says that:

> *... the gender divide in Physics at the level of higher education is also glaringly evident in both university and college, with male/female ratio approaching four to one.*

Crawley and Black (1992:586) also assert that "... nearly twice as many males enrol in Physics as do females". Furthermore, Kelly (1988:669) indicates that option choices in science are strongly stereotyped; i.e. 51% of boys in her sample opted to continue with Physics, compared to 12% of girls. Kelly (1988:673) further indicates that sex had a direct effect on the choice of Physics and can influence pupils' liking for Physics. Pupils who like Physics, achieve better it and are likely to choose it, hence more boys are willing to study Physics than girls.

Ormerod and Bottomley (1982:43) state that girls are only willing to choose Chemistry as a school subject if it does not appear to be difficult, while the dominant factor that influences boys to choose Chemistry is whether they like the subject or not. McGuffin (1983:84) maintains that Chemistry with Physics (Physical Science) is more popular with boys than girls. However, Biology with Chemistry is the most popular combination for girls. This might be the main explanation for the small numbers of girls who choose Physical Science as a school subject. Jones (1990:308) concurs with the above sentiment when she indicates that girls prefer Biology to Physics because boys are more interested in the physical and technological aspects of the world and girls appear to be more interested in human and natural aspects. Therefore, this shows that "... the problem of girls not doing Physical Science is a problem of girls not doing Physics" (Kelly 1988:669). Thus most girls prefer not to enrol for Physical Science as a school subject because they fear Physics.

2.1.6.2 *Gender Roles and Exposure*

In his study based on the exposure of females (7th and 9th grades) to traditional male dominated careers such as engineering, Räsänan (1989:356) indicates that there is a significant change of interest in science amongst girls who are in grade 10 to 12 who were exposed to male dominated careers. In two years of being exposed to male dominated scientific careers the proportion of girls who were exposed to male dominated careers almost doubled (from 35% to 61%). Wienekamp (1987:286) maintains that:

> *... girls need role models so that they can identify with science. Not the first female astronaut, but quite ordinary female scientists should be presented as examples.*

The same sentiment is shared by Okpala and Onocha (1988:363). In reference to Cook, Hessely (1992:373) indicates that "... women graduates in science are disadvantaged in real and concrete ways by the absence of role models and women with whom to network". The availability of female role models in scientific careers may remove existing role conceptions and it will possibly enable more girls to understand the point of learning scientific facts.

However, Solomon (1997:411) maintains that visits by female scientists to secondary schools as role models and the introduction of new learning programmes in secondary schools led to no significant change in either the pupils' attitudes or their choice of subject(s). Koballa (1988:485) asked female students in junior secondary schools to choose people or groups of people who influenced them to enrol in an elective course in Physical Science. It was found that scientists and doctors/dentists were placed 7th and 8th respectively out of 9 items while parents and science teachers were placed 1st and 2nd respectively. This shows that scientists, doctors and dentists can hardly influence secondary school pupils (especially females), to choose Physical Science as a school subject.

2.1.6.3 *Gender Roles and Textbooks*

According to Guzzetto and Williams (1996:5) in support of previous research by Bazler and Simon (1991), Blanchini (1993), and Tobio (1988), science textbooks promote gender bias because of their unequal treatment of genders. Illustrations, photos and texts of males far out-number those of females. It is further argued that from a female pupil's perception, textbooks appeal to those they perceive to have the most interest in and future inclination towards Physical Science.

The above sentiments are justified by a female student's response when asked about gender bias, caused by textbooks and textbook publishers:

> *...when they tend to use people, they always tend to use males, especially in a stereotypical situation, like here in chapter 10 .... When they decided to choose somebody lifting weights, it would have to be a male, even though women do lift weights. And when it is somebody pushing cars, it would be a male, even though women drive a lot and their cars do break down and they have to push their cars. Just really subtle things like that ...* (Guzzetti & Williams, 1996:5).

It is evident from the stipulations and studies quoted above that Physical Science text books can create negative feelings about Physical Science in pupils, especially girls. Thus, a poor self concept is instilled in them, hence poor enrolments in Physical Science. Therefore, textbooks may help to discourage girls to choose Physical Science for their future studies, even though textbooks with female role players and role models may possibly encourage more females to choose Physical Science as a school subject.

Blin-Stoyle (1983:226) supports the above sentiments when she indicates that the masculine image of Physical Science is caused by the domination of males in science related careers such as engineering, and by school textbooks and mass media which generally present Physics as a masculine preserve.

2.1.6.4 *Gender Roles and the Perception of Society*

Matthews (1994:127) maintains that pupils from the age of 16 tend to think of scientists as males. Reynolds (1994:60) confirms that society has a gender bias that might influence the choice of Physical Science. This is based on the belief within the society that toys for girls are dolls, while toys for boys are perceived to be cars. Colling (1983:5) also argues that society perceives scientists to be male, to have a high measured intelligence, to be conversant in their thinking,

> *... to be emotionally stable, tough-minded, self sufficient and interested in things and ideas rather than pupils.*

Hesseley (1992:373) concurs with the above sentiments when she mentions that there is a perception within society that 'science' is unfeminine and unfriendly. This perception by society will have a negative impact/influence on encouraging pupils to register for Physical Science as a school subject, especially with regard to girls.

In her study of "Girls' Science Education", Solomon (1997:414) found that:

> *... for young men, the choice may display a valuable gender-enhancing solidarity with what is predominantly male community. For young girls, it obviously cannot do that. Choice of science can only be a public description of themselves as non-typical females, which is continually reaffirmed by attending boy-dominated classes.*

Solomon (1987:416) further indicates that the choosing of Science, particularly Physical Science by females, seems to be ring-fenced by culture.

According to Blin-Stoyle (1983:226) and Rennie and Parker (1996:55), the attitudes that girls have towards Science, and Physical Science in particular, are based on the feminine role that women are involved with in society and the fact that Science (Physics in particular) is traditionally viewed as a masculine subject and it is taught and assessed in ways which are more in tune with the learning styles of boys than those of girls.

2.1.7 **Pupils' Self-Concepts**

Mwamwenda (1995:363) indicates that self-concept develops from childhood to adulthood as a result of the individuals' daily interaction with the environment, which includes his/her peers, his/her parents, his/her teachers and the various tasks and responsibilities he/she is assigned with, and the way in which he/she can cope with them. Furthermore, Joyce and Weil (1996:317) maintain that strong self-concepts are accompanied by:

> *... self actualising behaviour, a reaching out towards environment with confidence that the interaction will be productive. The self-actualised person interact richly with the milieu, finding opportunities for growth and enrichment ....*

According to Kelly (1988:674) self-confidence and pupils' self-concepts are recursions to choice of Physical Science as a subject in secondary schools. She also claims that teachers could probably boost their enrolment in Physical Science among girls if the teachers could persuade the girls to believe in their own abilities. Kelly (1988:674) further states that girls are more accurate than boys in their self-assessment while boys have more confidence than girls in their own abilities in Physical Science.

House (1988:635) emphasises the significant role that can be played by the teacher in building the self-concept of the pupil when she says:

> *... the starting point for all of us who teach Mathematics and Science will be to convince all students that, to some appropriate degree, these subjects are for them. Hence pupils should believe that they can learn Science, or they never will.*

Furthermore, House (1988:635) indicates that without a positive self-concept "... our best efforts to educate students can still meet with failure and frustrations".

Marsh (1988:100) states that

> *... academic achievement is moderately correlated with general self-concept and more substantially correlated with academic self-concept in the same academic area.*

Hence a pupil's self-concept will influence the pupil's choice of Physical Science as a school subject. The above sentiments are also shared by House (1988:635) and Mwamwenda (1995:365) when they report that pupils with positive self-concepts stand a better chance of performing well than pupils with negative self-concepts. Thus a negative self-concept can be so serious an impediment that it can prevent a pupil from choosing a subject, in particular Physical Science. Therefore, a positive self-concept in Physical Science can lead to high achievement in Physical Science which will positively influence the pupil to choose Physical Science as a school subject.

2.1.8 **Pupils' Age**

According to Ormerod and Bottomley (1982:42) there is evidence that potential scientists make their decisions on their choice of subjects and career aspirations at an earlier age than those who enter other major fields. They further indicate that, by the age of 14, pupils are supposed to have taken their decision on whether to enrol for Physical Science or not. The same sentiment is shared by Blin-Stoyle (1983:226) when she indicates, "... it is at the age of 13 to 14 for the majority of the girls that an explicit decision not to follow a Physics course can be made".

Du Toit, Lanchmann and Nel (1991:261) indicated that for Afrikaans-speaking high school pupils, an increase in positive attitudes towards Chemistry from grade 9 to grade 10 is observed, but there is a sharp decrease in attitude from grade 10 to grade 11. Sedotti and Tanaka (1989:497) also indicate that the enthusiasm of pupils in Science is elevated in grade 7 and grade 8, but drops off precipitously in high school, i.e. from, grade 11 to grade 12.

Because of the pupils' decrease in positive attitudes towards Physical Science as from grade 10 and grade 11 as indicated above, it seems that Physical Science is not taught until the drop off in interest takes place, because in our secondary schools, Physical Science is regarded as a full subject from grade 10 to grade 12. Du Toit, Lachmann & Nel (1991:53) supports the above stipulations, when he says that there is a relatively low interest in and poor attitude of the grade 11 pupils towards Chemistry when compared with grade 10 pupils.

In their study based on ways of improving Science Education and influencing students to choose Physical Science as a school subject in Denmark, Nielsen and Thomsen (1988:202) have this to recommend:

> *... students should meet Physics much earlier in school than they do now at grade 7, for example, in a form integrated with Chemistry and Biology in grade 3 and 4. The major goal for this early Physics course should be to give all children a common language and a common Physical Science experience so that the girls do not embark on their Physics course in grade 7 with a large handicap, in comparison with the boys.*

In accordance with the above, Chandavarkar et al. (1991:393) indicate that the international trend shows that pupils who study Physics over several years have a higher performance level, and they further mention that "... Physics can be studied and learned at a younger age with no significant difficulties".

2.1.9 **Pupils' View of Science (Pupils' Epistemological Beliefs)**

This section deals with the beliefs that students hold about Science and about learning of Science literature, which may influence secondary school pupils either to choose or not to choose Physical Science as a school subject. According to Hammer (1995:393), epistemological beliefs are:

> *... beliefs about knowledge and learning. In Physics class, for example, some students might believe learning consists of memorizing facts and formulas provided by the teacher, whereas others might believe it entails applying and modifying the conceptualisations of phenomena.*

For the purpose of this study, pupils' epistemology means the beliefs that secondary school pupils have about knowledge and learning of Physical Science as a school subject.

Songer and Linn (1991:766) argue that the students' beliefs about Science might, to a certain extent, empower them to integrate scientific knowledge, and thus encourage them to think of a further study in Science. They further indicate that:

> *... if students see scientists as grappling with complex ideas and trying to make sense of disparate information, they may feel empowered to engage in a similar process as they go about learning scientific ideas. In contrast, if they view scientists as quite different from themselves, they may decide to leave this grappling to scientists and wait until facts for them to memorize become available.*

These same sentiments are shared by Roth and Lucas (1997:149) and Hammer (1995:398).

According to Songer and Linn (1991:769) there are three groups of students. Firstly, there is a dynamic belief group (those who have the most productive beliefs about the nature of science). This group views science as understandable, interpretive and integrated with many activities in the world around them. Hammer (1995:396) indicates that these students are the most successful and their thoughts about science are characterised by coherence and independence. Their attitudes towards science are also very positive. Hence, most of them will choose Physical Science as a school subject. Secondly, there is the static belief group. The students in this group have the most unproductive beliefs and they view science knowledge as static. For this second group, learning is characterised by intensive memorisation of isolated bits of information from textbooks, rote application of Mathematical principles, separation of school and everyday knowledge, and non-existence of knowledge integration. Songer and Linn (1991:772) further indicate that the static belief group believes that the scientific principles in textbooks will always be true. They see science as static and unchanging. Hence, these pupils have a negative attitude towards Physical Science. Most of them will probably not choose Physical Science as a school subject. The third group is called the "mixed belief group". According to Songer and Linn (1991:769) this group have some dynamic beliefs, some static beliefs and some uninterpretable beliefs, and they are in the majority. However, according to the literature review consulted, nothing is said about the impact of the views of the third group on choice of Physical Science as a school subject.

Hammer (1995:409) indicates that pupils who are likely to enrol for Physical Science should expect:

> *... Physics knowledge to be coherent, rather than a collection of pieces of information; they should believe it is made up of conceptualisation of phenomena, rather than of formulas, and they should believe Physics learning is a matter of applying and developing one's own understanding, rather than simply of receiving and storing information.*

Based on the classification mentioned above, one can say that the dynamic belief group pupils are most likely to study Physical Science in secondary schools, while the static belief group will most probably prefer not to do Physical Science as from grade 10. However, there is no conclusive evidence on the mixed beliefs group.

2.1.10 Summary

The purpose of this section (2.1) is to provide a literature review on pupil variables and their influence on the choice of Physical Science as a school subject.

The literature review shows that the following pupil variables may influence choice of Physical Science as a school subject: attitude towards teacher, pupil's gender, pupil's self-concept, and pupil's age. However, inconclusive findings are reported on the following pupil variables: attitude towards subject content, pupil's interest in the subject, pupil's achievement in Physical Science, pupil's future career aspirations and pupil's epistemological beliefs.

In the following paragraphs the influence of the home environment on choosing Physical Science as school subject is discussed.

2.2 HOME ENVIRONMENT AND PUPILS' CHOICE OF PHYSICAL SCIENCE

2.2.1 Introduction

According to Van den Aardweg and Van den Aardweg (1988:110) a home is defined as "... a protective environment which surrounds a family". They further indicate that children are dependent on adults and need a protective environment in order to be able to develop both physically and psychologically. They also mention that a stable home environment is a dominant factor that can promote the positive growth and development of a child. Van den Aardweg and Van den Aardweg (1988:85) refer to an environment as "... the condition and the influence under which one lives".

According to Bastiani (1995:7) the family has

> *... by far the biggest influence upon the attitudes, behaviour and academic performance of children and young people. Much of what children will eventually know and be able to do is shaped in the home.*

Shaffer (1996:601) indicates that a family as a social system has a fundamental role to play in the economy of the country. He further refers to a study by Robert Levine (1974) which indicates that families in all societies have three basic goals for their children, namely:

(a) *The survival goal: to promote the physical survival and health of the child, ensuring that he/she will live long to have children too.*

(b) *The economic goal: to foster the skills and behavioural capacities that the child needs for economic self-maintenance as an adult.*

(c) *The self-actualising goal: to foster behavioural capabilities for maximizing other cultural values (for example, morality, religion, achievement, wealth, prestige, and a sense of personal satisfaction).*

Based on the above stipulations, it is clear that the home environment will, to a certain extent, influence secondary school pupils either to choose or not to choose Physical Science as a subject. This shows the need to identify and explore home environment variables that may influence the choice of Physical Science by secondary school pupils.

2.2.2 Society's Attitude Towards Physical Science

Since each home is situated within a society, the society's attitude towards Physical Science must be considered as another factor influencing the choice of this subject at secondary level.

The way society perceives Chemistry and Physics has an influence on whether pupils choose Physical Science as a school subject or not. Sedotti and Tanaka (1989:497) indicate that if society perceive:

> *... chemicals equal to toxicity. The practice of Chemistry causes problems for society. Without Chemistry, there will be no air pollution, water pollution, and toxic dumps. One cannot be a hero by*

going into Chemistry.

Furthermore, Joyce and Weil (1996:157) maintain that society teaches that there are genetic differences in pupils' aptitude which is based on gender, e.g. it is perceived by the society that boys are good at mechanical things and poor or less able in literacy matters. They further maintain that society perceives women to have a low mathematical aptitude, and are better at empathy and nurturing.

The above statements and beliefs may cause low enrolments in Physical Science as a school subject, particularly among girls.

2.2.3 **Exposure**

2.2.3.1 ***Pupils' Exposure to Science***

Mansell and Rodgers (1986:264) found that, if 13 to 14 year old pupils are exposed to scientific ideas, apparatus and equipment which they would not come across in their normal schooling, and when exposed to work carried out by practising scientists, most pupils choose Physics (Physical Science) as one of their subject options in secondary schools. Alters (1995:413) indicates that the grades of pupils who were exposed to Physics (Physical Science) previously are significantly higher than those who were not exposed to Physics (Physical Science) previously. This achievement influences pupils' choice of Physical Science as a school subject.

Neilsen and Thomas (1988:200) indicate that activities outside school, like visiting industries, power stations and other science related places should be encouraged because it might have a positive influence on the pupils' choice of Physical Science as a school subject. Aghadiumo (1995:219) claims that in order to encourage pupils to enrol for Physical Science as a school subject, pupils should first be exposed to general science as a broad field before they are exposed to Chemistry and Physics, (Physical Science) because a positive or negative attitude towards science in general can lead to positive or negative attitudes towards Physical Science.

Crawley and Black (1992:586) argue that "An understanding of Physics appeared to be lacking among the general public and also among high school pupils" which is caused by lack of exposure to science. They further indicate that the above shortcoming:

> *... may severely limit the size of science and engineering talent pool and further restrict the opportunities of many students to pursue careers in these fields.*

2.2.3.2 *Pupils' Exposure to Role Models*

In his study Koballa Jr. (1988:485) asked female junior secondary school pupils with an average of 13 years of age to list people who might have expectations about whether or not they should register in at least one elective Physical Science course. It was found that out of nine items, parents were at the top of the list. Thus parents can highly influence their children to choose Physical Science as a subject. Hessely (1992:276) also indicates that for women in graduate schools, the most important variable that influence them in their choice of science is the careers of their parents. Furthermore, Wood and De Laeter (1986:288) indicate that parents as role models have a very strong positive influence on their children's choice of subject(s). Donaldson and Dixon (1995:37) also mention that parental influence affect the achievement of university students, which in turn will contribute to the formation of career and life style perceptions. Crawley and Black (1992:587) contend that very limited encouragement from parents causes secondary school pupils to be negatively influenced in choosing Physical Science as a school subject.

However, other researchers came to different conclusions. For example, Milner, Bon-zvi and Hostein (1987:205) and George, Wystrach and Perkins (1987:431) indicate that extrinsic factors such as parents are perceived to be less effective in influencing students to enrol in Physical Science at secondary schools. The same sentiments are shared by Crawley and Koballa (1994:52) when they contend that:

... students facing the decision to enroll in Chemistry appears to be independent minded. In reaching a decision, they rely on their own perception of personal consequences of taking Chemistry, not on what other people want them to do. Providing parent/guardian with information about enrolling in Chemistry did not improve students' motivation to enrol in chemistry above chance expectations.

These studies seem to be inconclusive and in certain aspects, contradictory. Researchers such as Koballa Jr., Hessely, Donaldson and Dixon found that parents as role models have a significant influence on pupils' choice of Physical Science as a school subject. However, researchers such as Milner et al, George et al, Crawley and Koballa found that parents as role models are less effective in influencing pupils' choice of Physical Science as a school subject.

2.2.4 Parents Socio-Economic Status and Pupils' Choice of Physical Science

Alspaugh (1991:53) indicate that socio-economic status is measured by a number of factors, amongst others parents' educational level, parents' occupation, family income, place of residence, etc. Joyce and Weil (1996:59) indicate that socio-economic differences are the greatest prediction of pupils' success in school. They referred to a previous study by Colenman et al (1996) which found that

... parents education and occupation influenced pupils' academic achievement to an extent that the influence of differences between schools was so minor that they asserted that schools did not make a difference.

According to Tibergheim and Boyer (1989:306) students who are more interested in humanities than in Mathematics, Physics and Chemistry are mostly female, from the upper and the upper-middle classes of society. Thus female pupils from upper and upper-middle classes of society are less likely to register for Physics/Chemistry (Physical Science) as a school subject. Solomon (1997:411) also indicates that features in the home, such as whether the father did housework e.g. cleaning, washing and cooking or the mother went to work, correlate better than any other factor with girls' choice of Physics.

> *This suggests that for shifting societal images, the atmosphere of home is more powerful than that of schools. In that respect, modern science is certainly part and parcel of our whole society.*

Furthermore, Solomon (1997:412) claims that both the home and the national cultures may be powerful influences on choice of Science, in particular Physical Science.

However, Donaldson and Dixon (1995:45) argue that while siblings', teachers' and counsellors' influence on pupils' choice of science is significant, it should be noted that parents' or parental education does not have any significant influence on pupils' choice of Physical Science as a schcol subject. This may be due to lack of substantial interactions with children about career opportunities.

Clark and Starr (1996:292) mention that most pupils from disadvantaged socio-economic family and cultures tend to learn and express themselves through physical means, hence they are "... responsive to opportunities to manipulate learning materials, to perform exercises, and in general, to work with his/her hands". This may positively influence them to choose Physical Science as a school subject.

2.2.5 **Cultural Background**

The home environment is part of a specific culture which may also influence the choice of Physical Science as a subject. Aghadiumo (1995:13) also refers to previous research by Ogunniyi (1994) and Emon (1985) which indicates that it is very difficult to influence pupils in Africa to choose Physical Science as a school subject, because of superstition. The same situation prevails in the Northern Province. For example, some black pupils associate lightning and sickness with witchcraft and evil forces rather than giving scientific explanations for it. This may inhibit pupils' choice of Science as a subject.

On the other hand, Aghadiumo (1995:131) indicates that an African world-view does not significantly influence achievement in Science negatively.

Roth and Roychoudhurg (1994:6) also indicate that the pupils' view of learning is pieced together from what they experience in class and also from the clues they detect in their environment. Hence, it is bound to have a significant effect on what happens to them during lessons and in particular, during Physical Science lessons.

2.5.6 **Summary**

The purpose of Section 2.2 is to provide a literature review on home environment variables and their influence on the choice of Physical Science as a school subject in secondary schools.

The literature review shows evidence of the following home environment variables: society's attitude towards Physical Science, pupil's exposure to Science and pupil's cultural background significantly influence Science as subject choice. However, inconclusive findings are reported on the following home environment variables: pupils' exposure to parents as role models and parents' socio-economic status.

In the next chapter teacher and school environment variables that may influence choice of Physical Science as a school subject are explained.

CHAPTER 3

TEACHER AND SCHOOL ENVIRONMENT VARIABLES AND CHOICE OF PHYSICAL SCIENCE

3.1 TEACHER VARIABLES AND CHOICE OF PHYSICAL SCIENCE

3.1.1 Introduction

In this chapter, teacher and other school environment variables that may influence the choice of Physical Science as a subject are discussed.

Nielsen and Thomsen (1988:195) indicate that there is an overwhelming consensus that the teacher is regarded as the most decisive factor in forming the students' attitudes towards Physics in both lower and upper secondary schools. They further indicate that:

> *... a good teacher can make an otherwise disliked subject tolerable, maybe even interesting, but a bad teacher is able to kill any prior interest in the subject.*

House (1988:638) indicates an important role that can be played by a teacher when he says "Education is a partnership, and we won't develop successful students without also developing successful teachers". She also identified the following components of a successful teacher: student centredness, urgency, commitments, creativity, expectations, surprise and self-direction.

From the above, one can argue that a Physical Science teacher is of paramount importance in influencing the choice of the subject in secondary schools.

3.1.2 **Teachers' Attitudes Towards Pupils**

Moyana (1996:34) refers to a study by Tocci and Engelhard which maintains that pupils' attitudes are developed by the direct experience that the pupils have with the object, and by the interactions with relevant people like their teachers. Therefore, the Physical Science teacher can be an important factor in forming attitudes of the pupils towards the subject.

According to Lucido (1989:334), teachers transfer their attitudes to their students. Therefore, a teacher with a positive attitude towards pupils will have a positive influence on them, consequently moulding a positive attitude in them towards the subject. The above sentiments are emphasised by what Lucido (1989:344) says,

> *... many of us operate our classrooms with an attitude of coercion because that is the way we were taught. We were convinced by our teachers that we did not want to learn, and now pass our judgement onto our students.*

Robinson (1991:26) and Kelly (1988:675) find that to increase the enrolment in Physical Science, the teachers should change their feelings about who should study Chemistry and Physics, as these subject(s) are important to all students, and not only to the top students who are already well prepared in Mathematics and Science. Accordingly, Nielsen and Thomsen (1988:196), indicate that if a teacher needs to encourage his/her pupils to choose Physical Science as a school subject, the teacher should show a genuine interest in his/her students' lives, even when they are not doing Physical Science. Furthermore, the teacher should create a:

> *... warm positive and relaxed atmosphere in his (her) lesson so that the students feel free to come forward with suggestions, however wrong they may be.*

Both junior and senior secondary school teachers have influence on pupils' choice of Physical Science as a school subject. However, high school subject teachers are more influential (14%) than junior secondary school subject teachers (1.5%) (George et al 1988:432). Sorenson and Rouche (1986:305) indicate that among other things, teachers' negative attitudes may include:

> *... developing negative attitudes towards students, blaming other teachers for not teaching prerequisite skills for science, and blaming parents for not disciplining their children.*

They further indicate that a teacher who has a general negative attitude towards teaching Physical Science

> *... may present the content in a mechanical fashion with little or no enthusiasm, thereby rarely developing positive attitudes towards the subject* (Sorensen & Rouche, 1986:305).

Therefore, these studies show a significant correlation between teachers' attitudes towards pupils and pupils' choice of Physical Science as a school subject in secondary schools.

3.1.3 Teachers' Attitudes Towards Physical Science

According to Mwamwenda (1995:264), teachers with positive attitudes towards their subjects are most probably more motivating than those with less positive attitudes. Toews (1988:460) indicate significant correlation between teachers' attitudes towards Physical Science and pupils' choice of Physical Science in secondary schools. Toews (1988:460) further contends that most Physical Science teachers give personal interest and enjoyment in the subject as their main reason for teaching Physics. In his review of the literature, Robinson (1991:27) concludes that an introduction of a new curriculum is unlikely to increase enrolment in Chemistry and Physics (Physical Science) but a change in teachers' attitudes from negative to positive towards their subject can increase enrolment in Physical Science.

Kelly (1988:675) found that many teachers who offer Physical Science in junior and senior secondary schools seem to take a perverse pride in the reputation of their subject as being difficult and that it is only meant for the intellectual elite. By such actions, these teachers discourage less able pupils in science and those who are doing less well in science from choosing Physical Science as a school subject. Nielsen and Thomas (1988:196) also indicate that to influence pupils to choose Physical Science, the teacher should be able to relate his/her knowledge of the subject to things of the world outside his/her subject.

Aghadiumo (1995:131) supports previous studies by Ogunniyi and Okpala, which indicated that the teachers' attitudes towards the teaching of Science influence the learners towards the subject, which in turn will influence the choice of Physical Science as a school subject. He further indicated that, changes in the science curriculum and in instruction in science, could only be successful if they are mediated through positive motives and frame of mind of the science teacher.

Therefore, all the literature consulted in this study, show significant relationships between a teacher's attitude towards Physical Science and pupils' choice of Physical Science as a school subject in secondary schools.

3.1.4 **Teachers' Attitudes Towards Gender Roles**

The teacher's attitude towards gender roles have also been cited as responsible for gender stereo-typical behaviour with regard to the choice of Physical Science as a school subject. Moyana (1996:36) indicates that:

> *... in their interaction with pupils in class, teachers display subtle and mostly unconscious differential treatment of sexes and expectations of sex-related differences in achievement.*

This is confirmed by Herron (1996:5). Thus, teachers give more attention to boys than girls and this may discourage girls to choose Physical Science as a school subject.

According to Wienekamp (1987:281), in Physical Science classrooms, boys receive more attention from the teacher than girls, and boys are called more often and are given more time to give their opinions and are given more praise than girls. Wienekamp (1987:281) also refers to previous research by Spender, conducted in England and the Federal Republic of Germany which indicates that teachers are of the opinion that science is more important for boys than for girls. This attitude could cause a Physical Science teacher to consciously or unconsciously favour boys in particular situations during science lessons. In their study, Guzzetti and Williams (1996:5) also found that in teacher-led and whole-class discussions, boys are spoken to more frequently and are asked more higher-order questions than girls. Furthermore, teachers in science classrooms elaborate more on male responses than female responses in large group discussions of scientific concepts, and this proves to have a significant influence on preventing females from choosing Physical Science as a school subject.

In accordance with the previous studies Nielsen and Thomsen (1988:196) found that teachers often discriminate against girls by neglecting them, by making jokes about them, thus implying that Physics (Physical Science) is a male business. Furthermore, Nielsen and Thomsen (1988:196) contend that girls who are discriminated against seem very often to lose their self-confidence, and in addition, to develop rather strong feelings against Physics (Physical Science). House (1988:635) further mentions that "... without self-confidence and positive self-concept our (teachers) best efforts to educate students can still meet with frustrations".

Therefore, this shows that other significant role players like teachers can influence the choice of Physical Science as a school subject in secondary schools, especially by girls.

3.1.5 Teachers' Personalities

Mwamwenda (1995:525) defines personality as "... the unique combination of physical and psychological characteristics which determines an individual's behaviour". Furthermore, Mwamwenda (1995:322) indicates that the development of personality occurs as a result of the interaction between a child's heredity and the environment. Therefore, the home, the school, social forces, parents and teachers have varying levels of influence in the development of the child's personality.

Robinson (1991:26) indicates that "... if we had more exemplary science teachers, we might have more students who find science interesting and relevant to their everyday lives". Once we reach this stage, more pupils will be prepared to enrol for Physical Science as a school subject. Nielsen and Thomsen (1988:196) claim that pupils may be encouraged to do science in upper secondary schools if the science teachers also show the human side of themselves during as well as outside the Physics (Physical Science) lesson, instead of presenting themselves as the all-knowing "sage on the stage".

Brekelmans, Wubbels and Creton (1990:39) indicate that if science teachers intend to get high affective students' outcomes, they should display more helping, friendly and understanding personalities in addition to and be less dissatisfied with admonishing behaviour. They further contend that for science teachers to get better cognitive outcomes "... it seems that leading behaviour and being strict have a positive influence, whereas uncertain behaviour has a negative influence". Mwamwenda (1995:264) argues that a teacher's personality traits which are motivating to students and which the teacher should bear in mind in the interaction with pupils include democratic attitudes, wide interest, fairness, impartiality, interest in the pupil's well being, use of recognition, praise, etc. Mwamwenda (1995:369) further indicates that if a teacher does not have a positive perception of himself/herself, he/she is not likely to instil positive self-concepts in his/her pupils.

Therefore, from the literature review consulted, it seems that the teacher's personality will significantly influence the choice of Physical Science by secondary school pupils.

3.1.6 **Teachers' Competencies**

Mwamwenda (1995:511) defines competence as an "... appropriateness of ability or training for a task", while the Random House Dictionary defines competence as the "... legal capacity of qualification". However, for the purpose of this study, teachers' competence means teachers' qualifications, which includes the level of education attained by the teacher and the teachers' experience in the subject as well as the success that he/she has achieved with previous and present pupils and the teacher's ability to motivate learners.

3.1.6.1 ***Teacher's Education***

For the purpose of this study, the teacher's education means the amount of education, both professional and academic, that a teacher received in Physical Science.

According to Georgewill (1990:383), teachers are thought to be born and not made. However, education will make a "born" teacher to be more effective in class. This sentiment is supported by Throwbridge and Bybee (1990:35) when they contend that teachers' knowledge of subject matter, pedagogical content knowledge and curricular knowledge are all important for effective teaching to take place.

Barrow and Thompson (1996:3) claim that the low enrolments in Physics is caused more by teacher's constraints, probably due to low qualifications in their subject areas, than to lack of potential students. In more rural schools, Physical Science teachers are few. Due to lack of qualified teachers, other teachers are assigned to teach science in secondary schools. Hence, only few pupils choose Physical Science as a school subject in rural areas. Moriber (1984:807) maintains that one of the factors which helps to determine a student's attitude towards Chemistry and Physics is poor science training of elementary school teachers as well as the difficulty in retaining highly qualified teachers in secondary schools. Often these teachers are replaced by other, unqualified teachers who lack formal training in Science. Therefore, the recent retrenchments of teachers (in particular the experienced ones), especially of Physical Science teachers, will probably have a negative impact on science education, especially in the Northern Province.

Moyana (1996:38) refers to Vatter (1992) who recommend that teachers should make schoolwork hands on and be tied to the real work in the real world. Lilly (1989:33) and Brickhouse (1993:122) also claim that teachers should develop programmes that emphasize technological application of scientific principles and that science curricula should integrate everyday theory and hands-on-experience. This recommendation can only be effectively implemented by teachers who are academically and professionally well qualified and well versed in their subject area.

House (1988:638) argues that we will not develop successful students unless we have successful teachers. She further asserts that teachers should be student-centred, i.e. they should

> *... have empathy and patience, find ways to make the subject relevant to students. This means more than being an expert in the subject yourself. It means knowing it so well that you can make it understandable to a child.*

In their study in the USA schools, Chandavarkar et al (1991:392) found that higher performing classes are taught by teachers who do most of their teaching in their area of certification. This suggests that, to improve achievement in Physical Science and in turn influence pupils' attitudes towards Physical Science as a subject positively, schools should recruit and assign teachers who have the preparation needed for certification as a teacher in the subject concerned.

However, contrary to the above stipulations, Ramsden (1990:54) claims that the provision and availability of more subject specialists (Physical Science teachers) to teach their subjects in secondary schools may not result in a significant increase in the number of enrolments in Physical Science, unless such steps (i.e. provision of more subject specialists) are taken with other measures, like teachers' dedication and sense of responsibility, amongst others.

3.1.6.2 *Teacher's Experience*

The Random House Dictionary defines experience as "... the process or an instance of personally encountering or undergoing something". The Concise Oxford Dictionary refers to experience as "... actual observation of, or practical acquaintance with facts or events". The Oxford Advanced Learners Dictionary of Current English states that experience is "... knowledge or skills ... gained by doing and seeing things".

For the purpose of this study, experience means the knowledge or skills that have been gained by the teacher through his/her constant and daily interaction with his/her pupils during the process of teaching and learning.

Little empirical evidence is available regarding the influence of the teacher's experience on a pupil's choice of Physical Science as a school subject. However, Lin and Lawrenz (1992:907) claim that experienced teachers (above 35 years) appear to be more confident about their teaching than their younger counterparts. It is maintained that this 'confidence' may be the effect of in-service training, because experienced teachers are supposed to have been upgraded in science and science teaching through in-service programmes organised by the government's Education Department. Furthermore, it was found that experienced teachers would put more emphasis on laboratory techniques and hands-on experience than their younger counterparts.

3.1.7 Teacher's Approach/Methods

The Random House Dictionary refers to an approach as "... the method taken in setting about a task, problem". The Concise Oxford Dictionary defines an approach "... as a way of dealing with a person or thing". For the purpose of this study, the teacher's approach means the method and the way that the teacher will apply to achieve the aims and objectives of the lesson.

Lin and Lawrenz (1992:904) indicate that students' scientific literacy and positive attitudes towards science can be enhanced by using a pupil centred, process-based approach, rather than encouraging rote memorisation of science. Thus, the emphasis in the teaching of science should be based on hands-on and process-based inquiry teaching. This is in accordance with OBE as explained in Curriculum 2005 (Department of Education 1997:16). According to Kennedy (1996:57), the method or approach that the teacher should use should start with concrete, experimentation and specific aspects of Chemistry, leading to the abstract, theoretical and general areas.

Newton (1987:85) contends that the function of Physics is three fold: "... to educate in Physics, through Physics and about Physics". He further indicates that teachers concentrate only on educating in Physics and ignore the other two functions. Furthermore, McCormack and Yager (1989:47) indicate that there are five domains of teaching Science, namely: knowing and understanding, exploring and discovery, imagining and creating, feeling and valuing, and lastly, using and applying. Thus, the teaching methods used in Physical Science should focus on the achievement of the above mentioned domains. This will probably motivate pupils to further their studies in Physical Science. According to Robinson (1991:26) teachers should teach Chemistry and Physics in a more interesting manner if they intend to increase enrolments in Physical Science. Wienekamp (1987:286) suggested that Chemistry and Physics lessons should always begin with pupils' everyday experience, and the role of a teacher should become that of a facilitator of knowledge and its application to daily life, rather than being a keeper of knowledge. This is also in accordance with Curriculum 2005 (Department of Education, 1997:16).

Streitberger (1988:61) indicates that science and technology should be made relevant to the day-to-day experience of pupils, if we intend to encourage them to enrol for Physical Science as a school subject.

Moriber (1984:807) found that science teachers who:

> *... shunt aside application (of knowledge acquired) and opt for theoretical and problem solving courses are helping to drive students away from the study of Chemistry.*

This may also be applicable to Physical Science. Furthermore, he contends that an increase in the use of chemical applications might have a positive effect on students' interest, and hence influence pupils positively to register for Physical Science as a school subject in secondary schools.

According to a study by Roth and Roychoudhury (1994:6), if Science, and in particular Physical Science, is presented to pupils as a body of knowledge, proven facts and absolute truth, the pupils will focus on memorisation of facts, and have the perception that all knowledge can be ascertained through specific proof procedure embedded in the scientific method. They further indicate that if students experience science as a continuous process of negotiating the above meanings amongst individuals, the students might focus on concepts and their variations.

Throwbridge and Bybee (1990:30) indicate that:

> *... when science teachers lecture, show a film, take a field trip, have students work in the laboratory or guide discussions, they are using instructional methods that will develop understanding, skills or values relative to science and technology.*

They further contend that the method used for presenting a lesson should also be practical and appropriate for the enhancement of understanding through enjoyment.

In this regard, Dickie and Farrel (1991:444) indicate that the reason why enrolment in sciences keep on declining year after year may be the fact that the practices of teachers do not suit the learning styles of all students. Bosker, Kremers and Lugthort (1990:244) confirm that effective teaching has a positive effect on both girls and boys, but the effect is more pronounced for girls than for boys.

The following are a number of teaching methods that are prevalent in teaching science, which may positively or negatively influence the choice of Physical Science as a school subject by secondary school pupils.

3.1.7.1 *Demonstrations*

The purpose of a demonstration is to provide pupils with an opportunity to see a phenomenon or event that they otherwise may not observe. It can be used to teach concepts and skills or to prepare students for work in the laboratory (Throwbridge & Bybee (1991:30). Kennedy (1996:57) indicates that lessons should be introduced through experiments or demonstrations, then lead to explanations, generalisations and theories.

Robinson (1991:26) indicates that to improve instructions and influence enrolment in Physical Science, science teachers should use more induction and other motivational techniques at the beginning of the lesson. They indicate that the most interesting and applicable induction in science is usually demonstration and lecture-demonstration. They further contend that "... without demonstrations and labs, all science become less understandable, less interesting and less exciting". This may influence choice of science as a subject negatively.

Du Toit et al. (1992:264) mention that high school pupils have a positive attitude towards demonstration and practical work. Furthermore, they assert that the most influential factor with regard to interest in Chemistry, is the use of demonstrations and practical work. Boone and Roth (1992:348) also claim that a wonderful method to create a positive attitude towards science is through organising large-scale Physics and Chemistry shows (demonstrations) for secondary school pupils.

From the stipulations stated above, it seems that there is a general feeling among the researchers that the use of demonstrations can significantly arouse pupils' interest, thus influencing them positively to choose Physical Science as a school subject.

3.1.7.2 *Cooperative Learning*

Cooperative learning is in accordance with Curriculum 2005 (Department of Education, 1997:6). According to Platt and Platt (1993:87), cooperative learning is defined as

> *... an approach to teaching and learning in which classrooms are organised so that students work in small co-operative teams.*

The purpose of discussions within these groups is to promote and exchange information and ideas among members of a group or class, to generate more motivation, increase positive feelings towards one another, and to increase self-esteem (Joyce & Well, 1996:67). A group should consist of not more than 8 pupils to be effective. Discussions in a group motivate students and involve them in cognitive processes in greater dimensions (Throwbridge & Bybee, 1990:30).

Bracey (1994:807) indicates that as children move from concrete operations to formal operations in Piaget's Stage Theory of development (as is the case with early and middle adolescents), pupils "... exhibit the qualities of small scientists, testing hypotheses and reasoning things through". This can be achieved successfully through group work/cooperative learning. He further contend that pupils enjoy most and learn most through group work. This is possible because pupils are actively engaged in discussions "... during which they had to explain, elaborate and defend their positions". Furthermore, discussions give students an opportunity to develop creative thinking, to critically look at their own views/ideas, to formulate and apply principles and to accept feedback from peers (Joyce & Well, 1996:67-68). This enjoyment influences them to choose Physical Science as a school subject.

In addition to the aforementioned advantages of group work, Lucido (1989:337) found that team work/cooperative learning will lead to healthy team competition and in turn positively influence the choice of Physical Science as a school subject. Also, Streigberger (1988:61) mentions that teams/groups can embark on projects. These involvements and active participation in such projects can give students opportunity to manipulate materials and allow them to view "... science and problems in society and their lives from a broader, interrelated and more personalised perspective".

Harty and Al Falch (1983:86) reveal that small groups of students exhibited significantly greater Chemistry achievement than students in the lecture-demonstration group on both immediate and delayed post tests. Furthermore, pupils who are taught by a small group laboratory approach (cooperative learning) possess more desirable attitudes towards science. Hence, these students may be more likely to choose science as a subject.

3.1.7.3 *Discovery Learning*

As with cooperative learning, discovery learning is in accordance with Curriculum 2005 (Department of Education 1997:6). According to Mwamwenda (1995:213), discovery learning involves the pupil's discovery of what he/she is capable of doing and thinking for himself/herself, thus obtaining new information on or insight into concepts. He further asserts that, to promote discovery learning, the teacher should provide pupils with opportunities that engage them in insight, thinking and problem solving.

According to Skolnik (1995:35), discovery learning as a teaching method encourages:

> *... critical thinking more than memorisation; provides the complex and relevant stimuli necessary to allow learning to occur more easily through manipulation of materials and exploring possibilities.*

He further contends that pupils are actively involved during the lesson, and the teacher acts as a facilitator in helping pupils to explore and discover the possible solutions to issues under contention.

According to Throwbridge and Bybee (1990:208), discovery occurs when an individual is mainly involved in using the mental processes to mediate some concepts or principles e.g. observing, classifying, measuring, predicting, describing, inferring, etc. It is further indicated that inquiry (discovery) learning provides a pupil with an opportunity for greater involvement, thereby giving pupils more chances to gain insights, and better develop their self-concepts. This in turn may motivate pupils to choose science as a subject.

Discovery learning has an added advantage of increasing memory retention, making instruction student-centred, and thereby

> *... contributing to a person's self-concept, increase in expectancy levels, development of multiple, not just academic talents, help avoid learning mostly only on the verbal level, and allowing more time for students to assimilate and accommodate information* (Throwbridge & Bybee, 1990:215).

They further indicate that there is much evidence that students taught by these methods perform significantly better in cognitive tasks, including critical thinking, than those taught through traditional instructional methods. Clark and Starr (1996:238) indicate that while this teaching method can be very effective, one should accept that few pupils can understand abstract learning until they are 12 to 13 years old. Furthermore, many are not ready for this type of learning at this stage.

Based on the literature consulted in this study, it seems as if the regular use of discovery learning as a method of instruction in science classrooms may significantly influence secondary school pupils to choose Physical Science as a school subject.

3.1.7.4 *The Lecture Method*

According to Roth and Roy Choudhury (1994:6), the traditional science teaching/lecture method is based on the direct transmission of content whereby a teacher uses a whole-class non-interactive and whole-class interactive activities, in order to make his/her teaching effective. They further indicate that through the use of this method, the role of a teacher is to explain concepts and procedures for calculations required for problems in verbal form, followed by the pupils' work that emphasises completion of work over comprehension. Skolnik (1995:58) indicates that if this method is used in class, pupils expect the teacher to give them all the information they need to know to pass a test or examination. Therefore, this lecture method is examination centred and the teacher's role is that of a keeper of knowledge. Accordingly Sirestarajah (1994:6) indicates that the lecture method condition pupils to learn without answering questions and without understanding what they learn. He further mentions that pupils accept the "... teachers' word as the gospel truth".

Throwbridge and Bybee (1990:215) indicate that, in traditional teaching, the emphasis is on completion of work, i.e. the teachers are often "... suffering from a covering syndrome" because if they cover the learning material, they feel that their responsibility as teachers has been met. However, this leads to poor performance and a negative attitude towards the subject. This may result in only a few pupils choosing Physical Science as a school subject.

Throwbridge and Bybee (1990:219) further state that teachers who stick to this method (lecture method), rob pupils of the opportunity to use their minds because it effectively involves soaking up of information and memorising the same information without sufficient understanding. Hence in Curriculum 2005 there is a move away from this method towards cooperative learning and discovery learning (Department of Education, 1997:6-7).

3.1.8 Assessment Methods

The type of assessment methods that a teacher uses can influence a pupil's choice of Physical Science as a school subject. Boys prefer questions or items that focus on real-life contexts or where the context refers to male-stereotyped experiences (Rennie & Parker, 1996:55). Rennie and Parker (1996:57) maintain that students do better when tasks or challenges are contextualised, because contextualised problems are regarded as interesting and easier to visualise, while problems out of context are regarded as hard to visualise and very difficult. They further indicate that irrespective of the presence or absence of context, boys prefer tasks requiring calculations while girls prefer to answer questions which needs the use of words, depending on whether they can relate to what is happening and can solve the problem (Rennie and Parker, 1996:58).

From the literature review conducted, it is clear that pupils from both sexes differ in the type of questions that they prefer. Hence, the type of questions that the teacher uses in his/her assessment will influence the pupils' performance, thus influencing their choice of Physical Science as a school subject.

3.1.9 **Summary**

The purpose of this section is to provide a literature review on teacher variables and how they can influence the choice of Physical Science as a school subject.

The literature review shows a significant relationship between teachers' attitude towards Physical Science, as well as teachers' personalities and pupils' choice of Physical Science. However, inconclusive evidence are found on the relationship between competence and pupils' choice of Physical Science.

Teachers' methods of instruction, i.e. demonstration, cooperative learning and discovery learning are significantly related to secondary school pupils' choice of Physical Science. However, the lecture method shows a negative correlation with the pupils' choice of Physical Science as a school subject.

In the following section, school environment variables and their relationship to choosing Science as a school subject are explained.

3.2 SCHOOL ENVIRONMENT VARIABLES AND PUPILS' CHOICE OF PHYSICAL SCIENCE

3.2.1 Introduction

A school as an institution of formal teaching and learning has a significant role to play in a community. Hence, the success and the development of the community will be influenced by the teaching and learning that take place in the school. Ormerod and Bottomley (1982:43) indicate that:

> *... pupils of both sexes are far less affected in their choices by any influences other than those relating to the school ....*

Therefore, it is of importance that some of the school variables that may influence the choice of Physical Science as a school subject in secondary schools should be identified and discussed.

3.2.2 Type of School

According to Bastiani (1995:7), schools "... differ enormously in their ability to get the best out of their pupils, in ways that outweigh any initial differences between pupils". Bastiani (1995:8) further indicates that successful schools are well-led, are clear about what their main tasks should be, and they are also thorough in their organisations. They also relate effectively with their parents, e.g. provide opportunities for parents to see the children's work, discuss their progress, create a sense of shared identity and common purpose in which teachers, parents and pupils alike will talk about "our school".

According to Erinosho's (1992:25) study based on the performance of pupils in single-sex and co-educational secondary schools in Nigeria, it was found that pupils in single sex schools perform significantly better in science than those in mixed schools. This may imply that providing separate classroom environments for boys and girls may help pupils of both genders to develop greater confidence in their abilities and, in turn enable them to be actively involved in class. She further maintains that in mixed sex schools, girls feel intimidated by boys and this may develop into unhealthy academic rivalry or undermine their interest in the subject. Solomon (1987:414) argues that in an all-girl school, the need for girls to express solidarity with other girls is far less compelling. Hence, a greater number of girls coming from all-girls schools choose Physics (Physical Science) for further study than girls from mixed sex schools.

However, Blin-Stoyle (1983:226) argues that while there are:

> *... indications that girls perform better in Physics in single-sex schools, this has been attributed not to the type of school per se, but primarily to the expectation of and for girls in such schools.*

3.2.3 Role of Management Policy

3.2.3.1 *Introduction*

The Random House Dictionary defines a policy as "... a guiding principle or course of action adopted towards an objective or objectives". The Concise Oxford Dictionary refers to a policy as "... a course or principle of action adopted or proposed by a government, party, business or individuals".

However, for the purpose of this study, management policy means a guiding principle or course of action that have been adopted by the management of the school in dealing with issues related to the science curriculum in schools.

3.2.3.2 *Streaming of Subjects*

Different schools have different subject choices and subject options for their students, depending on the management policy of each individual school. Ormerod and

Bottomley (1982:43) observe that:

> *A complex range of factors, involving Physics, Biology and Mathematics as well as Chemistry are associated with Chemistry choice. This is because, making Chemistry choice is, for the majority, a decision to opt for either the arts or the science side.*

Hence, the major factors discriminating pupils who will like to do Physical Science are not specifically concerned with Physical Science only, but streaming of particular subject(s) with Physical Science can positively or negatively influence pupils' choice of Physical Science as a school subject.

3.2.3.2.1 *Streaming of Physical Science with Mathematics*

One of the main reasons why pupils opt not to choose Physical Science as a school subject is because mathematics is used as a "gate keeper" for those who intend to continue with science from grade 10 (Ayalon, 1995:39).

Ayalon (1995:39) indicates that in Israeli secondary education, science subjects are highly valued and it is believed that these subjects are demanding and difficult and it is appropriate only for the most able and gifted pupils. As a result, secondary schools develop mechanisms for selecting students for higher level science courses. Hence, pupils are only allowed to take higher level courses in sciences if they take the highest level of Mathematics. He further contends that:

> *... by making access to higher level courses in sciences conditional on taking higher level mathematics, schools limit the number of students who can be considered appropriate candidates.*

According to Toews (1988:458) with reference to a previous study by McClassy, many pupils decide not to take Physical Science as a school subject because of "... fear of Mathematics and poor attitudes towards Mathematics".

The same sentiment is shared by Hessley (1992:376) who indicates that fear or disinterest or lack of skills in Mathematics can have a negative influence on pupils' choice of Physical Science as a school subject.

According to Wood and De Laeter (1986:286), schools usually recommend that only students who have advanced level grades in Mathematics in year 8 to 10 should study Physics (Physical Science). Okpala and Anocha (1988:362) claim that Mathematics is the language of science, thus without Mathematics, one cannot do science. They further indicate that Physics demands higher abstract reasoning and mathematical ability than necessary for other science subjects. Hence, they argue that exposing a Physics (Physical Science) pupil to Mathematics will enable the pupils to achieve better in Physics, thus encouraging these pupils to enrol for Physical Science as a school subject in secondary schools and tertiary institutions.

3.2.3.3 ***Number of Subjects***

According to Dekkers and De Laeter (1994:25) as well as Kennedy (1996:56) the matriculation enrolments in science in the past two decades were influenced by, amongst others, the interplay of various factors such as an increase in the number of matriculation subjects and an interest in and enjoyment of science.

In his research in Australia, Rosier (1988:170) found that in Western Australia, the year 12 students had to register for six subjects and the total enrolment in science was 17%. However, in Victoria, students were expected to register for a maximum of five subjects in year 12, and only 8% of the students registered for science. Furthermore, Rosier (1988:171) indicates that:

> *... high mean score often follows as a result of restricting the participating rate, either by deliberate policy decision or as a function of self selection of courses by students. Therefore, the number of subjects that one is expected to register per grade will influence the choice of Physical Science as a school subject.*

3.2.3.4 *Time-Table*

Blin-Stoyle (1983:226) indicates that:

> *... because of the option schemes between subjects and time-table constraints, pupils, especially girls, may be required to choose between Physics (Physical Science) and traditional girls subjects like Needlework and Clothing or Home economics.*

Based on the stipulations above, the author may highlight that in some secondary schools, Physical Science alternative with Needlework and Clothing. This situation may prevent girls to enrol for Science.

Because of this, girls might be channelled away from Physical Science and be encouraged to enrol for the above mentioned traditional girls' subjects. Very little other evidence has been established regarding the influence of time-table constraints on pupils' choice of Physical Science as a school subject, hence the need for this study.

3.2.3.5 *Rules Regarding the Use of Chemicals*

Little empirical evidence has been established regarding the influence of rules regarding the use of chemicals by pupils on the choice of Physical Science as a school subject. Sedotti and Tanaka (1989:497) indicate that rules and regulations regarding the usage of chemicals are making Chemistry hard to do. They further indicate that pupils are fascinated with Chemistry because of chemical reactions, smells of chemicals, etc. Unfortunately, much of the chemicals are outlawed in science laboratories. Hence, some students feel discouraged to choose Physical Science as a school subject.

3.2.3.6 *Availability of Science Laboratories and Equipment*

School laboratories and the availability of equipment can play a significant role in making Physical Science a hands-on experience and laboratory based science most effective (Lin & Lawrenz, 1992:903). However, it is unfortunate to note that:

> *... the amount of laboratory work has been decreasing in many school districts because of budget cuts, more stringent safety requirements,*

and other related reasons (Scaife, 1986:790). Wong and Fraser (1995:911) found that the following five dimensions have a significant positive relationship with enjoyment of Chemistry and may influence pupils to choose or not to choose Chemistry: cohesiveness, open-endedness, integration, rule clarity and material environment. Roth (1994:197) maintains that access to laboratories and the experience of enquiry are important aspects of school science. Therefore, there is a significant positive correlation between the availability of science laboratories and the choice of Physical Science.

Okebukola (1986:532) asserts that the attitude of pupils towards Chemistry is significantly related to the attitude of pupils towards the science laboratory. However, it was found that:

> *... the location of the school and the experience of the chemistry teachers were not significantly correlated with students' attitudes towards the chemistry laboratory.*

George et al. (1987:432) maintain that laboratory work, experimentation and research experience are significant factors that may influence pupils to choose chemistry (Physical Science) as a school subject. Chiapetta, Waxman and Sethra (1990:52) found that after the use of demonstrations and laboratory experiments, students' attitudes, perceptions and achievements improve significantly. Crawley and Black (1992:586) share the same sentiments and further assert that practical work correlates significantly with the choice of Physical Science as subject by both males and females.

Okebukola (9186:532) found that pupils' participation in laboratory activities is the most positive factor that influence students towards laboratory work and hence increase pupils' enrolment in Physical Science. Thus a greater degree of pupils' participation in laboratory activities may produce a more positive attitude towards the laboratory. Kelly (1988:663) shares the same sentiments when she claims that practical work is by far the most popular feature of science lessons. However, it should be noted that boys enjoy laboratory activities more than girls. The same sentiments are shared by Lind Gunter (1982:276) when she claims that Physics experiments motivate pupils to choose Physical Science as a school subject.

In their study on the relationship between student outcomes and psychosocial science environments, McRobbie and Fraser (1993:84) found that both cognitive and attitude outcomes of pupils are enhanced in laboratory classes in which the laboratory activities are integrated with the work in non-laboratory classes. Roth (1994:197) indicates that science in the laboratory grants pupils an opportunity to manipulate instruments and materials which will help students in their development of conceptual understanding. Such understanding motivates and encourages pupils to choose Physical Science as a school subject.

Throwbridge and Bybee (1990:232) maintain that laboratory work/activities involve the individual directly in the learning process as well as imparting skills. They further indicate that a person/pupil working on a laboratory problem/activity learn far more than just the answer to the problem. Some of the skills that pupils can learn in a laboratory activity which will later influence them to choose Physical Science as a learning area will be efficiency, self-reliance, observation, manipulation of apparatus and most importantly, learning to work on their own.

Thus, this study shows a significant positive correlation between pupils' participation in laboratory science activities and their choice of Physical Science as a school subject.

3.2.4 Textbooks

Throwbridge and Bybee (1990:253) states that:

> *... textbooks are still a basic (source) science information in science classes, and when used judiciously and with realisation of their limitations, textbooks contribute substantially to the teaching - learning situation.*

They further state that while the textbook has its good qualities like stressing important concepts, directing activities and organising information, the science teacher must always place the textbook in it's proper perspective in his/her class.

Throwbridge and Bybee (1990:253) highlight that a science textbook cannot address the main objectives of science teaching. They further assert that a textbook "... cannot provide self-reliance in solving problems" (Throwbridge & Bybee, 1990:254). Accordingly, Clark and Starr (1996:315) mention that while the textbook is the most common source of reference used in the classroom as a teaching tool, it has its own shortcomings, such as: it can be flawed, dull, represent one viewpoint, employ one style of presentation, it's content can be over the students' heads, it can fail to stimulate young readers to experiment with new ideas and it might more likely be difficult for most students to read and understand. Hence, the science textbook should be used as a "... servant and not as a dictator" of teaching and learning (Moyana, 1996:39). Excessive textbook use will probably not encourage pupils to choose science as a subject.

3.2.5 School Curriculum

According to studies conducted by Toews (1988:459) and Du Toit et al. (1992:262), it is argued that the science curriculum of that time have been designed to cater for those who will need it in their future education, hence little attention is given to application of theory. Chandavarkar, Doran and Jacobson (1991:3939) indicate that in planning future Physics education, the Physics curriculum should emphasise aspects which are relevant to students after graduation in everyday life. Furthermore, Rennie and Parker (1996:55) indicate that a Physics curriculum which is associated or related to real-world contexts is likely to enhance interest in Physics, especially among females, thus resulting in enrolments in Physical Science.

Accordingly, House (1988:305) as well as Songer and Lin (1991:766) state that teaching Physical Science can be frustrating because many pupils have little or no interest in science and pupils view science as irrelevant to their everyday life. Pupils do not see any integration between "classroom science" and their "own experience".

Krojak and Yager (1987:433) claim that the science curriculum should be integrated with students' experiences. The same sentiment is shared by Davis and Halley (1995:348) when they argue that the separation of theoretical science from practical science may influence pupils to have negative attitudes towards science and hence negatively influence the choice of Physical Science as a subject.

According to Du Toit (1991:53), the syllabus content, the theory and the abstract nature of the syllabus content can positively or negatively influence pupils' choice of Physical Science as a school subject. Lucido (1989:336) also suggests that to stimulate the interest of the pupils and thus influence them to enrol in science, the science teacher should make science relevant to pupils' everyday lives.

This can be achieved through discussing the:

> *... chemistry of the foods we eat, Physics of music that they listen to and through the television that they watch.*

Therefore, once the pupils can see the benefits of studying science on their everyday lives outside the school, they will be interested in more information about those things

(Lucido, 1989:337). In support of the above stipulations, Brickhouse (1993:122) indicates that the science curriculum should be based on the chemistry of everyday occurrences and their importance in social issues.

Moriber (1984:807) and Kennedy (1996:56) contend that there was a lack of balance between chemical principles and their applications in chemical education. Therefore, it is argued that this lack of balance is an important factor in the decline of interest in Chemistry, hence the low enrolment in Physical Science.

Morber (1984:80) further indicates that:

> *... application, enhancing the basic chemical principles could help breath new life into the teaching of Chemistry.*

Lilly (1989:32) argues that if we need more pupils to choose Physical Science as a school subject, teachers should develop programmes that emphasise technological applications of scientific principles. This will most probably leave pupils feeling good about themselves and with more positive attitudes towards science by enhancing purposeful learning.

The literature review shows a significant relationship between the views pupils have of the Physical Science curriculum and their choice of Physical Science as a school subject.

3.2.6 **Summary**

The purpose of section 3.2 is to provide a literature review on school environment variables and how they influence the choice of Physical Science as a school subject by secondary school pupils.

The literature review shows a significant relationship between the following school environment variables and choice of Physical Science as a school subject: streaming of Physical Science with Mathematics, number of school subjects enrolled, time-table constraints, proper utilization of laboratories and pupils' view of the Physical Science curriculum.

However, there is no conclusive evidence of the following school environment variables and their influence on the choice of Physical Science as a school subject: science textbooks; rules regarding the use of chemicals and the type of school.

In the next chapter, a number of specific problems and hypotheses are stated. Thereafter, the research design is explained.

CHAPTER 4

RESEARCH DESIGN

4. INTRODUCTION

In the previous two chapters, chapters 2 and 3, pupil, home environment, teacher and school environment variables were identified and their influence on choice of Physical Science as a school subject by the pupils were discussed.

This chapter focuses on the research design of this study of factors that influence the choice of Physical Science as a school subject by secondary school pupils. In this chapter, a number of specific research problems, null and research hypotheses are stated. Thereafter, the research design is explained.

4.1 GENERAL PROBLEM STATEMENT

As stated in Chapter 1 (section 1.3), the general research problem is as follows:

Which factors influence secondary school pupils in choosing/not choosing Physical Science as a subject?

4.2 SPECIFIC PROBLEM STATEMENTS

The following are specific research problem statements which were identified during the literature review that will direct the empirical research of this study:

(1) Is there a significant difference between the number of boys and girls who choose Science as a subject from grade 9?

(2) Is there a significant difference between the number of pupils from diverse age

groups who choose Science as a subject from grade 9?

(3) Is there a significant difference between the number of pupils from diverse socio-economic backgrounds who choose Science as a subject from grade 9?

(4) Is there a significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a subject from grade 9?

(5) Is there a significant difference regarding the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

The pupil variables include: attitude, interest, achievement, career expectations, gender role concept, self-concept, beliefs and age.

(6) Is there a significant difference regarding the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

The home environment variables include: attitude of the society, exposure to role models, socio-economic background and cultural background.

(7) Is there a significant difference regarding the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

Teacher variables include: teacher's attitude - towards pupils, Physical Science and gender roles, personality, competence (including level of education and experience) and methods (e.g. demonstrations, cooperative learning, discovery learning, lecture) and teacher's way of assessment.

(8) Is there a significant difference regarding the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

School environment variables include: curriculum, type of school, management policy, availability of laboratories and equipment, quality and use of the textbooks.

4.3 HYPOTHESES

4.3.1 Research Problem one

Null Hypothesis

H_{01}: There is no significant difference between the number of boys and girls who choose Science as a subject from grade 9.

Research Hypothesis

H_1: There is a significant difference between the number of boys and girls who choose Science as a subject from grade 9.

4.3.2 Research Problem two

Null Hypothesis

H_{02}: There is no significant difference between the number of pupils from diverse ages who choose Science as a subject from grade 9.

Research Hypothesis

H_2: There is a significant difference between the number of pupils from diverse ages who choose Science as a subject from grade 9.

4.3.3 Research Problem three

Null Hypothesis

H_{03}: There is no significant difference between the number of pupils from diverse socio-economic backgrounds who choose Science as a subject from grade 9.

Research Hypothesis

H_3: There is a significant difference between the number of pupils from diverse socio-economic background who choose Science as a subject from grade 9.

4.3.4 Research Problem four

Null Hypothesis

H_{04}: There is no significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a school subject from grade 9.

Research Hypothesis

H_4: There is a significant difference between the numbers of pupils from diverse levels of Science achievement who choose Science as a subject from grade 9.

4.3.5 Research Problem five

Null Hypothesis

H_{05}: There is no significant difference regarding the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

Research Hypothesis

H_5: There is a significant difference regarding the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

The pupil variables include: attitude, interest, achievement, career expectations, gender role concept, self-concept, beliefs and age.

4.3.6 **Research Problem six**

Null Hypothesis

H_{06}: There is no significant difference regarding the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

Research Hypothesis

H_6: There is a significant difference regarding the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

The home environment variables include: Society's attitudes, exposure to role models, socio-economic background and cultural background.

4.3.7 **Research Problem seven**

Null Hypothesis

H_{07}: There is no significant difference regarding the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

Research Hypothesis

H_7: There is a significant difference regarding the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

Teacher variables include: teacher's attitude - towards pupils, Physical Science and gender roles, personality, competence (including level of education and experience) and methods (e.g. demonstrations, cooperative learning, discovery learning, lecture) and teacher's way of assessment.

4.3.8 **Research Problem eight**

Null Hypothesis

H_{08}: There is no significant difference regarding the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

Research Hypothesis

H_8: There is significant difference regarding the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

School environment variables include: curriculum, type of school, management policy, availability of laboratories and equipment, quality and use of the textbooks.

4.4 THE RESEARCH DESIGN

The research methods to be used in this study will be a literature study and an empirical investigation.

From the literature review presented in Chapters 2 and 3, it is evident that the results of various sources consulted between diverse factors/variables and choice of Physical Science are inconsistent and inconclusive. Some studies established significant and high relationships, others significant but low relationships, while others reported no significant relationships.

From the literature review, no study of the relationship between various variables and pupils' choice of Physical Science has been previously documented in the Northern Province and in particular in the Malamulele district, hence the need for this study.

4.4.1 Respondents

The population will include all standard 7 pupils in the Malamulele district in the Northern Province of South Africa. Schools with science laboratories and schools without science laboratories will be identified by stratified sampling. Thereafter, two schools from each of these two groups will be randomly selected in the following manner: firstly, names of schools with science laboratories were written on pieces of paper, put in a container, shuffled and two pieces which represented two schools were picked up. Secondly, names of schools without science laboratories were written on pieces of paper, put in a container, shuffled and two pieces of paper which represented two schools were randomly picked up. Thus, four secondary schools from a total of 41 secondary schools in Malamulele district in the Northern Province will take part in the research. (All the standard 7 [grade 9] pupils from these four schools will be respondents.)

4.4.2 Instruments

A questionnaire will be used to collect data on pupil variables, home variables, teacher variables and school environment variables as well as other important data. (See Appendix A)

4.4.2.1 *Organisation of the Questionnaire*

Closed form and structured items are used in the design of the questionnaire to promote effective quantification, and to facilitate data analysis (Gay, 1992:225) and Borg and Gall (1989:428). Questions from each variable (i.e. pupil variables, home variables, teacher variables and school variables) are spread throughout the questionnaire. This placement causes questions or items from each variable to be widely separated throughout. In cases dealing with opinion-sensitive or debatable issues/items or in situations where respondents may be tempted to give prudent rather than true answers/responses, countercheck questions at some distance from each other were incorporated (Leedy, 1993:189). Thereby, consistency of the questionnaire is maintained and verified.

4.4.2.2 *Focus of the questions/items in the questionnaire*

The questionnaire has 120 items, consisting of 6 statements based on background information, 56 positive statements and 58 negative statements. The development of these items had their base in Chapters 2 and 3 and items are spread as follows:

(a) Pupil variables:

Items on pupils' attitude and choice of Science have developed from 2.1.2. Items on pupils' interest and choice Science is based on the literature survey done in 2.1.3. Items on pupils' future careers and choice of Science have developed from 2.1.6. Items measuring pupils' self-concepts and choice of Science are based on the literature survey done on 2.1.7. Questions on pupils' age and choice of Science originated from 2.1.8, whereas questions on pupils' beliefs and choice of Science are formulated from the related survey in 2.1.9. (See Appendix B)

(b) Home Environment Variables

Items measuring society's attitude towards Science and the pupil's choice of Science are formulated from related literature in 2.2.2. Items measuring pupils' exposure to role models at home and choice of Science originated from 2.2.3. Items based on pupils' cultural background and choice of Science originated from 2.2.5. (See Appendix B)

(c) Teacher Variables

Teachers' attitudes (towards pupils, Science and gender roles) and pupils' choice of Science questions originate from 3.1.2., 3.1.3 and 3.1.4. Items on teachers' personality and pupils' choice of Science are formulated from the related literature in 3.1.5. Items measuring teachers' methods of instruction and pupils' choice of Science are formulated from the related literature in 3.1.7. Items measuring teachers' assessment originated from 3.1.8. (See Appendix B)

(d) School Environment Variables

Items measuring the type of school and pupils' choice of Science originated from 3.2.2. Items measuring the role of the management policy and pupils' choice of Science are developed from 3.2.3. Items measuring the availability of Science laboratories and equipment and pupils' choice of Science are formulated from related literature in 3.2.3.6. Items measuring the availability/nature/condition of the Science textbooks and pupils' choice of Science originated from 3.2.3. Items related to school curriculum and pupils' choice of Science are formulated from the literature survey in 3.2.5. (See Appendix B)

4.4.3. Procedures

Permission for administering questionnaires in secondary schools in the Malamulele area was requested from the Malamulele area office (Department of Education, Sports and Culture). A list of schools in the area was requested and obtained. Cluster sampling was used to select schools to be used as samples as indicated in 4.5.1. The researcher made appointments with principals of selected schools to arrange dates for the administration of the questionnaires to all standard 7 (grade 9) pupils.

4.4.4 Pilot Study

A pilot study with one class of 25 standard 7 (grade 9) pupils of a school not included in the research was conducted. A number of problems with the wording of items came to light. Necessary changes, adjustments and refinements were made accordingly.

4.5 VALIDITY

"Validity is concerned with the soundness, the effectiveness of the measuring instruments" (Leedy, 1993:40).

4.5.1 Content Validity

According to Leedy (1993:41), content validity is

> *... the accuracy with which an instrument measures the factors or situation, i.e. the content being studied.*

Thus, how well the questionnaire will be able to cover all the variables identified and discussed through the literature review in Chapters 2 and 3.

The questionnaire was given to experts in the field in order to check the content validity.

4.5.2 Face Validity

Face validity relies upon the subjective judgement of the researcher. According to Leedy (1993:41), face validity asks two questions, namely:

(a) *Is the instrument measuring what it is supposed to measure?*

(b) *Is the sample being measured adequate to be representative of the behaviour or trait being measured?*

Thus, face validity is a matter of judgement.

The questionnaire was given to experts in the field in order to check the face validity of the questionnaire.

4.6 RELIABILITY

Leedy (1993:43) and McMillan and Schumacher (1993:227) refers to reliability as the accuracy or the consistency of measurement, i.e. the extent to which the results remain similar over different forms of the same instrument. Therefore, if a measuring instrument is reliable, the information will be reliable. Hence "similar results will be obtained if the same instrument is used more than once" (Moyana, 1996:96).

Reliability was checked by means of computer analysis which calculated the Cronbach alpha correlation coefficient of the 7 items. This is a split-half method.

4.7 ANALYSIS OF DATA

4.7.1 Statistical Techniques

The following statistical techniques may be used to test the hypotheses as listed under 4.4:

(a) Chi-square for (H_{01}) to (H_{04})

(b) T-Tests for (H_{05}) to (H_{08})

4.8 SUMMARY

This chapter focussed on the investigation of the research problem statements under 4.3 by using an empirical research design. The various statistical techniques that are to be used in testing the hypotheses in this research were also identified (4.8.1).

In the next chapter, the results of the empirical investigations with regard to pupil variables and school environment variables as well as teacher variables and school environment variables will be presented and discussed.

CHAPTER 5

RESULTS AND DISCUSSION OF RESULTS

5.1 INTRODUCTION

As explained in Chapter I, this study was motivated by a concern about the small number of pupils that choose Science as a school subject up to matric level. According to the literature study a number of variables may be involved in influencing pupils to choose or not to choose Science as a subject. By studying these variables from the literature, a number of specific problems came to the fore which had to be addressed to enable recommendations which may improve the situation:

Problem 1: Is there a significant difference between the number of boys and girls who choose Science as a subject from grade 9?

Problem 2: Is there a significant difference between the number of pupils of diverse ages who choose Science as a subject from grade 9?

Problem 3: Is there a significant difference between the number of pupils from diverse socio-economic backgrounds who choose Science as a subject from grade 9?

Problem 4: Is there a significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a subject from grade 9?

Problem 5: Is there a significant difference regarding the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

Problem 6: Is there a significant difference regarding the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

Problem 7: Is there a significant difference regarding the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

Problem 8: Is there a significant difference regarding the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

The research design of the empirical investigation (as described in Chapter 4) focused on these aforementioned problems and the hypotheses which were stated accordingly.

The remainder of this chapter is a description of the biographical data of the respondents and the results which were obtained after analysis of the questionnaires. These are given in 26 tables.

5.2 BIOGRAPHICAL INFORMATION

The sample consisted of 849 respondents which may be divided into categories as follows:

gender: males = 373
females = 421
missing = 55

age: 15 and less = 389
16 = 146
17 = 110
18 = 59
19 = 45
20 = 41
missing = 59

monthly income of father:

none = 165

R1-R999 = 72

R1000-R2999 = 76

R3000-R6999 = 34

R7000+ = 22

Uncertain = 414

missing = 66

monthly income of mother:

none = 292

R1-R999 = 59

R1000-R2999 = 48

R3000-R6999 = 29

R7000+ = 26

Uncertain = 338

missing = 57

Usual scores in Science tests or examinations:

0-19% = 85

20-39% = 188

40-59% = 238

60-79% = 132

80% + = 135

missing = 71

5.3 RESULTS

5.3.1 Problem 1

Is there a significant difference between the number of boys and girls who choose Science as a subject from grade 9?

H_0: There is no significant difference between the number of boys and girls who choose Science as a subject from grade 9.

H_1: There is a significant difference between the number of boys and girls who choose Science as a subject from grade 9.

To test this hypothesis a chi-square value was calculated. The results are as follows:

Table 1 Chi-square value and probability of the number of boys and girls who choose Science as a subject

Gender	Df	chi square-value	probability
male = 292 female = 302	1	4,503	$p<0,05$

Missing = 55

Contrary to what one would have expected, according to Table 1 significantly more girls than boys choose Science as a school subject. This is on the 5-% level of significance ($p<0,05$).

5.3.2 **Problem 2**

Is there a significant difference between the number of pupils of diverse ages who choose Science as a subject from grade 9?

H_0: There is no significant difference between the number of pupils of diverse ages who choose Science as a subject from grade 9.

H_2: There is a significant difference between the number of pupils of diverse ages who choose Science as a subject from grade 9.

To test this hypothesis a chi-square value was calculated. The results are as follows:

Table 2 Chi-square value and probability of the number of pupils of diverse ages who choose Science as a subject

Age	Df	chi square-value	probability
<=15 = 389 16 = 146 17 = 110 18 = 59 19 = 45 20 = 41	5	8,037	$p>0,05$

Missing = 59

Table 2 indicates that there is no significant difference between the number of pupils of diverse ages who choose Science as a subject from grade 9.

5.3.3 **Problem 3**

Is there a significant difference between the number of pupils from diverse socio-economic backgrounds who choose Science as a subject from grade 9?

H_0: There is no significant difference between the number of pupils from diverse socio-economic backgrounds who choose Science as a subject from grade 9.

H_3: There is a significant difference between the number of pupils from diverse socio-economic backgrounds who choose Science as a subject from grade 9.

To test this hypothesis a chi-square value was calculated. The results are as follows:

Table 3 Chi-square value and probability of the number of pupils with fathers of diverse incomes who choose Science as a subject

Income	Df	chi square-value	probability
none = 165 R1-R999 = 72 R1000-R2999 = 76 R3000-R6999 = 34 R7000+ = 22 Don't know = 414	 5	 6,068	 p>0,05

Missing = 66

According to Table 3, there is no significant difference between the number of pupils with fathers of diverse incomes who choose Science as a subject from grade 9.

Table 4 Chi-square value and probability of the number of pupils with mothers of diverse incomes who choose Science as a subject

Income	Yes	No	Df	chi square-value	probability
none = 292 R1-R999 = 59 R1000-R2999 = 48 R3000-R6999 = 29 R7000+ = 26 Don't know = 338	223 25 40 22 18 264	69 34 8 7 8 74	 5	 37,502	 p<0,01

Missing = 57

According to Table 4 there is a significant difference between the number of pupils with mothers from diverse incomes who choose Science as a subject from grade 9. When the figures are studied, the trend is not clear. However, it does seem that as income grows (from R1000-R2999 to R3000-R6999 to R7000+), there are progressively more children who choose Science as a subject than children who do not choose Science (40 as opposed to 8; 22 as opposed to 7 and 18 as opposed to 8.)

5.3.4 **Problem** 4

Is there a significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a subject from grade 9?

H_0: There is no significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a subject from grade 9.

H_4: There is a significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a subject from grade 9.

To test this hypothesis a chi-square value was calculated. The results are as follows:

Table 5 Chi-square value and probability of the number of pupils with various scores in Science who choose Science as a subject

Usual test score	Yes	No	Df	chi square-value	probability
0-19% = 85	46	39			
20-39% = 188	122	66			
40-59% = 238	180	58			
60-79% = 132	119	13			
80% + = 135	114	21	4	52,157	p<0,01

Missing = 71

Table 5 shows that there is a significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a subject from grade 9. When the frequencies are studied, it shows clearly that the better pupils do at Science, the more likely that they would choose Science as a school subject.

5.3.5 Problem 5

Is there a significant difference regarding the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

H_0: There is no significant difference regarding the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

H_5: There is a significant difference regarding the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

To test this hypothesis t-values were calculated. The averages of the seven pupil variables alone were used (namely attitude, interest, career, gender role, self-concept, age and beliefs) for those pupils who choose science and those who do not. The results are depicted in Tables 6 to 12:

Table 6 T- value and probability of the *attitude towards Science* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,5769 3,2502	6,0194	816	p < 0,01

Table 7 T- value and probability of the *interest in Science* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,7551 3,2131	8,0046	816	p < 0,01

Table 8 T- value and probability of the *value of Science for choice of career* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,5448 3,0461	8,3152	816	p < 0,01

Table 9 T- value and probability of the *self-concepts* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,6445 3,0933	8,0366	816	p < 0,01

Table 10 T- value and probability of the *gender role -concept* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,2758 3,1821	1,6382	816	p > 0,05

Table 11 T- value and probability of influences at a *younger age* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,5260 3,2667	4,1057	817	p < 0,01

Table 12 T- value and probability of *beliefs about Science* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,4038 3,2281	3,1726	817	$p < 0,01$

If Tables 6 to 12 are studied, it seems that there are significant differences (on the 1-% level since p<0,01) between pupils who plan to take Science as a school subject, and those who do not plan to take Science as a school subject with regard to six of the seven variables, namely: attitude, interest, career choice, self-concept, age and beliefs. Pupils who want to take Science as a school subject have significantly more positive attitudes towards and interest in Science. In contrast to those pupils who do not plan to take Science, they feel that it is an important subject for future career options, they have significantly more positive self-concepts, they enjoyed Science at primary school age and they believe that Science is a subject that has to be understood.

Only with regard to gender role concept is there no significant difference between pupils who plan to take Science as a school subject, and those who do not plan to take Science as a school subject since the probability is greater than 0,05.

5.3.6 **Problem 6**

Is there a significant difference regarding the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

H_0: There is no significant difference regarding the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

H_6: There is a significant difference regarding the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

To test this hypothesis t-values were calculated. The variables on which the questionnaire focused included society's attitude, exposure to role models, cultural background and socio-economic background. Tables 13 to 16 indicate the results.

Table 13 T- value and probability of *society's attitude* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,5077 3,1778	4,2118	815	$p < 0{,}01$

Table 14 T- value and probability of *exposure to role models* of pupils who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,5266 3,1548	7,6379	816	$p < 0{,}01$

Table 15 T- value and probability of pupils from *diverse cultural backgrounds* who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,1544 3,1411	0,1661	816	p > 0,05

Table 16 T- value and probability of pupils with diverse *socio-economic background* who choose or do not choose Science as a subject

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,3957 3,1579	5,0750	816	p < 0,01

According to Tables 13 to 16 there are significant differences (on the 1%-level since p<0,01) between pupils who choose Science as a school subject and those who do not choose Science as a school subject with regard to three of the four *home environment* variables, namely society's attitude, exposure to role models and socio-economic background. Pupils who plan to choose Science as a school subject view Science as a valuable subject for our daily lives, have among other things, parents who are positive towards Science and come from a better socio-economic backgrounds than those pupils who do not plan to take Science.

Only with regard to cultural aspects (such as superstition) were no significant differences found between the two groups of people since the probability is greater than 0,05.

5.3.7 **Problem 7**

Is there a significant difference regarding the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

H_0: There is no significant difference regarding the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

H_7: There is a significant difference regarding the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

To test this hypothesis t-values were calculated. The variables on which the questionnaire focused included the following five: teacher's attitude, personality, competence, methods and teacher's way of assessment. Tables 17 to 21 portray the results.

Table 17 T- value and probability of pupils who choose or do not choose Science as a subject and with teachers with diverse *attitudes*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 610 No = 209	3,3914 3,2560	3,0880	817	$p < 0{,}01$

Table 18 T- value and probability of pupils who choose or do not choose Science as a subject and with teachers with diverse *personalities*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,2305 3,0742	2,8987	816	$p < 0,01$

Table 19 T- value and probability of pupils who choose or do not choose Science as a subject and with teachers with diverse *competence*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,2367 3,1262	2,5242	816	$p < 0,05$

Table 20 T- value and probability of pupils who choose or do not choose Science as a subject and with teachers with diverse *methods*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	2,9481 2,9371	0,2067	816	$p > 0,05$

Table 21 T- value and probability of pupils who choose or do not choose Science as a subject and with teachers with diverse *ways of assessment*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,0744 2,9406	2,1629	816	p < 0,05

According to Tables 17 to 21, there are significant differences (on the 1%- or on the 5%-level since p<0,01 or p<0,05 respectively) between pupils who choose Science as a school subject and those who do not choose Science as s school subject regarding their perception of teachers. Pupils who choose Science as a school subject view the attitudes, the personalities, the competence and the methods of assessment of their Science teachers significantly more positively than those who do not choose Science for matric.

Only with regard to their views of the methods the teachers use is there no significant difference between the two groups of pupils since p>0,05.

5.3.8 **Problem 8**

Is there a significant difference regarding the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

H_0: There is no significant difference regarding the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

H_8: There is a significant difference regarding the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

To test this hypothesis t-values were calculated. The variables on which the questionnaire focused included the following five: curriculum, type of school, management policy, availability of laboratories and textbooks. The results are in Tables 22 to 26.

Table 22 T- value and probability of pupils who choose or do not choose Science as a subject and their views of the *curriculum*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,5064 3,2088	5,0443	816	$p < 0,01$

Table 23 T- value and probability of pupils who choose or do not choose Science as a subject and their views of the *type of school they are in*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,1754 3,1096	1,1592	816	$p > 0,05$

Table 24 T- value and probability of pupils who choose or do not choose Science as a subject and their views of the *management policy of the school they are in*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,2813 3,2317	0,8679	816	p > 0,05

Table 25 T- value and probability of pupils who choose or do not choose Science as a subject and their views of their *science laboratories*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	2,9403 2,8481	1,3391	816	p > 0,05

Table 26 T- value and probability of pupils who choose or do not choose Science as a subject and their views of their *textbooks*

Choose Science as a school subject	Mean	t-value	df	probability
Yes = 609 No = 209	3,4316 3,2169	2,7395	816	p < 0,01

According to Tables 22 to 26, there are significant differences (on the 1%- level since $p<0,01$) between pupils who choose Science as a school subject and those who do not choose Science as a school subject regarding their perception of the science *curriculum* and their science *textbooks*. Pupils who choose Science as a school subject view the science curriculum and textbooks significantly more positively than those who do not choose Science for matric.

With regard to their views of the type of school they are in, the management policies of these schools and the science laboratories at their schools, there are no significant differences between the two groups of pupils since $p>0,05$.

5.4 SUMMARY

In this chapter the research problems and hypotheses were restated. The results of the empirical investigation were given and discussed. In Chapter 6, the final chapter, conclusions are made as well as recommendations for improving the number of pupils who choose Science as a matric subject.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The focus of this study is to investigate the different factors (variables) that influence learners' choice of Physical Science as a subject at secondary school level. The variables are identified as: home environment variables, teacher variables, pupil variables and school environment variables. Despite a number of similar/related studies in other countries, there has been hardly any empirical study conducted in South Africa in general, and in the Malamulele Area in the Northern Province in particular. Hence the need for this study. Thus the findings of this empirical study will, among other things, add to the field of knowledge as described in the literature study where the significant factors that may influence secondary school pupils' choice of Physical Science as a school subject in South Africa are highlighted.

The researcher formulated a general problem statement, specific and general aims, eight specific problem statements and their respective hypotheses to guide him in conducting this study.

6.1.1 General Problem Statement

Which factors influence secondary school pupils to choose or not to choose Physical Science as a school subject?

6.1.2 Specific Aims

This research attempts to:

(i) identify and discuss factors which may significantly influence secondary school pupils to choose or not to choose Physical Science and

(ii) make recommendations on how the adverse influences can be minimised in the short as well as the long term.

6.1.3 General Aims

The general aims of this study are as follows:

(a) To create awareness, amongst the stakeholders, of the influence of various factors that positively or negatively affect choice of Physical Science at school.

(b) To make a contribution to the Government's plans to channel the country's resources in developing manpower in fields such as medicine, engineering, technology and other related areas. This may enable South Africa to compete internationally in the fields of Science and technology.

(c) To guide the planners of education and curricula to perform their duties more effectively.

(d) To provide education specialists with information that will assist them with the implementation of Physical Science policies, teaching methods and strategies based on and beyond the envisaged Curriculum 2005.

6.1.4 Problem Statements and Null-Hypotheses

The following eight specific problem statements and their respective null hypotheses were formulated to guide the researcher in conducting this empirical study:

6.1.4.1 *Problem Statement 1*

Is there a significant difference between the number of boys and girls who choose

Physical Science as a subject from grade 9?

H_{01}: There is no significant difference between the number of boys and girls who choose Physical Science as a school subject from grade 9.

6.1.4.2 ***Problem Statement 2***

Is there a significant difference between the number of pupils of diverse ages who choose Physical Science as a school subject from grade 9?

H_{02}: There is no significant difference between the number of pupils of diverse ages who choose Physical Science as a subject from grade 9.

6.1.4.3 ***Problem Statement 3***

Is there a significant difference between the number of pupils from diverse socio-economic backgrounds who choose Physical Science as a subject from grade 9?

H_{03}: There is no significant difference between the number of pupils from diverse socio-economic backgrounds who choose Physical Science as a subject from grade 9.

6.1.4.4 ***Problem Statement 4***

Is there a significant difference between the number of pupils from diverse levels of achievement who choose Physical Science as a subject from grade 9?

H_{04}: There is no significant difference between the number of pupils from diverse levels of Science achievement who choose Physical Science as a subject from grade 9.

6.1.4.5 ***Problem Statement 5***

Is there a significant difference in the average influence of pupil variables between the pupils who choose Physical Science as a subject from grade 9 and the pupils who do not choose Physical Science as a subject from grade 9?

H_{05}: There is no significant difference in the average influence of pupil variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

These variables are: attitude towards Science, interest in Science, value of Science for choice of career (career aspirations), self-concept, age and beliefs about Science.

6.1.4.6 *Problem Statement 6*

Is there a significant difference in the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?
H_{06}: There is no significant difference in the average influence of home environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

These variables are: society's attitude, exposure to role models, socio-economic background and cultural background.

6.1.4.7 *Problem Statement 7*

Is there a significant difference in the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?
H_{07}: There is no significant difference in the average influence of teacher variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

These variables are: teachers' attitudes towards pupils, Physical Science and gender roles, teachers' personalities, competencies (including level of education and experience) and methods of teaching and assessment.

6.1.4.8 ***Problem Statement 8***

Is there a significant difference in the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9?

H_{08}: There is no significant difference in the average influence of school environment variables between the pupils who choose Science as a subject from grade 9 and the pupils who do not choose Science as a subject from grade 9.

These school environment variables are: curriculum, type of school, management policy, availability of laboratories and equipment, quality and use of the textbooks.

6.2 CONCLUSIONS

6.2.1 Conclusions from the Literature Study

6.2.1.1 ***Problem Statement 1***

A review of previous research reveals that there is a significant difference between the number of boys and girls who choose Physical Science as a subject at secondary school: More boys choose Physical Science as a subject at school. (See section 2.1.6). In addition it was found that Biology with Chemistry is the most popular combination for girls, while Chemistry with Physics (Physical Science) is more popular with boys.

6.2.1.2 ***Problem Statement 2***

The literature review suggests that age may influence interest in Science. It is found that pupils' interest and enthusiasm in Science is high at the ages of 13 to 14 years, (grade 9 and 10) but that this enthusiasm diminishes from grade 11 to 12. (See section 2.1.8).

6.2.1.3 ***Problem Statement 3***

The literature review on socio-economic status and choice of Physical Science as a school subject by secondary school pupils is inconclusive. Some researchers report a significant difference between the number of pupils from diverse socio-economic backgrounds who choose Physical Science as a subject. However, contrary to the above findings, other researchers report that parents or parental education does not have any significant influence on choice of Physical Science as a school subject (See section 2.2).

6.2.1.4 ***Problem Statement 4***

The literature review is inconclusive on whether there is a significant difference between the number of pupils from diverse levels of Science achievement who choose Physical Science as a school subject in secondary school. Most research findings suggest that pupils who achieve well in Physical Science may be inclined to choose the subject for study up to matric level. However, some research findings reveal no significant difference between the number of pupils from diverse levels of Science achievement who choose Science as a school subject. (See section 2.1.4).

6.2.1.5 ***Problem Statement 5***

* Pupil Variables

(i) Attitude towards subject content and the teacher

Most previous studies reveal the significant role played by the attitudes of pupils towards Science content in influencing the choice of Science as a subject at secondary school. Pupils who view Science content negatively will not be inclined to choose Physical Science as a subject. On the other hand, pupils who view Science content positively will most probably choose Physical Science as a school subject. However, not all research confirms this. (See section 2.1.2.1).

Regarding pupils' attitudes towards their teachers, previous studies report a significant, positive correlation between pupils' enjoyment of Physics and their perception of their teachers' behaviour as friendly, helpful, strict and leading. Furthermore, if pupils perceive their teachers positively they are inclined to choose Physical Science as a school subject. (See section 2.1.2.2).

(ii) Pupils' interest

The literature study reveals a significant difference in interest in Science between those pupils who choose Physical Science and those who do not choose Physical Science as a school subject: Pupils who are interested in Science are inclined to choose it as a subject. However, some researchers disagree. (See section 2.1.3).

(iii) Career aspirations

The literature review reveals a significant difference in the career aspirations of pupils between those who choose Physical Science and those who do not choose Physical Science as a school subject at secondary school. (See section 2.1.5). However, other researchers report that while the possibility of a career in Science can influence pupils' choice of Physical Science at secondary school, it should be noted that it is not the most dominant factor persuading pupils to choose this subject.

(iv) Pupils' self-concepts

The literature review reports a significant difference in self-concept between pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject: Pupils who choose Physical Science as a subject have positive Science self-concepts and positive self-concepts in general. Conversely, pupils who do not choose Physical Science as a subject have negative self-concepts towards

Science and towards themselves as individuals. (See section 2.1.7).

(v) Pupils' age

In section 2.1.8 it is revealed that there is a significant difference in the number of pupils of diverse ages who plan to choose Physical Science as a school subject: Pupils at the ages of 13-14 years (probably in grades 9 and 10) may be more willing to choose Science as a subject while interest in Science drops for the 16-18 year old pupils.

(vi) Pupils' views/beliefs

The literature review in section 2.1.9 shows a significant difference in the views/beliefs of pupils towards Science between those pupils who choose Physical Science as a school subject and those who do not choose Physical Science as follows: Those who have the most productive beliefs about the nature of Science (they view Science as understandable, interpretive and integrated with many activities in the world around them) are more inclined to choose Physical Science as a school subject. On the other hand, those pupils who view Science knowledge as static, as characterised by the intensive memorisation of isolated information and mathematical principles from textbooks and as isolated from everyday knowledge are not interested to choose Physical Science as a school subject.

(vii) Pupils' gender role concepts

The literature review reports a significant difference in gender role concepts between pupils who choose Science as a subject and those who do not choose Science as a subject at secondary school level. Hence more boys choose Physical Science as a school subject at secondary school level than girls. (See section 2.1.6.1).

The literature review on gender roles and exposure reveals that the availability of female role models in scientific careers may remove existing gender role stereotypes and influence girls to choose Physical Science as a school subject. (See section 2.1.6.2).

Contrary to the above view one study found that visits by female role models to secondary schools as role models led to no significant change/difference in the pupils' choice of Physical Science as a school subject. Thus research on this aspect is inconclusive.

In section 2.1.6.3 the literature study on gender roles and Science textbooks reports that Science textbooks which are gender biased may significantly influence pupils' choice of Physical Science as a school subject at secondary school level negatively, especially for girls.

The literature review on gender roles and the perception of society reveals that society's gender bias regarding Science may also significantly inhibit girls to choose Physical Science as a school subject. (See section 2.1.6.4).

In conclusion, the literature study on pupil variables indicates that all seven pupil variables may play a significant role to influence pupils to choose or not to choose Physical Science as a school subject. These variables include: *attitude, interest, career aspirations, self-concept, age, beliefs about Science* and *gender role concepts*. The evidence on the influence of *gender role stereotypes* and pupils' *exposure to role models* as factors that can influence the choice of Physical Science as a school subject at secondary school level is inconclusive.

6.2.1.6 ***Problem Statement 6***

(i) Society's attitude towards Physical Science

Research on the influence of society's attitude on the choice of Physical Science as a school subject reports it to be a significant variable: More pupils from societies which have positive attitudes towards Science will choose Physical Science as a school subject at secondary school level. On the other hand only a few pupils from societies with negative attitudes towards Science will choose Physical Science as a school subject at secondary school level. (See section 2.2.2).

(ii) Pupils' exposure to Science

The literature study on pupils' exposure to Science shows that this may play a significant role in influencing them to choose Science at school. (See section 2.2.3.1). Some researchers report a significant correlation between pupils' exposure to role models in Science at home and their choice of Physical Science as a school subject at secondary school level. Others report that parents as role models have a very strong positive influence on their childrens' choice of subject(s). Contrary to the above view, still others report that there is no significant difference regarding pupils exposure to role models in Science at home and their choice of Physical Science as a school subject at secondary school. Furthermore, extrinsic factors such as parents, may be *less* effective in influencing students' choice of Physical Science as a school subject at secondary school level. (See section 2.2.3.2).

(iii) Parents' socio-economic status

There is inconclusive evidence on the influence of parents' socio-economic status on pupils' choice of Physical Science at secondary school. Researchers report a significant difference in socio-economic status of parents between those pupils who choose Science and those pupils who do not choose Science. In contrast, others reveal that there is no significant relationship between the socio-economic status of parents and their childrens' choice of Physical Science as a school subject. (See section 2.2.4).

(iv) Cultural background

The literature on cultural background and choice of Science as a school subject is contradictory. Some researchers report a significant difference between pupils who choose

Science and those who do not choose Science as a subject when cultural background is taken into consideration. For example, it is very difficult to influence pupils in Africa to choose Physical Science as a school subject because of their superstitious beliefs. Contrary to the above, it is also reported that an African world-view does not significantly influence achievement in Science. Thus, if an African world-view does not influence achievement negatively, then an African world-view will most probably not inhibit choice of Physical Science as a subject. (See section 2.2.5).

6.2.1.6 ***Problem Statement 7***

(i) Teachers' attitudes

The literature review on teachers' attitudes towards pupils indicates a significant, positive correlation between this variable and pupils' choice of Physical Science as a subject at secondary schools. Teachers with positive attitudes towards pupils will influence the pupils in their classes to have positive attitudes towards Science and thus choose it as a subject at secondary school level. (See section 3.1.2).

The literature review on teachers' attitudes towards Physical Science (section 3.1.3). reveals a significant positive correlation between teachers' attitudes towards Science and pupils' choice of Science as a secondary school subject. Furthermore, teachers with positive attitudes towards their subject are most probably more motivating than those with less positive attitudes towards their subject. Thus if teachers hold positive attitudes towards Physical Science, their pupils may also develop positive attitudes and consequently choose Physical Science for further studies.

The literature study (section 3.1.4) reveals a significant difference regarding teachers' attitudes towards gender roles between those pupils that choose Science and those that do not choose Science as subject: Teachers who are gender biased against females will consciously or unconsciously discourage females to enrol/choose Physical Science as a school subject .

(ii) Teachers' personalities

Previous studies on teachers' personalities (described in section 3.1.5) reveal a significant influence on the choice of Physical Science as a subject by secondary school pupils. Uncertain behaviour by a teacher has a negative influence on pupils' choice of Physical Science as a school subject. Therefore, teachers' personalities will significantly influence the choice of Physical Science as a subject by secondary school pupils.

(iii) Teachers' competencies

Research on the influence of a teachers' education on choice of Physical Science as a school subject by secondary school pupils is inconclusive. (See section 3.1.6). Most studies reveal a significant influence of teacher's competence on choice of Physical Science by secondary school pupils. Thus, teachers who are highly qualified in Science (Physical Science) will most probably influence more students to choose Science (Physical Science) as a school subject. Furthermore, low enrolments in Physics are caused more by teachers' constraints due to low qualifications in their subject areas, than lack of potential students.

The literature study on teachers' experience and choice of Physical Science as a school subject indicates the significant role this aspect may play. (See section 3.1.6.2). The more experienced teachers may influence pupils to choose Physical Science as a school subject at secondary school level.

(iv) Teachers' methods

In section 3.1.7 the literature review reveals the significant role of the use of cooperative learning, discovery learning and demonstration methods in class to motivate pupils to choose Physical Science at school. However, the literature review also reveals a significant, negative correlation between pupils' choice of Physical Science as a school subject and the use of the lecture method. Thus the use of demonstrations, discovery learning and cooperative learning will encourage more pupils to choose Physical Science as a subject, while the constant use of the lecture method will most probably discourage pupils to choose Physical Science as one of their school subjects at secondary school level.

(v) Assessment methods

In section 3.1.8 the literature study indicates that the teachers' assessment methods may influence pupils' choice of Physical Science as a school subject as follows: Boys prefer questions that focus on real-life contexts and calculations, while girls prefer to answer questions requiring verbal answers.

In conclusion, the literature review on teacher variables show that they may significantly influence pupils' choice of Physical Science at secondary school level. These variables include: *attitude, personality, teaching methods* and *assessment methods.* However, the literature review on *teachers' competencies* and pupils' choice of Physical Science as a subject is inconclusive.

6.2.1.8 ***Problem Statement 8***

(i) Curriculum

The literature review (discussed in section 3.2.5) reveals a significant influence of pupils' views of the Science curriculum on their decision to choose or not to choose Physical Science as a school subject. If pupils view the curriculum as relevant they are more inclined to choose Science at school.

(ii) Type of school

According to the literature review, there is a significant difference in the views of their school between those pupils who choose Physical Science as a school subject and those pupils who do not choose Science. Apart from this, pupils in single-sex and co-educational schools (especially girls) achieve better in Science than those in mixed-sex schools. Due to their high achievements in Science, girls from single-sex schools are inclined to choose Physical Science as a school subject. Conversely, females from mixed -sex schools may be less motivated to choose Physical Science as a school subject because of their poor achievement in Science at school. (See section 3.2.2).

(iii) Management policy

In section 3.2.3.2, the literature review shows a significant influence of the streaming of Physical Science with Mathematics on choice of Physical Science as a school subject by secondary school pupils.

The literature review (in section 3.2.3.3) also reveals that the number of subjects that a pupil is allowed to register for may influence pupils to choose or not to choose Physical Science as a subject at secondary school level: The more subjects a pupil is allowed to register for, the higher the chances that such a pupil may choose Physical Science as one of his/her subjects at school.

The literature review on time-table constraints (described in section 3.2.3.4) reveals that if Physical Science alternate with traditional female subjects like needlework and clothing, home economic and housecraft, more females will probably decide not to choose Physical Science as a subject.

(iv) Science laboratories and equipment

The literature review (in section 3.2.3.6) indicates that the availability of Science laboratory equipment at school may motivate pupils to choose Physical Science as a school subject at secondary school.

(v) Science textbooks

The literature review reveals that excessive use of Science textbooks will inhibit pupils to choose Physical Science as a subject at secondary school. (See section 3.2.4). The way pupils view their textbooks also play a role: Thus pupils who view their Science textbooks positively will be encouraged to choose Physical Science as a subject. Conversely, pupils who view their textbooks negatively will most probably refrain from choosing Physical Science as a school subject at secondary school level.

In conclusion, the literature review reveals the significant role all five school environment variables may play to influence pupils' choice of Physical Science as a school subject at secondary school level. The variables are as follows: the *Science curriculum, type of school, management policy at school, availpbility of Science laboratories and equipment*, and *Science textbooks*.

6.2.2 Conclusions From the Empirical Investigation

6.2.2.1 ***Problem Statement 1***

Since the probability is less than 0.05, H_{01} is rejected on the 5% level. Hence the empirical research of this study establishes a significant difference between the number of boys and girls who choose Physical Science as a school subject from grade 9. Contrary to the literature study, this study reveals that more girls than boys in the Malamulele district choose Physical Science as a school subject. However, more girls than boys took part in the research: (males = 373 and females = 421).

6.2.2.2 ***Problem Statement 2***

In contrast with the literature review, this study establishes no significant difference between the number of pupils of diverse ages who choose Physical Science as a subject from grade 9. Thus H_{02} may not be rejected.

6.2.2.3 ***Problem Statement 3***

Since the probability is greater than 0.05, H_{03} may not be rejected. Thus the empirical study finds no significant difference between the number of pupils with fathers of diverse incomes who choose Physical Science as a school subject from grade 9.

However, in accordance with previous research, this study establishes a significant difference between the number of pupils with mothers from diverse incomes who choose Physical Science as a subject from grade 9. This difference is significant on the 1%-level ($p < 0.01$). Therefore, the null hypothesis (H_{03}) is rejected on the 1%-level of significance. As mothers' incomes grow, there is progressively more chance that there children will choose Physical Science as a subject at secondary school level.

6.2.2.4 ***Problem Statement 4***

Since the probability is less than 0.0.1, the null hypothesis (H_{04}) is rejected on the 1%-level of significance. Thus this research establishes a significant difference on the 1%-level of significance between the number of pupils from diverse levels of Science achievement who choose Physical Science as a school subject from grade 9. The better pupils achieve in Science, the more likely that they will choose to study Science.

6.2.2.5 ***Problem Statement 5***

In accordance with the literature study, this study establishes a significant difference on the 1%-level (since $p< 0.01$) between pupils who plan to take Physical Science as a school subject and those who do not plan to take Physical Science as a school subject with regard to six of the seven pupil variables namely: attitude/interest, career choice/aspirations, self-concept, age and beliefs. Thus the null hypothesis (H_{05}) with regard to the above pupil variables is rejected on the 1%-level of significance. Pupils who want to take Science as a school subject have significantly more positive attitudes towards and interest in Science. They feel that it is an important subject for future career options, have positive Science self-concepts, enjoyed Science at primary school and believe that Science is a subject that has to be understood.

The empirical study establishes no significant difference with regard to gender role concepts between pupils who plan to take Physical Science and those who do not plan to take Physical Science as a school subject. (The probability is greater than 0.05, thus the null hypothesis may not be rejected with regard to this aspect.)

6.2.2.6 ***Problem Statement 6***

The empirical study establishes a significant difference on the 1%-level between pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject with regard to three home environment variables namely: society's *attitude towards Science*, *exposure to role models*, the *parents' socio-economic background*. (Thus the null-hypothesis, H_{06}, is rejected.) Pupils who plan to choose Science at school view Science as a valuable subject for our daily lives, have, among other things, parents who are positive towards Science and come from a better socio-economic background that those pupils who do not plan to take Science.

The empirical study also reveals no significant difference (since $p>0,05$) between the pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject with regard to one home environment variable, namely: cultural background. In this regard the null hypothesis may not be rejected.

6.2.2.7 ***Problem Statement 7***

The empirical study reveals that there is a significant difference on the 1%-level or on the 5%-level (since $p< 0.01$ or $p< 0.05$) between the pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject with regard to four of the teachers variables namely: *attitudes, personalities, competencies* and *methods of assessment.* Hence the null hypothesis H_{07} may be rejected at the 1%-level or on the 5%-level of significance. Pupils who choose Science as a school subject view the attitudes, the personalities, the competencies and the methods of assessment of their Science teachers more positively than those who do not choose Science for matric.

The empirical study further reveals no significant difference between the pupils who choose Physical Science as a subject and those who do not choose Physical Science as a school subject regarding *teaching methods* used by the Physical Science teacher in Science classes since $p > 0.05$. In this regard the null hypothesis may not be rejected.

6.2.2.8 ***Problem statement 8***

This research finds a significant difference on the 1%-level of significance between the pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject with regard to their perceptions of the Science curriculum and their Science textbooks since the probability is less than 0.01. (Hence the null hypothesis, H_{08}, may be rejected at 1%-level of significance.) Pupils who choose Science as a school subject view the Science curriculum and textbooks more positively than those who do not choose Science for matric.

However, the empirical study reveals no significant difference between the pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject regarding *management policies* of the school, *availability of Science laboratories and equipment*, and the *type of school* - since the probability is greater than 0.05. Therefore the null hypothesis cannot be rejected.

6.2.3 Final Conclusions From Literature Study and Empirical Research

6.2.3.1 ***Problem Statement 1***

Both the literature review and this study establish a significant difference between the number of boys and girls who choose Physical Science as a subject in secondary school. Contrary to what would have been expected from the literature review (more boys choose Physical Science as a school subject than girls in secondary school) the empirical investigation reveals that in the Malamulele district there may be more girls than boys that choose Physical Science as a school subject.

6.2.3.2 ***Problem Statement 2***

Contrary to the literature review which suggests a significant difference between the number of pupils of diverse ages who plan to take Physical Science as a school subject in secondary school (pupils lose interest as they grow older) the empirical investigation reveals that there is no significant difference between the number of pupils of diverse ages who plan to choose Science as a school subject in secondary school level in the Malamulele district.

6.2.3.3. ***Problem Statement 3***

The literature review and empirical study on socio-economic status and it's impact on choice of Physical Science is inconclusive. In support of the literature review this study finds no significant difference in socio-economic status of the father between pupils who choose or do not choose Physical Science as a school subject. Contrary to the above view, some researchers and the empirical study reveal a significant difference in the mothers' socio-economic status between those pupils who choose or do not choose Science as a school subject: Thus, as income grows there are progressively more children in the Malamulele district who choose Science as a school subject. Such children may have more opportunities to be exposed to Science, for example via television.

6.2.3.4. ***Problem Statement 4***

Contrary to the literature review which is inconclusive on the influence of Science achievement on choice of Physical Science as a school subject, the empirical study establishes a significant difference between the number of pupils from diverse levels of Science achievement who choose Physical Science as a subject. Thus, the better the pupils in the Malamulele district do at Science the more likely that they will choose Physical Science as a school subject in secondary school.

6.2.3.5 ***Problem Statement 5***

The literature review on pupil variables reveals the significant role played by pupil variables to influence choice of Science at school. These variables include: attitude, interest, career aspirations, self-concepts, age, beliefs. Pupils in the Malamulele district who want to take Science as a school subject have significantly more positive attitudes towards and interest in Science. They feel that it is an important subject for future career options, have positive Science self-concepts, enjoyed Science at primary school and believe that Science is a subject that has to be understood.

However, the literature review is inconclusive with regard to the influence of gender role concept on choice of Physical Science as a school subject. This study supports the findings of the literature study.

6.2.3.6 ***Problem Statement 6***

The literature review reveals the significant role of home environment variables (society's attitude and pupils' exposure to Science) to influence the pupils to choose Physical Science as a subject in secondary school. The literature review reveals inconclusive evidence with regard to the influence of pupils' exposure to role models at home and cultural background on choice of Physical Science as a school subject.

In support of previous research, this study finds a significant difference between pupils who choose Physical Science as a subject and those who do not choose Physical Science as a subject in school with regard to: *society's attitude* and *pupils' exposure* to Science. This study also reveals a significant difference with regard to socio-economic background between pupils who choose Physical Science as a subject and those who do not choose Physical Science as a subject at secondary school level. Pupils in the Malamulele district who plan to choose Science at school view Science as a valuable subject for our daily lives, have, among other things, parents who are positive towards Science and come from a better socio-economic background that those pupils who do not plan to take Science.

Contrary to the inconclusive evidence in the literature review with regard to cultural background, this study establishes no significant difference between pupils who choose Physical Science as a subject at school and those who do not choose Physical Science as a school subject at secondary school with regard to this aspect.

6.2.3.7 ***Problem Statement 7***

The literature review reveals a significant difference with regard to four teacher variables: attitude, personality, teaching methods and assessment methods. However, the evidence on teacher's competence on choice of Physical Science is inconclusive. In accordance with the literature study, this study also establishes a significant difference between the pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject, regarding the following teacher variables: *attitude, personality* and *methods of assessment*. Pupils who choose Science as a school subject view the attitudes, the personalities, the competencies and the methods of assessment of their Science teachers more positively than those who do not choose Science for matric.

Contrary to previous research, this study reveals no significant difference with regard to the methods of teaching that the teacher uses, between the numbers of the two groups of pupils. This may be due to the fact that in most schools in the Malamulele district pupils are only exposed to one method of teaching - the lecture method.

6.2.3.8 ***Problem Statement 8***

The literature review reveals the significant role played by the following school environment variables: *curriculum, type of school, management policy, Science laboratory and equipment* and *Science textbooks* on pupils' choice of Physical Science as a school subject. In support of the previous research, this study reveals that two school environment variables may motivate pupils to study Science: a *perception of the Science curriculum* as relevant and positive views of *Science textbooks*.

Contrary to the literature review, this empirical study shows that there is no significant difference between the number of pupils who choose Physical Science as a school subject and those who do not choose Physical Science as a school subject with regard to the following three school environment variables: *management policy, Science laboratories and type of school*. This may be attributed to failure of Physical Science teachers in the Malamulele to take grade 8 and 9 pupils to the laboratory to do practical work and demonstrations.

6.3 RECOMMENDATIONS FROM CONCLUSIONS

As mentioned in Chapter one, Physical Science is one of the key learning areas which can help create wealth, thereby uplifting the economy of any country wishing to progress economically in the new millennium. Therefore, in order to face the challenges of the new century and to win the economic battle of the century, we need professionals in Science related careers to lead our march to a new competitive era.

To have the above mentioned professionals, our youth should be encouraged from an early age to enrol in Science, Mathematics and Technology and in particular in Physical Science. Based on the literature review and the empirical investigation of the research, a number of recommendations which may motivate pupils to choose Science and which may improve education in South Africa in general (and the Northern Province in particular) are discussed.

6.3.1 Recommendations regarding the variables which were investigated

6.3.1.1 *Recommendations Regarding Pupils' Career Choices*

As revealed by this study, pupils' career aspirations have tremendous influence on choice of Physical Science as a school subject.

In order to encourage more pupils to choose Physical Science as a school subject, pupils should be informed and exposed to various career opportunities in Science and be made aware of the basic requirements of such careers. This can be done during Physical Science and also during school guidance periods. Once pupils are aware of career opportunities in Science at an early age, they will be more motivated and more willing to choose Physical Science as a school subject in order to fulfill their career aspirations. Furthermore, pupils can also be exposed to Science related materials and experiences by means of books, activities and excursions.

6.3.1.2 *Recommendations Regarding Pupils' Self-Concepts*

As indicated in the study pupils' self-concepts develop as a result of their daily interactions with teachers and other significant personalities like parents. Since self-concepts and confidence are important for choice of a subject, pupils should be encouraged to develop positive self-concepts from early childhood. Physical Science teachers should, at all times, strive to convince all students that Physical Science is meant for them and they can learn and pass Physical Science. Such motivation and words of encouragement from teachers can develop positive self-concepts within individuals and thus encourage them to choose Physical Science as a school subject. The Science teacher should also alleviate the fear for Mathematics by secondary school pupils, because fear of Mathematics have a negative impact on choice of Physical Science as a subject. It should also be noted, that pupils with positive self-concepts and views of a subject will be able to actualise themselves.

6.3.1.3 ***Recommendations Regarding Age***

In order to improve enrolment in Physical Science at secondary schools, Science should be introduced to students much earlier in schools, probably starting from grade three. This early introduction of Science will expose pupils to scientific principles at an early age and as such, they will have a better background exposure to Science. Hence, such pupils will most probably do well in Science and they will also be encouraged and motivated to do Physical Science at secondary school and at tertiary levels.

6.3.1.4 ***Recommendations Regarding Pupils' Achievements***

As revealed in the literature review and empirical study, pupils' achievements in Science significantly influence their choice of Physical Science as a school subject. In order to improve pupils' achievements in Physical Science as a school subject, the following recommendations are made:

(a) Only well qualified teachers should teach Science (Physical Science) in all classes. The tendency of allowing less qualified and unqualified teachers to teach Physical Science (especially in primary schools and grades 8, 9 and 10) while well qualified teachers are reserved for grades 11 and 12 should be discouraged.

(b) Schools should build the necessary facilities such as Science laboratories and libraries equipped with Science related resource materials and further encourage pupils to make use of these facilities at all times for their benefit through assignments and projects on a regular basis. The common practice of making the above facilities, where they are available, accessible for only grade 11 and 12 pupils, should be discouraged.

(c) In grades 8 and 9, where General Science is taught, there should be different teachers for Biology and Physical Science part disciplines. If one teacher teaches both Biology and Physical Science the emphasis will be on the teacher's area of interest, i.e. either Biology or Physical Science at the expense of the other.

6.3.1.5 *Recommendations on Exposure to Role Models*

In order to encourage more pupils to choose Physical Science as a subject, attention should be focussed on the following:
(a) The school should organise Science shows, workshops and seminars where Science professionals such as medical doctors, engineers, pharmacists, dentists, radiographers, scientists and other related professional will be able to address pupils on Scientific issues and their careers.

(b) Schools should organise Science related educational tours at least twice per year. Some of the interesting places that can be visited are industries, power stations, water purification plants, sewage plants, hydro-electric projects, agricultural stations, expos, ect.

The above issues will make pupils aware of " Science in Practice" and this can arouse the curiosity and interest of pupils and hence influence them to take Physical Science as one of their subjects at secondary school level.

6.3.1.6 *Recommendations on Socio-Economic Status of parents*

In order to influence pupils' achievement and choice of subject(s), ties between school and home should be created and strengthened, especially in areas that are socio-economically disadvantaged. This can be done in a number of ways:

(a) Organise parents' days or parents' evenings where parents meet Science teachers and specialists in Science and discuss the value of Science in life.

(b) Organise parents' visits once per quarter where teachers can discuss pupils' progress with the parent. The focus of these visits should be on Science and Mathematics.

The above recommendations will highlight to parents the progress of their children in Science and further equip parents with information on how to assist their children in Science, thus influencing them to choose Physical Science as a school subject.

6.3.1.7 *Recommendations on Teachers' Competencies*

In order to increase pupils' enrolment in Physical Science we need more qualified teachers. As Moyana (1996:158) mentioned

" The prevailing tendency of teachers taking degree majors for which they are not professionally qualified to teach should be brought to a halt" immediately. Teachers should be encouraged, motivated and be remunerated if they further their studies in subjects that they are qualified to teach, in particular in Physical Science. Furthermore, the Department of Education, Arts and Culture should also organise workshops, in-service training and seminars to update teachers on new developments in Science as well in Science methodology. Science teachers should also be encouraged to form professional Science teachers' forums in their areas and affiliate to national and international Science teachers' bodies. This can provide opportunities for interested personnel to come together, exchange ideas and also organise promotional / informative / educational / awareness activities.

6.3.1.8 *Recommendations on Teaching Methods*

Though this research in the Malamulele district does not show any significant influence of teaching methods on pupils' choice of Physical Science as a school subject, the literature review reveals a significant correlation between teaching methods and choice of Physical Science as a school subject.

Thus, based on the literature review and Curriculum 2005, it seems justifiable to recommend the following methods of teaching as more appropriate in the teaching of Physical Science as a school subject: demonstration, discovery and cooperative learning. Thus teachers are encouraged to move away from the traditional method of teaching (lecture method) which leads to poor participation by pupils and less creative thinking. Teachers should use demonstrations, discovery and cooperative learning methods to promote creativity, critical thinking and observation. Manipulation of equipment may lead to the drawing of scientific conclusions, ect. This shift in methods of teaching may encourage more secondary school pupils to choose Physical Science as one of their subjects.

6.3.1.9 ***Recommendations on the Curriculum***

The Physics curriculum should emphasise aspects which are relevant to pupils' everyday lives. Furthermore, Science teachers should, through their presentations, give equal emphasis on both theory and the *application* of theory. In support of the above view, Neilsen and Thomsen (1988:196) state that to influence more pupils to choose Physical Science , the teacher should be able to relate his/her knowledge of the subject to things of the world outside his/her subject. A relevant curriculum (which is in accordance to Curriculum 2005) will make Science more meaningful to pupils and influence them to choose Physical Science as one of their subjects at school.

The researcher also recommends that, in order to increase enrolment in Physical Science, Science teachers should start from practice to theory i.e. from the known to the unknown in their lessons' presentations.

6.3.1.10 ***Recommendations on Science Textbooks***

While the textbook has it's good qualities like stressing important concepts, directing activities and organising information, the teacher should:

(a) guard against the excessive use of the Science textbook. A number of Physical Science textbooks should be used by both pupils and Science teachers. Additional notes from other sources should be made available to pupils.

(b) choose and recommend Science textbooks which are free from gender bias, i.e. the teacher should select unbiased text materials and other recommended literature.

The above views will most probably encourage more pupils to choose Physical Science as a school subject at secondary school level.

6.3.2 Recommendations for Future Investigation

(a) Future investigation should replicate this study with respondents who have already made their choice /not made their choice on Physical Science as a school subject. Thus, pupils in grade 10, 11 and 12 who have already made their choice on Science as a subject could be researched with regard to the variables considered in this research.

(b) Future investigation should further probe the influence of pupils' age on choice of Physical Science as a school subject.

(c) It is recommended that future investigation should further probe the influence of various teaching methods on pupils' choice of Physical Science as a school subject by secondary pupils.

(d) Future investigation should also investigate the influence of pupils' socio-economic background on choice of Physical Science as a school subject.

(e) It is also recommended that future research should investigate the influence of pupils' gender role concepts on choice of Physical Science as a school subject.

(f) Future research should replicate this study but use qualitative data gathering techniques, such as interviews and observations, in addition.

(g) It is also recommended that future investigation should look at the influence of the peer group on choice of Physical Science as a school subject in secondary school.

6.4 LIMITATIONS OF THIS STUDY

This study used the questionnaire as its main data collecting instrument. There is a possibility that more useful data may have been gathered if qualitative data gathering instruments, such as interviews, were used.

6.5 SUMMARY

In this chapter, the general problem, specific and general aims of the study, and eight null hypotheses from chapters one and four respectively were restated. Conclusions from the literature study and the empirical investigation were made and compared and consequently the eight null hypotheses were either rejected or *not* rejected.

Recommendations from conclusions for improving the enrolment of pupils in Physical Science as a matric subject and for future investigations were given. Lastly, the limitations of this study were revealed/highlighted.

6.6. FINAL WORD

To all Physical Science teachers:

The future of our pupils is in our hands and thus the future of our country depends on us. With hard work, regular updating, patience, understanding, commitment, a sense of responsibility, love for the child and dedication we can make a difference.

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APPENDIX A

QUESTIONNAIRE

Hi, there! this is not a test but a questionnaire for which you have all the answers.

(a) Please do not write anything on the questionnaire. Write only on the response page provided.

(b) Do not write above the red line, this is for office use only. Start below the red line next to number 1.

(c) For each item indicate your answer by means of a single stroke with a pencil on the appropriate number:

[1] [2] [3] [4] [5] or [6]

(d) Please make sure that the number on the questionnaire is the same as the number on the answer sheet.

(e) Sometimes only two alternatives are given from which to choose but sometimes more. Please ignore the numbers you do not need.

---

1. I will choose Physical Science as a subject for matric = [1]
   I will NOT choose Physical Science as a subject for matric = [2]

2. Gender: Male = [1]
   Female = [2]

3. Age: 15 years or less = [1]
   16 years = [2]
   17 years = [3]
   18 years = [4]
   19 years = [5]
   20 years and above = [6]

4. Monthly income of father:
   None = [1]
   R1-R999 = [2]
   R1000 - R2999 = [3]
   R3000 - R6999 = [4]
   R7000 and above = [5]
   I don't know = [6]

5. Monthly income of mother:

None	=	[1]
R1-R999	=	[2]
R1000 - R2999	=	[3]
R3000 - R6999	=	[4]
R7000 and above	=	[5]
I don't know	=	[6]

6. In Science tests/examinations, I usually score:

0-19%	=	[1]
20-39%	=	[2]
40-59%	=	[3]
60-79%	=	[4]
80% and above	=	[5]

Directions for the rest of the questionnaire

(a) The rest of the questionnaire contains statements on how you feel about the activities in your Science learning, in class and at home. There are no right or wrong answers. Your opinion is what is wanted.

(b) Think about how well each statement describes your feelings about Science and the way it is taught. Indicate your answers by means of a dash in the appropriate number in the square on the answer sheet provided.

(c) The numbers have the following meanings:

5 = Strongly Agree

4 = Agree

3 = Undecided

2 = Disagree

1 = Strongly Disagree

(d) Provide your choice to each statement truthfully.

(e) Make sure that you indicate your answer in the space next to the same number as that of the question.

(f) Do not write down your name on the answer sheet.

(g) Thank you for your co-operation.

Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)

7. The Science tests we write are too difficult.
8. I believe I should try and understand Science.
9. It is useless to struggle with Science problems.
10. Most of the Science topics are interesting.
11. The tests we write in Science are fair.
12. I find Science difficult.
13. I am not interested in scientific matters.
14. Science is dull.
15. I really enjoy Science.
16. Science content is boring.
17. I want to learn more about Science.
18. I prefer other subjects to Science.
19. I never listen to or watch Science programmes on TV/radio.
20. I would enjoy a career in the Sciences.
21. Female Scientists can be competent as men.
22. Only males should become Scientists.
23. Science is not useful in everyday life.
24. Boys understand Science better than girls.
25. I am good at Science.
26. Primary school Science was difficult.
27. Science knowledge is simply receiving and memorising information.
28. Our Science teacher enjoys teaching Science.
29. My Science teacher enjoys talking to us about scientific matters.
30. My Science teacher encourages both boys and girls to do Science.
31. Our Science teacher is strict but fair in his/her classes.
32. My Science teacher knows a lot about Science.
33. My Science teacher is an encouraging person.
34. My Science teacher often lets us work in groups during classes.
35. My Science teacher does not perform demonstrations in class.

Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)

36. My Science teacher asks a lot of questions based on difficult calculations.
37. Science interests me.
38. Our school has a well equipped Science laboratory.
39. Science can help us improve our living conditions.
40. I get the chance to go on excursions to industries, power stations, etc.
41. My parents expect me to do well in Science.
42. My parents help me with my Science homework.
43. My parents are bored by Science.
44. I do not believe in Science.
45. We learn many useful facts in Science.
46. It is difficult to relate Science knowledge to everyday life.
47. We have lovely Science textbooks.
48. Science is important in our everyday lives.
49. Our school exposes us to work carried out by practising scientists and engineers.
50. Science is interesting.
51. I dislike Science courses.
52. I do not need Science for my future career.
53. Our school lacks important Science apparatus.
54. I do not see a job possibility in Science.
55. Boys understand Physics better than girls.
56. It is strange if a Scientist is female.
57. Males and females are equally capable to do Science.
58. I understand Science.
59. Science is boring.
60. Science was one of my favourite subjects in primary school.
61. Science never stimulated me as a young child.
62. My Science teacher is fair in marking science tests/examination scripts.
63. My Science teacher is on time for lessons.
64. We do a lot of boring activities in Science.

Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)

65. My Science teacher gets impatient when I ask for help.
66. My Science teacher is pleasant.
67. My Science teacher is unfriendly.
68. My Science teacher is often unable to answer our questions.
69. My Science teacher often commits mistakes while teaching Science.
70. My Science classes usually consist of lectures.
71. My parents think Science is a waste of time.
72. Science is dangerous to our health/well-being.
73. There are no scientists in our community.
74. Science is interesting.
75. My father/mother is interested in Science.
76. I cannot use the Science we learn at school.
77. Our school principal/teachers discuss our academic progress with our parents.
78. Our school time-table makes it easy to choose Science as a subject.
79. Science is one of my favourite subjects.
80. I would enjoy becoming a Scientist.
81. I would prefer a career outside of Science.
82. Science is difficult.
83. I enjoyed primary school Science.
84. Science learning is applying and developing understanding.
85. My Science teacher is often late for class.
86. My Science teacher does not always turn up for his/her class.
87. My Science teacher gives more attention to boys than to girls.
88. My Science teacher has no sense of humour.
89. Sometimes my Science teacher makes me feel dumb.
90. My Science teacher is confident about his/her knowledge of Science.
91. My Science teacher allows us to do our own experiments.
92. My parents do not understand Science.
93. Sickness/illness is caused by witchcraft and evil forces.

Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)

94. My Science textbook is well written.
95. My Science textbook is old and/or filthy.
96. Our time-table is such that it is difficult to choose Science as a subject.
97. Our school never informs our parents about our academic progress.
98. Our school principal/teachers encourage us to seek help with our school work from our parents.
99. Our Science teacher scolds us for answers we get through help from our parents.
100. Science is a prerequisite for my future career.
101. Girls are as good at laboratory work than boys.
102. My Science teacher does not enjoy teaching Science.
103. Science seems to bore my Science teacher.
104. My Science teacher explains how Science is relevant to our lives.
105. My Science teacher discourages discussions/debates during Science classes.
106. My Science teacher asks probing questions during Science lessons.
107. We seldom do experiments in Science class.
108. My Science teacher asks questions relevant to real-life experience in tests and examinations.
109. Science is a useless subject.
110. My parents have no scientific knowledge.
111. My family watches/listens to Science programmes on TV/radio.
112. Our school forces pupils who take Physical Science to take other specific subjects as well.
113. Physical Science can be taken with any other subject at our school.
114. Girls waste their time to study Science.
115. My Science teacher expects as many as possible for us to further our studies in Science.
116. I have no books on Science at home.
117. My parents encourage me to work hard in Science.

118. My parents encourage me to choose Science as a subject.

119. We have a lot of Science equipment as school.

120. There is no Science laboratory at school.

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APPENDIX B

SUMMARY OF THE QUESTIONNAIRE INDICATING EACH VARIABLE

(a) PUPIL VARIABLES

ITEM NUMBER	VARIABLE	SCORING DIRECTION
15, 18, 74, 79	Pupil's attitude	+ve
14, 16, 19, 51, 64	Pupil's attitude	-ve
17, 37, 50	Pupil's interest	+ve
13, 59	Pupil's interest	-ve
20, 80, 100	Future career	+ve
52, 54, 81	Future career	-ve
21, 57, 101	Gender role concepts	+ve
22, 24, 55, 56, 114	Gender role concepts	-ve
25, 58	Pupil's self-concepts	+ve
12, 82	Pupil's self-concepts	-ve
60, 83	Pupil's age	+ve
26, 61	Pupil's age	-ve
8, 84	Pupil's beliefs	+ve
9, 27	Pupil's beliefs	-ve

(b) **HOME ENVIRONMENT VARIABLES**

ITEM NUMBER	VARIABLE	SCORING DIRECTION
39	Society's attitudes	+ve
72, 109	Society's attitudes	-ve
40, 41, 42, 49, 75	Exposure to models	+ve
111, 117, 118	Exposure to models	+ve
43, 71, 73, 92	Exposure to models	-ve
110, 116	Exposure to models	-ve
93	Cultural background	+ve
44	Cultural background	-ve

(c) **TEACHER VARIABLES**

ITEM NUMBER	VARIABLE	SCORING DIRECTION
28, 29, 30, 62, 63, 115	Teacher's attitudes	+ve
65, 85, 86, 87, 102, 103	Teacher's attitudes	-ve
31, 33, 66	Teacher's personality	+ve
67, 88, 89	Teacher's personality	-ve
32, 90, 104	Teacher's competence	+ve
68, 69, 91, 106	Teacher's competence	-ve
34, 35	Teacher's methods	+ve
70, 105, 107	Teacher's methods	-ve
11, 108	Teacher's assessment	+ve
7, 36	Teacher's assessment	-ve

(d) **SCHOOL ENVIRONMENT VARIABLES**

ITEM NUMBER	VARIABLE	SCORING DIRECTION
10, 45, 48	Curriculum	+ve
23, 46, 76	Curriculum	-ve
77, 98	Type of school	+ve
97, 99	Type of school	-ve
78, 113	Management policy	+ve
96, 112	Management policy	-ve
38, 119	Science Laboratory	+ve
53, 120	Science Laboratory	-ve
47, 94	Textbooks	+ve
95	Textbooks	-ve
VARIABLE	**POSITIVE**	**NEGATIVE**
Pupil's attitude	4	5
Pupil's interest	3	2
Pupil's future careers	3	3
Pupil's gender role concepts	3	5
Pupil's self-concepts	2	2
Pupil's age	2	2
Pupil's epistemological beliefs	2	2
Society's attitude	1	2
Pupil's exposure to role models	8	6
Pupil's cultural background	1	1
Teacher's attitudes	6	6
Teacher's personality	3	3
Teacher's competence	3	

VARIABLE	POSITIVE	NEGATIVE
Teacher's methods of instruction	2	3
Teacher's assessment	2	2
Curriculum	3	3
Type of school	2	2
Management policy	2	2
Science laboratory	2	2
Textbooks	2	1

Positive statements: 56

Negative statements: 58