A Case Study of Girls' Participation in Physical Science at a Rural High School

BY

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ABSTRACT

The study aimed to add to our understanding of why many girls in rural high schools were not choosing to study Physical Science. A case study of a local high school was used as the research method. Questionnaires to the 120 learners in grade 9 and 10 were the main instrument used to gather data. This was followed up with interviews of a sample of learners and some classroom observations. The science teacher was also included as a key informant in this study. The data collected aimed at answering the following key question: What influences girls in their decision to choose to study Physical Science at a rural school? The following sub questions guided the researcher in answering the key research question: (a) Are there any differences in participation between boys and girls? (b) What influences their choice in Grade 9? (c) Were Grade 10 learners happy with their subject package choices made in grade 9? The data were captured, coded, analysed and interpreted.

The study produced evidence that the learners' family, the classroom environment, peer influence and the shortage of role models were the main reasons for the low number of girls participating in Physical Science. The study found that these factors have a significant influence on girls' subject choices. Of the four factors found, the family was the most significant factor (i.e. where the family members tended to choose the subject package for girls). In the classroom the girls were involved in proportionally the same number of interactions but importantly the female teacher had a disproportionate number of interactions with the boys. In apparent contradiction to the teachers comments that the boys were the more active learners, the girls initiated more interactions with the teacher. However, the girls reported that they were

uncomfortable in the class as boys mocked and intimidated them during the lessons. Unfortunately, a large percentage of the girls who did choose to take Physical Science were unhappy with their choice as they then found it difficult.

The main recommendations of the study were that; teacher and community awareness programmes should be established to raise awareness of the gender issues and to promote girls taking science; career guidance should be given to learners so they could make their own informed decisions; and possibly specialist science girls schools could be established. Further suggestions for research were made. The findings of this study should provide policy makers, curriculum developers, and science teachers with valuable information about some of the factors that influence girls not to take Physical Science.

PREFACE

The work described in this dissertation was carried out in the School of Science, Mathematics and Technology Education, University of KwaZulu-Natal, from July 2002 to November 2005 under the supervision of Prof Paul Hobden (Supervisor).

This study represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any tertiary institution. Where use has been made of the work of others, it is duly acknowledged in the text.

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CHAPTER 1
INTRODUCTION AND OVERVIEW

1.1 INTRODUCTION

People who do not study science are in some ways disadvantaged. Among others they are denied opportunities; to become scientists or engineers or technologists whose services are required most by the country; to acquire basic scientific knowledge and skills that are useful in daily life; and to understand and explain the world around them from a scientific perspective. Women have a long history of being disadvantaged in participating in science. In European countries, for instance, women were barred from the academic high schools which offered science subjects and in certain countries such as Poland, Russia and Austria women were even barred from universities (Baker, 1998). It was only after 1964 that science for women was emphasized in South Africa (Nassor, 2001). At that time, girls had few positive role models in science and mathematics. There were few women scientists, medical doctors, agriculture officers and science teachers. Even today, the situation has not changed significantly. The number of women who participate and succeed in science is relatively low. For example, research by Kelly, Whyte and Smail (1984) found that 95% of entries in all science and technical subjects are men. Reddy (1998) in her study has pointed out that "In some parts of Africa certain racial groups and nomadic tribes were discriminated, resulting in poor participation in science and technology education" (p.91). This indicates that women's opportunity to participate in scientific occupations is unacceptably low given our technological society. Educational researchers both locally and internationally have indicated a need for an urgent elimination of this imbalance (Baker, 1998; Byrne, 1993; Parker, Rennie & Harding, 1995; Reddy, 1998; Wamburu, 2000).

The need for women to access scientific knowledge goes without saying. Wamburu (2000) points out that women are the providers of primary health care and are also responsible for the nutritional status in the home and they therefore need to have a thorough scientific knowledge. According to reports by international bodies such as the

United Nations and womens' organisations worldwide, women are the main producers of food outside of large mechanised faming producers. They use primitive methods of production by applying their inborn technological knowledge. Nassor (2001) listed some reasons why it is important for women to study science. Among these are that naturally females bring human life to this world and also nurture life. It is through the mother that the child learns and develops. A mother who has studied science could perform these responsibilities better.

The lower participation of women in science may have a negative impact on the economy of the country and Government sees this as an important issue in education. It argues that equal opportunities are necessary so that both boys and girls can be part of the country's development. For this reason, the national curriculum statements for grades 10 to12 (Department of Education, 2003) emphasises the need for all learners to be given equal opportunities to study science subjects at school. It states clearly in the section dealing with developmental outcomes that it requires learners that will be able to

- participate as responsible citizens in the life of local, national and global communities;
- explore education and career opportunities;
- develop entrepreneurial opportunities;
- reflect and explore a variety of strategies to learn more effectively.

Given this emphasis in the curriculum documents, this study will investigate girls' current participation in science at a rural high school.

1.2 MOTIVATION FOR STUDY

The study was conducted at a rural high school where I am presently working as a school principal. From the time that I was a class teacher and now in my present position, I have noted with a growing concern that there has been decline in the number of girls choosing a science subject package in Grade 10. For example, in year 2003 there were 75 science learners in Grade 10 of whom only 24 were girls and in Grade 12 the enrolment was 18 with 6 girls. Girls would appear to exhibit a negative attitude towards physical science studies while boys show a positive attitude. As the Headmaster and science teacher

of this school, I have carried out this research to find out what actually demotivated or prevented girls from choosing Physical Science at a rural school. In South Africa, fifty percent of schools are in rural areas. From the rural areas there are a number of learners who are at present not participating in science. It is important for this particular study to have a look at and see if the general results found in the literature overseas and in Africa apply in a particular rural school. Hopefully, the study will form a baseline for other similar studies in rural schools.

1.3 THE RESEARCH QUESTIONS

The study attempted to answer the following key research question: *What influences girls in their decision to choose to study Physical Science at a rural school?*

The following sub questions guided me in answering my key research question:

(a) Are there any differences in participation between boys and girls?

(b) What influences their choice in Grade 9?

(c) Were Grade 10 learners happy with their subject package choices made at end of grade 9?

In order to answer these questions, I felt that the most appropriate method, given my particular circumstances would be a case study. I gathered my data by giving questionnaires to 80 Grade 9 learners, 40 Grade 10 physical science learners and forty Grade 10 non-physical science learners. I interviewed six Grade 10 physical science learners and four Grade 10 non-physical science learners and the science teacher followed by the observation of two physical science lessons.

1.4 AN OVERVIEW OF THE DISSERTATION

This dissertation consists of five chapters. Chapter 1 is an introductory chapter, in which a brief introduction and the motivation of the study, is laid out. Chapter 2 is the literature review, which provides a broad discussion of the research topic. Chapter 3 describes and accounts for the research methods employed in this study. The different

methods used to collect data are accounted for. Chapter 4 focuses on the presentation of the findings paying special attention to the questionnaires, interviews and classroom observations used in the study. Chapter 5 provides a summary of the main findings of the research study and recommendations for the improvement of girls' participation in science subjects. This chapter also links this study's findings to the findings of previous research.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

The study concerns itself with girls' participation in science. This chapter is organised into the following major areas: (a) the need for women to participate in the economy; (b) why science should be taught at school; (c) girls' participation in schooling in general; (d) girls' participation in school science, and (e) why are girls reluctant to take up science. The following terminology will be used in the study: Girls – this term will be used when referring to female school learners; Women – this term will be use when referring to post school females.

2.2 THE NEED FOR WOMEN TO DO SCIENCE

The South African economy requires the participation of women. They are an important part of the economy and they are needed in science related jobs such as engineering, technology, science teaching etc. Research by among others, Baker (1998), Byrne (1993), and Reddy (1998) indicate that one of the reasons why women's participation is low is because they have not taken science at school. The low participation of girls in science greatly hinders the nation's economic development. South Africa has a global economy, the growth of which is dependent on technology and science. The growth of the country's economy is good for everybody because it raises the general standard of living. To achieve this, we need people with scientific skills. We need highly skilled professionals in the field of science and technology to be able to compete in the global economy. We need large numbers of these people and unfortunately we have a shortage of them. One of the ways of dealing with this situation is to involve more women in science related jobs, both because the economy requires it and from an equity point of view, as we do not want to see a situation where one gender dominates the other. Erinosho (2001) argues that "women are a 'missing half' in this critical sector of development because their

experiences and skills are not being used" (p.13). In order for the economy to work effectively, we need more involvement in science by women. The full development of the country can be attained when both males and females are allowed to contribute equally. The world as a whole cannot afford to neglect women while in Africa the dream of an African Renaissance will remain hollow if women do not take their rightful place in the world of science and technology.

2.3 WHY SCIENCE SHOULD BE TAUGHT AT SCHOOL?

We need to teach science in order for the economy of the country to grow. We want our learners to leave school having gained scientific skills. We want them to go out and do further studies in science. The government has recognised this as important. They have realized that, in order to produce citizens who will fit in today's technological society, they must introduce science and technology at a school level. The 1995 syllabus for Physical Science states as its broad aim that the teaching of Physical Science is to "provide learners with the necessary subject knowledge and comprehension" (Department of Education 1995, p.3). The South African Government White Paper on Science and Technology (Department of Education, 1996) argues that government " has a responsibility to promote science culture, science education and literacy amongst both children and adults....and influence the attainment of equity by providing incentives for disadvantaged groups to study mathematics, science and achieve computer literacy" (p.11). It explicitly states that the purpose of science and technology teaching and learning is to make citizens of the country who are able to use scientific and technological information in their daily lives thereby improving the economy of the country. That is why the new South African Government has recognised the central importance of investing in science and technology in its development plans.

The draft policy document for natural sciences states explicitly that the study of natural science must achieve three major goals:

- the acquisition and use of science skills in variety of settings
- the acquisition and application of scientific knowledge and understanding

- an appreciation of the relationship and responsibilities between science and society (Department of Education, 2001, p.2).

Thus, the teaching and learning of science will ensure that all learners become science literate as they will acquire skills, attitudes and values that may be useful in their personal lives, in the community and in the work place.

Another argument for learning science is that it helps citizens cope with today's technological society. Science is part of everyone's daily life. It touches every aspect of our lives, for example, what we eat and what we wear; the work we do, what we think and what we feel and can even influence when we are born and how we die. It is thus evident that ordinary people need it for everyday life. As noted by Roberts (1982) "Science is useful for understanding and coping with the gadgetry one encounters everyday in a technological society" (p.244). He goes on to say that science education is about acquiring competence in the use of skills required in scientific activities. In the same way, Nassor (2001) argues that "Science is important for life " (p.104). This implies that science holds some of the important keys to the development and unlocking of unused skills, thus improving the quality of life of an individual.

Most basic scientific skills are acquired at school level. It is therefore necessary that the school system provides its learners with such basic skills. That is, the skills that can be used throughout life, such as problem solving, decision- making, communication etc. many of which are developed through doing science. Thus, it is necessary that all learners, irrespective of their gender, should be taught. The new science curriculum attempts to address this by referring to promotion of inclusivity and being sensitive to issues of gender (Department of Education, 2003, p.4)

2.4 GIRLS' PARTICIPATION IN SCHOOLING IN GENERAL

Generally, girls participate equally with boys in primary schools as well as in junior secondary schools (basic education) but at senior secondary schools and higher levels their participation starts to decline. This has been a trend in many developed and developing countries. Looking at the continent as a whole, Reddy (1998) reports that in

1990, in Africa, girls made up 45% of primary learners. A study by Nassor (2001) in Zanzibar indicated that enrolment rates of girls and boys in primary education were 81% and 82% respectively and in basic education was 71% for girls and 72% for boys. Also Wasanga (2003) in his research on female participation and performance in Science, Mathematics and Technology in Kenya, found that in 1998, 49% of the total enrolment were girls at the primary school level. This indicates that there is little difference between the participation and enrolment rates of girls and boys in primary schools and in junior secondary schools.

However, in senior secondary schools (Grades 10-12) and at higher levels of education, the girls' enrolment rates starts to decline. Nassor (2001) found that at secondary level, girls' enrolment was only 32% and then dropped even further to 3% at the college. This has been supported by the findings by Reddy (1998) who found in Southern African countries, such as Zimbabwe and South Africa the senior secondary school participation rate of girls varies from 50% to less than 10% in some cases. This indicates that fewer girls participate in science at the secondary school level.

Previous studies have suggested that some of the factors that lead to this poor participation of girls in senior secondary schools are the cultural influences, the home environment, curriculum inadequacies, and different treatment in the classroom of girl learners by both male and female teachers (Haarmbokoma, 2002; Kahle & Meece, 1994; Parker et al.,1995; Wamburu, 2000).

2.5 GIRLS' PARTICIPATION IN SCIENCE

The number of girls who participate and succeed in science all over the world is generally low. Most science courses, like medicine, engineering etc. are still male-dominated. As noted by Forrest (1992) "many countries in the world are experiencing this phenomenon since their female students, at all levels, are tending to avoid the physical sciences" (p.93). African countries have also begun to pay attention to this issue. As reported by Haambokoma (2000) research done by the Female Education in Mathematics and Science Association (FEMSA), in Cameroon, Tanzania, Ghana, Uganda, and

Swaziland, indicated that girls enrolments in science and mathematics is lower than in other subjects. A recent research study by Mbano (2003) in Malawian schools suggests that there is an average of one girl for every two boys in physical science classes. The Honourable Deputy Minister of Arts Culture, Science and Technology, Bridgette Mabandla in her speech of declaring 1998 as a year of Science and Technology in South Africa (Department of Education, 1998), also voiced a concern that, women form 52% of the population, and yet are under-represented in the science fields. She goes on to say that female researchers make up only 29% of researchers with only 13% of those in the field holding doctoral degrees as opposed to 25% of their male counterparts. In 1993 only eight percent of the enrolment for engineering was female and of these only four percent graduated. It can be seen that participation rates are unacceptably low.

There are claims that the number of girls wanting to study science could be increased if there were more single sex schools. Girls seem to have better attitudes to, and be more likely to choose, Physical Science in single sex schools than in mixed schools (Kelly et al., 1984). Shymnsky and Kyle (as cited in Monk & Amosum, 2002), reveal that girls in single sex-school achieve better in science than girls in mixed gender schools. They are therefore motivated to study science further. There are reports by Byrne (1993), Delamont (1994), Haambokoma (2002) and Parker et al., (1995) that all-girls schools holds some advantages for girls learners because gender stereotyping is eliminated. Girls in the single sex schools are taught all subjects and thus beliefs prevalent in co-education schools that subjects, such as Physical Science and Technical drawing, Mathematics and others, taken mostly by boys, are unsuitable for girls are removed. Furthermore, the false comparisons, which prevail in mixed schools between girls and boys in terms of activeness and intelligence, may be less emphasised. Studies indicate that girls in girls' only schools perform equally well as boys in boys' only schools (Kaino, 2002).

A study by Haambokoma (2000) indicates that within the school environment there are general factors, which influence girls attitudes to science in co-educational schools. He mentions gender biased classroom interaction, which favour boys, negative teacher attitude towards girls, and the poor attitude of boys towards girls. He argues further that boys may intimidate, mock and use insulting language to girls. They may do various things that lower the girls' self esteem, confidence and the ability to express themselves in front of

boys. Wamburu (2000) in his study on factors that adversely affect the performance of Ugandan girls in Physical Science, found that teachers' intimidating attitudes discourage girls from participating in classroom activities. He argues that harsh teachers make girls tense in front of boys. They are also discouraged by teachers' comments which make them feel that they are not capable of performing well in science subjects. There are, therefore, arguments in the literature that in co-educational schools, girls and boys should be separated during class sessions in order to improve girls' attitudes toward science. These are discussed more fully in the next sections.

2.6 WHY ARE GIRLS RELUCTANT TO TAKE UP SCIENCE?

Various explanations are offered for the low participation of girls in science education. These include psychological explanations, the school environment, home influence and community and peer influence

2.6.1 Psychological Explanation

There is an argument in the literature that girls have a low self-esteem and self-confidence in science subjects. Ditchfield and Scott (1987), found that the majority of girls in secondary schools develop a self concept which under-estimates their academic abilities as they tend to rate themselves lower on academic subjects when compared to boys. This view has been supported by Kahle and Meece (1994) who also found that girls rate themselves lower than boys in science subjects, thus develop low morale, and consequently perform poorly in these subjects. This view has also been reported by Keys (as cited in Forrest, 1992) who argue that female learners used to perceive Physical Science as a difficult subject and they therefore avoid it in their subject package. Delamont (1994) found that girls, especially in adolescence stage, are bored by Physical Science and Mathematics and they subsequently become disinterested in these subjects.

Furthermore, the studies by Delamont (1994), and by Ditchfield and Scott (1987) also report that the majority of girls are not interested in Physical Science and Mathematics and that there are strong beliefs among girls that science is a male subject. Kamwendo (as cited in Mbano, 2003) in a small study on factors that adversely affect the performance of

Malawian girls in Physical Science found that they had a negative attitude to Physical Science and did not see its relevance to their future and they therefore avoided it in their subject packages. Given the fact that girls have low self-esteem, self-confidence and interest regarding science, the chance is therefore, that within the school situation they will avoid science subjects and as a result their participation will be lower than boys.

2.6.2 The school environment

It is the role of the school to provide teaching, for the purpose of imparting knowledge, attitudes and skills. Freyberg and Osborne (1984) maintain that the role of the science teacher is to assist the learners to

- investigate things and explore ideas,
- broaden their experience of nature and technology,
- become interested in exploring how and why things behave as they do and how explanations have been obtained.

The school has an obligation to prepare all learners, both boys and girls to be scientifically literate. Yet, research by Haambokoma (2002) indicates that science teachers consciously and/or unconsciously discourage girls from taking up science subjects. He found that some teachers tell learners that science is difficult and only boys can do it. He maintains that one possible reason for such comments is that some teachers are not trained teachers, but were offered teaching posts due to the shortage of science teachers. This situation is, therefore, expected to prevail in rural areas where there is a shortage of qualified science teachers.

Furthermore, there is an argument that, some teachers choose subject packages for learners. Erinosho (2001) in her research on problems that girls face in science and technology, found that some teachers expect and encourage girls to study "feminine" or "soft" subjects such as home economics, literature, or at best biology that are considered appropriate for them which are thought will prepare them for their expected adult roles. On the other hand, boys are encouraged to study 'hard' subjects such as physics, technology and mathematics. Such behaviour by teachers demotivates girls to study science subjects.

There is also a general finding that during the lessons in the classroom, girls are discriminated in one way or the other by both the teacher and the boys and yet learning in

the classroom is supposed to be non-discriminative. This was confirmed in a study by Sears, Feldman and Wernersson (as cited in Kelly et al., 1984) who found that teachers interact more with boys than with girls in the classroom. They argue that boys were always regarded by teachers as being more competent than girls. Studies by Nassor (2001), Parker et al., (1995) and Wamburu (2000) confirm these differential classroom practices by teachers. Nassor (2001) who did a research project to investigate the behaviour of the teacher and learners in science classrooms at secondary school level in the Zanzibar, found that teachers encouraged boys to investigate and be creative, while girls were ignored. Boys were found to treat girls as assistants and secretaries, telling them what to do during classroom activities. Nassor's observations at Zanzibar Science Camp confirmed the fact that teachers are unconsciously biased against girls when teaching. 'Teachers perceive girls to have less ability, to be less hard working than boys' (Mbano, 2003, p.62). Wamburu (2000), made similar observations in Ugandan science classrooms and found that teachers' discouragement of girls who wish to do science, takes place mainly in the classroom, as she remarked : "sometimes it is direct through harsh punishments and abuses but sometimes it is subtle through comments that sound like praises but carry connotations and implications that the girls are not supposed to perform well in science"(p.1). These views have been supported by Haambokoma (2002) who attributes girls' discouragements to study science to; gender biased classroom interaction which favours boys; negative teacher attitude towards girls; and the poor attitude of boys towards girls learning science.

Another factor is that prescribed textbooks appear to be gender biased. Analysts of textbooks have shown how school texts reflect sex bias. Seldom do we see a science textbook recognising female scientist achievement and success. Illustrations and examples do not show girls in active situations. This has caused concern to many researchers such as Erinosho (2001), Forrest (1992), Kaino (2002) and Kelly et al, (1984). For example Whyte, Kelly and Abraham cited in Kaino (2002), did a study to examine how science textbooks affect girls' participation in science. One area that is highlighted by these studies is that, in some textbooks women are portrayed as insignificant or invisible compared to men who dominate and were referred to as pioneers and great scientists. This is confirmed by Tembo in FEMSA Report No. 2 (as cited by Haambokoma, 2002, p.111) when he says "Some textbooks look gender biased with text and illustrations favouring boys". These

findings confirm my personal experience. I have been examining some physical science textbooks, prescribed for secondary schools and I have found that, in nearly all cases only male scientists have been described as great scientists, for example, Sir Isaac Newton, John Dalton, Millikan etc. Only Madam Curie and her discovery of X-ray process is well cited. Given the fact that science textbooks favour boys, the chances are that girls will not be encouraged to take up science subjects.

2.6.3 The home and community environment

The home environment is one of the major factors that discourage girls from studying Physical Science. Erinosho (2001), Forrest (1992) and Kahle and Meece (1994) all mention this as a strong factor. The family members choose the subjects to be studied for their girls. According to Erinosho (2001), the family members have developed gender stereotypes, which have put girls at a disadvantage in terms of entering into science and technology fields. Huston (as cited in Kahle & Meece, 1994) points out that parents tend to structure the social and physical environment to favour boys. It has also been found that "from infancy, girls may be discouraged from playing with mechanical or scientific toys" (Forrest, 1992, p.95). Parents tend to buy more scientific toys for boys while girls are bought objects like shopping bags, sewing or knitting kits and caring toys like baby dolls, nurses' outfits etc. This has been confirmed by Erinosho (2001), who further pointed out that, society itself expects girls to manage homes and be involved in careers that will make them good housewives and that will satisfy marital demands. Such behaviour by family members and society may demotivate girls from expressing an interest in science and technical subjects.

Societies expect girls and boys to perform a specific role within the community. Because of these gender roles, as noted by Kahle and Meece (1994), societies perceive some gender characteristics as more masculine and some as feminine. Consequently, such practices as noted by Erinosho (2001) cause the "society to develop gender stereotypes of careers that result in men gaining power and control over certain fields such as science and technology" (p.12). This has been observed in nearly all cultures. Furthermore, these cultural expectations of the society give rise to differences in performance between boys and girls in school subjects and such expectations could influence the occupational choices of the two genders. Other studies that have specifically addressed this issue of gender

stereotyping are Baker, Backe, Power, and Shroyer (as cited in Kahle & Meece, 1994) who found that the stereotyping of science as masculine by the society, affects girls more than boys. These gender roles and the stereotyping of girls expected by the members of the community, discourage them from participating in science subjects. Given that the home and the community are prescribing gender roles that are favouring boys and are also choosing subjects for girls, the chances are that few girls will enter science and technology fields especially in rural areas where society rules are still enforced and respected.

2.6.4 The peer influence

Peer pressure forces children to follow their friends. This has been observed in the school environment. Learners influence one another in the choice of subjects. As noted by Forrest (1992) "Female and male attitudes to schooling and to school subjects are affected not only by their perception but those of their peers and other around them" (p.95). Consequently, they choose subjects they had not intended studying. This is more apparent in girls at secondary school level especially during the teenage and adolescent stage. Moroke, Nkoane, Mahlomaholo, Sookdin and Khabanyane (2000) carried out a study in some secondary schools in Phuthaditjhaba on gender differences and found that peer-group influence is very powerful during the teenage period. When girls were interviewed in this investigation, they agreed that they were influenced by their friends of the same sex on how to choose their subjects. This suggests that peers may have a decisive influence on a learner's subject choice. Most children would like to choose what their friends choose due to peer-group socialisation. Peer-group socialisation is important for them as it plays a major part in reinforcing and shaping their gender identity. As noted by Ditchfield and Scott (1987) and Giddens (1989), most children choose what their friends choose as it is natural for most people to conform to the norms of their group. This view is in accordance with the gender identity theory, which suggests that a child identifies himself or herself as belonging to a specific sex and as a result, friendship develops. Therefore it is likely that many of the learners would be persuaded by their friends of the same sex to choose a subject that might not be useful for their future career.

2.6.5 Role models

There is growing concern throughout the world that, in the society at large, female scientists have had a very low visibility. This is supported by a number of reports from

FEMSA. For example Swainson (as cited in Haambokoma, 2002) found that there is a shortage of female science teachers in the school environment and this contributes to a low participation of girls in Physical Science. Science subjects like Physical Science, Mathematics and Technology lack career models on the part of women. Reddy (1998) affirms this view as she says females in science and technology are under-represented. There are many reasons put forward for the low number of female scientists. Among them are those suggested by Dlamini and Nkosi (2003) who say "Girls fear mathematics, science and technical subjects and programmes because they do not have girls and women to model with in those fields" (p.556). Hence they avoid science subjects. Obviously, the shortage of role models in these subjects will contribute to the low participation of girls in science.

2.7 SUMMARY

There is evidence from the literature that there are factors demotivating girls from participating in science. This chapter has discussed four of the factors contributing to the low participation: (a) the influence of the home environment and the community, (b) the school environment, (c) the peer influence, and (d) the shortage of female role models. Schools are not producing adequate numbers of female learners in the science fields resulting in a low participation of girls in science which has an impact on the economy. Consequently, the schools need to produce more scientifically literate girls. The following chapter will discuss the research methodology to be employed to answer the research question as to why girls do not take science.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes the research method, and the research tools adopted in this study. The purpose of the study was to investigate girls' participation in science in a rural school. I wanted to be able to add to our understanding of why many girls do not participate. The study was as much to do with the observational questions as it was trying to answer the question of why girls are not choosing science. To do this I chose a case study methodology in order to obtain a good description of my case. To answer the research questions, the instruments that I used were interviews, questionnaires and classroom observations. I did this in my school with 800 learners and I chose Grade 9 and 10. The data were coded and analysed and the findings arose through interpretation of the qualitative and quantitative data collected.

3.2 RESEARCH METHOD

The study attempted to answer the following key research question: *What influences girls in their decision to choose to study Physical Science at a rural school?*
The following sub questions guided me in answering my key research question:

(a) Are there any differences in participation between boys and girls?
(b) What influences their choice in Grade 9?
(c) Were Grade 10 learners happy with their subject package choices made at end of grade 9?

This study aimed to gain an in-depth understanding of why girls at a rural school are reluctant to choose Physical Science in their subject packages. A case study of one rural school was chosen as the best method in my context to answer the research questions. I chose to employ this method because it would give me an opportunity to concentrate on

one specific situation within a limited time scale and with limited resources. As noted by Cohen, Manion and Morrison (2000), "A case study provides a unique example of real people of real situations, enabling readers to understand ideas more clearly than simply by presenting them with abstract theories or principles" (p.181). A case study method, like other approaches, has advantages and disadvantages. Stressing the advantages of case studies, Adelman et al., (as cited in Bassey, 1999) point out that:

- Case studies do not allow generalisations either about an instance or from an instance to a class. Their peculiar strength lies in their attention to the subtlety and complexity of the case in its own right.
- Case studies recognise the complexity and 'embeddedness' of social truths. By carefully attending to social situations, case studies can represent something of the discrepancies or conflicts between the viewpoints held by participants. The best case studies are capable of offering some support to alternative interpretations.
- Case studies, considered as products, may form an archive of descriptive material sufficiently rich to admit subsequent reinterpretation.
- Case studies are 'a step to action'. They begin in a world of action and contribute to it. Their insights may be directly interpreted and put to use (p.23).

Data were obtained through a number of instruments. A triangulation technique was used to verify data. Adelman et al., (as quoted by Cohen et al., 2000) say "Triangulation can be a useful technique where a researcher is engaged in a case study" (p.115). The triangulation method allows for the data collected from different research instruments to be compared and validated. Cohen et al., define triangulation as the use of two or more methods of data collection in the study of some aspects of human behaviour. I therefore employed this approach to enhance the validation and reliability of the study findings. For example, the learner interviews probed the written reasons given in the questionnaire and the observations were done to verify the classroom interactions spoken about in interviews.

The investigation gathered both qualitative and quantitative data with an interpretative approach used for analysis and interpretation (Burgess, 1983). The instruments used were questionnaires, interviews and classroom observations that enabled me to gather qualitative and quantitative data in order to explain why the proportion of

girls at a rural school is lower than that of boys. A quantitative approach (structured questionnaire) was used to provide more information about girls' stated interests in learning Physical Science while the qualitative approach (unstructured interview) facilitated an in-depth discussion and understanding of girls' feelings in a physical science class. This allowed subjects to express their views freely.

3.3 DESCRIPTION OF THE CASE

This research employed a case study methodology (Merriam, 1988) which my research questions required. The target population within the school was Grade 9 and Grade 10 physical science and non physical science learners. The science teacher was involved in the study. It was not appropriate or possible with my resources to include all learners in the school in the study. The grade 9 classes were chosen from all the grades in the school because they were required to make subject choices that year, which would come in to effect when they started Grade 10. They were chosen as the key informants for this case study. I also decided to include Grade 10 physical science learners (those who have already chosen the subject) and Grade 10 non-physical science learners were also included in order to verify their choices, that is, to find out from them if they were still comfortable with their subject choices. As far as the learners selected for interview were concerned, they were chosen at random from the classes but a gender balance was deliberately maintained. Six Grade 10 physical science learners (3 girls and 3 boys) and four Grade 10 non- physical learners (2 girls and 2 boys). Because of the limited time available to me for this study, I decided to choose the above-mentioned number of learners as I felt the ten interviews would provide sufficient insight into their choices of subject package and satisfaction with that choice. The interviews were conducted on an individual basis. The science teacher was also interviewed. She is an experienced science teacher who started teaching in 1995 and holds a Bachelor of Science degree and a Secondary Teachers Diploma. She has attended a number of physical science workshops to develop herself in the field of teaching. She teaches three grades of physical science i.e. Grades 10, 11and 12 and Mathematics in Grade 8. The principal teaches the chemistry section in Grade 12. As a result of the shortage of science teachers, the school is forced to use teachers who have no science background to teach Natural Science to Grades 8 and 9.

The study was conducted at a rural high school. I chose this school because I work on the research site and the subjects would be easily accessible and data could therefore be easily collected. The school is situated in a rural area in Loskop district near the Drakensberg mountains lying about 30km from nearest town. The school was founded in 1979 and had its first Grade10 science group in 1981. It was formerly under the control of the KwaZulu Department of Education and Culture. This school admits both girls and boys. Physical Science is offered from grade10 to 12. Learners have three subject packages to choose from: Science, Commerce and General. The majority of learners come from a poor socio-economic background. Most of them were born and bred in this area and are cared for by their grandparents out of a pension allowance. Their parents are either unemployed or are away in cities like Durban and Johannesburg doing unskilled labour jobs. As a result, many learners cannot afford to pay the school fees, which are R65 per year per learner and therefore the school's annual budget is very low. This has implications for teaching and learning at this school. It is under-resourced because of the limited budget and operates under very difficult conditions. The school cannot afford to buy all the necessary teaching and learning aids. It is even difficult to buy all the consumables required for the practical work prescribed in the science syllabus. It does not have the necessary textbooks for learners to consult and this also makes difficult it for teachers to organise lessons. Learners fully rely on stationery and textbooks supplied by the Department of Education.

3.4 DATA COLLECTION STRATEGIES

In order to collect data required to answer the research questions, questionnaires, interviews and classroom observation have been used. The major source of data was the questionnaire, filled in by the learners.

3.4.1 Questionnaires

Motivation for questionnaire use: The major tool used in this case study was the questionnaire. Goddard and Melville (2001) define a questionnaire as a printed list of

questions that respondents are asked to answer in order to answer the research questions. Some reasons for choosing questionnaires are:

- A questionnaire provides access to large groups. For this research, the use of the questionnaire technique was important because in the school there were more than 60 grade 9 learners and so a questionnaire seemed to be appropriate to gather the required data. As noted by Cohen et al., (2000) "Questionnaires are a relatively inexpensive method of gathering information, they allow for easy data collection for a large sample" (p.248).
- Questionnaires permit the collection of reliable and reasonably valid data, cheaply and in a short space of time. Munn and Drever (1990) summarise the advantages of using questionnaires as follows: an efficient use of time, anonymity (for the respondent), the possibility of a high return rate and standardised questions.
- Questionnaires can consist of both closed (structured) and open-ended (unstructured) questions. Open-ended questionnaires were used in this research in order to allow respondents to express their personal opinions, so that deeper interpretations could be obtained i.e. to allow for flexibility and full explanations.

Construction of the questionnaire: The first questionnaire for all learners in grade 9 only had closed questions (Appendix A). The different choices offered were those which the literature suggested were most common reasons in other studies. After analysing the responses, it was decided to include more open ended questions in the questionnaires to the same learners now in grade 10 the following year (Appendix B). A separate open ended questionnaire was produced for those who had decided not to choose science (Appendix E). It was hoped that by giving learners an opportunity to respond by giving their own reasons rather than selecting from set categories, would provide richer data.

Administration of questionnaires: The process of filling in the questionnaires was divided into two phases. The first phase took place in October 2002, filled in by all Grade 9 learners at the time they had to choose their subject package. The second phase took place in July 2003, filled in by Grade 10 physical science and non-physical science learners. This was six months into the following year during which they had started their new subject packages. The process of collecting data took a week to complete. In each case, the filling in of questionnaires was done in the classroom. I indicated to the learners that this exercise

was voluntary. It was done during breaks, in my presence, so that clarification of questions could be given where it was required. The need for honesty was emphasised when filling in these forms. All learners both boys and girls readily participated. However, I experienced some difficulties in trying to convince them that it was not a test as it was the first time they had completed a questionnaire. Some of them thought that it was a test whose results might count into their year-mark. To overcome this problem, I explained fully to them the purpose of the study and also elaborated on what was required of them. It was indicated on the questionnaires that it was not a test but an exercise that was designed to gather information about the participation of girls in science.

3.4.2 The Interviews

The rationale for using interviews as one of the strategies for data collection in this research, stemmed from the suggestion made by Cohen et al., (2000) that "Interviews enable participants to discuss their interpretations of the world in which they live and to express how they regard situations from their own point of view" (p.267). Bearing the above suggestion in mind, I realised that the interview technique would be a suitable research tool. The interview technique allows for opportunities to solicit attitudes and understandings about issues that were experienced by learners and the teacher during classroom interaction. As the learners' attitudes and opinions were the basis of this study, the interviews were appropriate, as they would allow the researcher to see all subjects face-to-face, that is, to get the true feelings of the subjects. The interview technique was used, as it would give me the individual learner's feelings about his/her choice of subjects. Kvale (as cited in Cohen et al., 2000) regards an interview as an interchange of views between two or more people on a topic of mutual interest. Stressing the purposes of interviews, Cohen et al., points out that

- Interviews may be used as a principal means of gathering information which has a direct bearing on the research objective.
- Interviews may be used to test hypotheses or to suggest new ones or as an explanatory device to help identify variables and relationships.
- Interviews may be used in conjunction with other methods in a research undertaking (p.268).

Construction of the interview schedule: The interview schedule for both the learners and the science teacher was designed for the study. It also contained semi-structured questions to yield qualitative data related to the research questions. This idea stemmed from the suggestion by Cohen et al., (2000) that, the semi-structured interviews allow for follow up questions and clarifications so that the researcher could go deeper into the feelings of subject. Questions were worded in everyday language and the use of unfamiliar technical terms was avoided. The interviews focused on Grade 10. This group, I thought, would give me detailed information with regard to: their interest in learning Physical Science, feelings in a physical science class, their interactions in a physical science class, peer influence and family influence. The interview technique is relevant when the researcher wants to explore something in depth, when he wants to get a better understanding of the information gathered. When constructing the questions, I kept on asking myself the following question: Do I need such information to answer my research questions? Will this information help me to understand why girls choose or don't choose science?

Administration of interviews for *Learners:* The interviews took place in the science laboratory during the lunch breaks. I chose this venue for these interviews, because it was a quiet room on the school premises and it was also cool during hot days. Moreover, I wanted to eliminate any disturbances that could have affected the interviews proceedings. I first explained to the learners what the purpose of the interview was and also what was required of them. I indicated that all information given would remain strictly confidential. I also informed them that a tape recorder would be used to capture the information. I also indicated to them that they were free to use their mother tongue in answering questions. This was done to make it easier for them to express their views freely and explore their ideas without the difficulty of a language in which they had limited proficiency. During the interview, notes were taken from time to time. These interviews took place over a period of five days.

The science teacher: This interview took place in the science laboratory during non-teaching periods. The purpose of the teacher interview was to listen to her views on the gender differences in the science class. When constructing the interview questions (Appendix F), I was guided by the research question: What influences girls in their decision to choose to study Physical Science? The purpose of the interview was explained

to the teacher, before the formal interview started. Confidentiality of all information given in this interview was also discussed. I initially planned to use the tape recorder in this interview but the teacher did not wish to be recorded. As the interview proceeded, I took notes. The interview with the teacher was conducted over two days in two sessions of thirty minutes each.

The procedure for data analysis: As the interviews were tape- recorded, I had to transcribe them. Those that were conducted in mother tongue, had to be first translated, then categorised and classified according to the themes of the study. A rough analysis was done first to identify statements that fitted existing categories and looked for new thoughts on girls' participation. When doing the analysis of interviews, I looked for patterns, overlapping of points, similarities and differences in the opinion of respondents. Thereafter, a more detailed transcript was done. I then grouped similar statements together to provide supporting evidence to the questionnaire results. This idea stemmed from the suggestion made by Cohen et al., (2000) when identifying the methods of handling interviews they suggested the following methods:

- looking for the total pattern of choice
- looking for the similarities and differences of opinion among respondents
- grouping items together

The above approach allows for generalisations to be made about participants' opinions. This prompted me for example to count the number of respondents who unanimously agreed with a particular point.

3.4.3 Classroom observations

The main purpose of the classroom observations was to observe the interaction patterns that exist between the science teacher and the learners and also between the girls and the boys. Patton (as cited in Cohen et al., 2000) highlights the purposes of observation as " it enables researchers to understand the context of programmes, to see things that participants might not freely talk about in interview situation" (p.205). Based on the idea given above, it is clear that the main advantage of collecting data using the observation tool was to allow the researcher to come closer to the situation under study and thus gain a realistic picture of that situation.

A direct non-participation observation method was used i.e. the observer did not participate in the lesson except to write notes on the observation schedule in which interaction patterns were noted. A direct observation method allowed for structured observations of these interactions. Cohen et al., (2000) say, "A structured observation is very systematic and enables the researcher to generate numerical data from observation" (p.306). The observations took place in two physical science lessons. The science teacher had been informed beforehand that I would be visiting the class. My main focus was to observe interaction patterns. The observation schedule was used to record how many times the teacher interacted with boys or girls or how many times the learners interacted with one another. As noted by Cohen et al., (2000) "This method is useful for finding out the frequencies or incidents of observed situations or behaviours so that comparisons can be made" (p.308). Observations included watching and listening to learners talking to one another. After each lesson, I conducted a short informal interview with the teacher to obtain explanations for certain kinds of behaviours observed during the lesson. Detailed notes from observations in two lessons were analysed.

3.5 SUMMARY

Below in Table 3.1 is a summary of the data collected and analysed in order to answer my research questions. This chapter has dealt with the methodology used in the study, namely, the case study. The case study was presented and the background of the research site was also described and discussed. The rationale for using a case study method was discussed. The reasons for using each of the instruments to collect data, namely, the questionnaires, interviews and classroom observations were discussed. A description of each instrument has been given and also the manner in which it was structured. The procedure for data collection as well as how it was analysed, was provided. Data analysis and findings will be discussed more fully in the next chapter.

Table 3.1 Summary of data corpus

Instrument	Subject	Number	Year
Questionnaire	Grade 9 All students	86	2002
Questionnaire	Grade 10 Non-Science	46	2003
Questionnaire	Grade 10 Physical Science	75	2003
Interview	Grade 10 Non-Science	4	2003
Interview	Grade 10 Physical Science	6	2003
Interview	Science Teacher	1	2003
Observation	Grade 10 Physical Science	2	2003

CHAPTER 4
PRESENTATION OF FINDINGS

4.1 INTRODUCTION

In summary, this study was designed to investigate girls' reasons for participating in science or choosing not to do Physical Science as a subject at school. Data was collected from the actual learners who had made the decisions. The study obtained data from a population of learners in one school when they were in grade 9 and then again when in grade 10. While the grade 9 learners were treated as one group, they were divided into physical science and non physical science learners for the grade 10 data collection. The data collection took place in two phases. The first phase was conducted during October 2002 to June 2003 and the second phase was conducted from the period July to October 2003. In addition, a number of interviews were done to support the questionnaire data.

4.2 THE QUESTIONNAIRES

The first sets of questionnaires constitute the first phase of the project. It sets out to investigate Grade 9s' interests in Physical Science and the extent to which friend, the home and the school affect them in choosing the subjects they will study in Grade 10.

4.2.1 The first phase

This section discusses the data collected from Grade 9 learners who were choosing their subject packages for the first time.

The subject interest: Learners were asked to indicate the subject package they liked most. They were expected to choose from the following: Physical Science, History and Accounting. Fifty-two questionnaires for girls and 34 for boys were analysed. The responses are provided in Table 4.1 below. It can be seen that when learners were given an option to choose between History, Physical Science, and Accounting packages, only a

small percentage of girls chose the science package. Of the 52 girls, sixty-one percent chose Accounting which was the most popular choice, followed by Physical Science (23%). The least popular choice was History (16%). On the other hand, seventy percent of boys showed a keen interest in studying Physical Science while History was also the least popular subject for boys.

Table 4.1 Responses of Grade 9 learners with regard to choice of subject packages.

		Girls n = 52	%	Boys n = 34	%
a	History	8	16	3	10
b	Physical Science	12	23	24	70
c	Accounting	32	61	7	20

Influence of friends, home and the school: When asked to indicate the reasons why they had made these choices, 48% of girls indicated that their friends encouraged them and 37% said family members influenced them. However, for boys, these were not as important as it was 7% and 23% respectively. Fifty-eight percent of boys indicated that their future career was most important reason for choosing science for them. This has been summarised in Table 4.2. Girls have very different reasons to boys for choosing their subject packages. It would appear that boys are very career oriented while girls are more people oriented.

Table 4.2 Reasons why Grade 9 learners chose the Science package.

		Girls n = 52	%	Boys n = 34	%
a	Encouraged by friends	25	48	2	7
b	Encouraged by family	19	37	8	23
c	Encouraged by teachers	0	0	4	12
d	Future career requires it	8	15	20	58

4.2.2 The second phase

After completing the first phase, I submitted it to my supervisor, Dr Paul Hobden, to have a look at. We then discussed the findings, and he recommended a second phase of investigation which would involve the Grade 10 physical science and non- physical science learners. These learners had already chosen their subject packages and they were half way through the year. The second phase was conducted from the period July to October 2003. The purpose of conducting this phase was to find out from the Grade 10 learners (Physical Science and Non-Physical Science learners) whether they were still comfortable with their subject choices.

Non-physical science learners: These learners had chosen not to study Physical Science in Grade 10. Learners were asked to indicate the reason why they did not choose to study Physical Science in Grade 10. The responses are provided in table 4.3 below.

Table 4.3 Reasons why non-physical science learners did not chose science

	REASONS	Girls n = 29	%	Boys n = 17	%
a	Discouraged by teachers	6	21	3	18
b	Discouraged by family members	7	24	3	18
c	Discouraged by friends	3	10	2	12
d	Physical science is difficult to do	9	31	1	6
e	I had no interest in Physical Science	4	14	7	41
f	I dislike physical science teacher	0	0	1	6

In general, it appears that boys and girls again give different reasons for not choosing the science package. "Physical Science is difficult" was the prime reason for girls with 31% giving this reason and 24% indicating that they were "discouraged by family members". On the other hand, 41% of boys indicated that they were not interested in Physical Science. In linking this to the first questionnaire, which they completed in grade 9, the girls said the family and friends would influence them the most. Now that they had chosen their subject package, and they were half way through the year, I asked them why they did not choose Physical Science and they said it is more because of the difficulty and less because of their family and friends. These results are different to the first questionnaire. The reason is that

in the grade 9 questionnaire the learners were not asked why they have not chosen a particular package. The focus was on reasons for choosing a particular package. In hindsight, this was a questionnaire design flaw. Had "difficulty" been offered as a choice, the learners may have mentioned it as a factor in which case the percentages for family would have been lower. Given the above, a significant percentage of over 30% of the boys and girls still chose family and friends as an influence.

Physical Science learners: Learners were asked if they were still happy with their subject choices (science package). In responding to the question, learners had to answer "Yes, or No". The summary of the responses is given in Table 4.4

Table 4.4 Responses of physical science learners

		Girls n = 24	%	Boys n = 51	%
a	Yes	10	42	46	90
b	No	14	58	5	10

The examination of the Table 4.4 shows that boys were still happy with their choices while more than half of the girls were unhappy. This is indicated by the fact that 58% of girls wanted to change while 90% of boys said they were still comfortable with Science package. In a section of the questionnaire dealing with the open-ended questions, a number of reasons were given by those who answered "No" (i.e. 19 learners), meaning that they were "not happy with their choices". The responses are provided in Table 4.5 below.

It can be seen that the factors "Discouraged by family members" and "Physical Science is difficult" are the main reasons offered for girls wanting to change. This is indicated by 50% and 42% respectively and is further supported by the following comments. One girl said: "I failed the first quarterly test in March, and I had to battle to understand this subject" and another one said: "Science involves too many experiments and calculations and I found the subject difficult for me". In as far as family influence is concerned, one girl said: "My parents advised me to change because I have been failing Physical Science since the beginning of the year" and another one said "Physical Science is a very tough subject for me. My brother advised me to do commercial subjects".

Table 4.5 Reasons why physical science learners wanted to change to another subject package

	REASONS	Girls n = 14	%	Boys n = 5	%
a	Discouraged by teachers	1	8	0	0
b	Discouraged by family members	7	50	1	20
c	Discouraged by friends	0	0	1	20
d	Physical science is difficult to do	6	42	0	0
e	I had no interest in Physical Science	0	0	2	40
f	I dislike physical science teacher	0	0	1	20

When the physical science learners were asked to give advice to Grade 9 learners, boys and girls did not show differences in their advice. From seventy-five questionnaires which were analysed, 80% of the learners advised Grade 9 learners to choose the physical science package. They mentioned the fact that Physical Science is for all learners irrespective of gender and learning abilities. They dismissed the beliefs that science is for boys only. The following comments are from a boy and a girl. A boy said: "I do not believe that science is for boys only. Science is for all those who need it for their future career" and a girl said "Science is for all learners although it sometimes appears as if boys like it more than us. It is because boys tend to be very active than girls." However, two girls advised girls not to choose the science stream as they claimed that science is hard to do. This is what one had to say: "I found science difficult; I therefore do not advise girls to do it". Another learner warned off all learners: "Science involves too many formulae and it is hard to remember them so I would advise everyone to think carefully before choosing it".

4.2.3 Summary

In examining the learners' responses in the questionnaires, it appeared that the original factors mentioned in Grade 9 were still strong in Grade 10. Girls and boys offered different reasons for not choosing science. Overall boys choose science more for the career opportunities while girls choose it because they were influenced by friends and family. However, a new factor that was offered to them in grade 10 was that science was difficult

and this was a popular choice by the girls. It appears that after doing Physical Science many girls are unhappy with their choice because they find it difficult and are encouraged to change by family members. Those boys who were unhappy indicated that they had no interest in the subject. However, nearly all would encourage learners to take Physical Science.

4.3 INTERVIEWS

Data were collected from ten interviews with learners. These consisted of six Grade 10 physical science learners (3 boys & 3 girls) and four Non-physical science learners (2 boys and 2 girls). In addition, the science teacher was interviewed. This study used semi-structured interviews, as they were less formal. They allowed for questions to be repeated and to be changed in order to suit the situation. They allowed me to clarify anything they were uncertain about and allowed me to request additional information when a response seemed incomplete or not entirely relevant. Most questions were open-ended to encourage explanation.

4.3.1 Grade 10 learners

Questions were asked to obtain data on (a) learners' interest in learning Physical Science, (b) the learners' views on Physical Science, (c) the influence of the school, (d) the influence the home environment, (e) peer influence and (f) physical science role models.

a) Learners' interest

The physical science learners: When learners were asked to comment on their interest in learning Physical Science, there were not significant differences between the responses of the different genders. For example, out of three girls interviewed, two indicated that they liked science and they even cited the fact that science was interesting and was important for their future career. This is illustrated by the following comments from two girls. One girl said "I like science. I require it for my future career" and another one said: "I love science but my performance is not satisfactory." All three boys interviewed indicated that they are interested in science, as they needed it for their future career. Generally, the

findings on this question indicated that both boys and girls were interested in Physical Science. However, one girl indicated that, her love of science had deteriorated because of her poor performance in science and mathematics. This was illustrated by her comment that "I initially had love of Physical Science, but because I always get lower marks in tests and examinations I am no more interested in it and in Mathematics as well."

Non-physical science learners: Generally, the learners' responses again indicated no gender differences. The analysis showed that all two boys and one girl interviewed, had been interested in learning science while they were still in lower grades but certain learning factors prevented them from continuing with science studies. They mentioned, among other things the many calculations, the practical work and their poor performance in Mathematics and General Science in lower grades. The following quotations illustrate their views. A boy said:" When I grew up, I intended to do chemical engineering, but my poor performance in both Mathematics and general science blew my chances away of studying science." A girl said " Initially, I had a great love of science but as I studied further, I realised that science is hard to learn especially calculations."

b) Learners' views on Physical Science

Learners were asked to comment on the following statements: "Science is for boys only" and "Science is for smart learners". The question was posed to both science and non-science learners. In both cases, learners dismissed these beliefs. Boys and girls interviewed unanimously agreed that Physical Science was for all learners who intend to study it irrespective of gender and learning abilities. This is illustrated by the following remarks. A boy said "I do not believe that science is for boys only. Science is for all those who need it for future careers" and a girl said, "Science is for all learners, although it sometimes appear as if boys like it more than us it's because they tend to be very active in science activities than girls."

c) The influence of the school environment

The question required them to comment on what they enjoyed most or least in science classroom and they were also asked to comment on the treatment they received from co-learners and teachers.

The physical science learners: From the interview, it emerged that both boys and girls enjoy student-student interactions i.e., working in groups especially in practical work. However, girls felt they were not treated equally by the boys. Three girls, who were interviewed, criticised boys for their misbehaviour towards girls during science lessons. They mentioned the discouraging remarks made by boys that contributed to their low participation in science activities. The following quotes from two girls illustrate this. One girl said: "I do not like remarks by boys in our class. They like to laugh at you when you do not answer the teacher's question correctly" and another one said "Boys like to harass girls in class. I feel not secured when working with them."

Non-physical science: Both boys and girls indicated that they received different treatments from each other in the classroom. This is illustrated by the following. A girl said: "Boys like to discuss things that are not related to the lesson when we work together in groups, for example they like to propose love" and a boy said: "I cannot concentrate when working with girls because they became noisy and playful".

Furthermore, both boys and girls (physical and non-physical science) indicated that, there were no noticeable gender differences in the treatment they received from their subject teacher. However, one girl expressed a concern that gender equity is not practised in their class. She said: "In our class, boys are given more responsibilities than us. The class captain is a boy and the group leaders are also boys." When this issue was raised as a follow up question to all other learners, girls said that this was not an issue affecting their class only, as there were many classes in the school where this issue was practised. They cited as the reason that boys seem to be more active than girls.

d) The influence of the home environment

When learners were asked to comment on the influence that the home had when choosing the subjects for their future career, both boys and girls unanimously agreed that the home environment had a great influence on their subject choice. They said that family members decide for them what to choose in Grade 10. This is illustrated by the following quotations from a boy and girl in each group. A boy from the group doing Physical Science said "I was advised by my elder brother, to choose mathematics and science because I want to become a medical doctor when I finish school" and the girl from the

same group said "Yes, I got influenced from home because I just followed what everybody chose at home." A girl from the group not doing Physical Science said "My aunt is a school teacher, she advised me to choose accounting because I was not performing well in science" and another girl said "My parents have never been to school to guide me in selecting subjects, I just followed my older brother's footsteps to do accounting." A boy from that group said "My parents wanted me to become a bank teller and I therefore respected their decision."

e) Peer influence

When learners were asked to comment on the influence of their friends in choosing their career subjects, generally it was found that there were no gender differences in the responses on this question. Both boys and girls indicated that their friends in one way or another influenced them at some stage. For instance, two girls out of three indicated that, the influence they received from their friends persuaded them to choose a science package. This is supported by the following remarks from two girls. One girl said: "When I was doing Grade 8, my friends and I used to discuss about subject we gonna choose for our future careers. So when we passed Grade 9 we all chose science" and another said "My friends in Grade 11 encouraged me to choose science so that we could do a nursing course after matric."

Boys also agreed that their friends had influenced them but they highlighted the fact that they did not allow their friends to decide for them. The following quotations from the two boys illustrates this. One said: "I used to study together with my friends and we always encouraged one another to do well in school work but I do not allow them to decide for my life" and another one said "Yes, I do things together with my friends but I always evaluate what they want me to do in their favour."

f) Physical science role models

Learners were asked to mention three to five names of persons of their gender who resided around their homes and who had successfully studied Physical Science and pursued a career in a science related jobs. The question was posed to both science and non-physical science learners. Three boys interviewed mentioned five or more male persons who had studied Physical Science and pursued a science related job. Two girls said they did not

know any female who had studied science residing around their homes or who was a member of the family.

4.3.2 The science teacher interview

The main purpose of interviewing the science teacher was to validate the information received from learners and also from the classroom observations. The interview questions sought answers regarding the following (a) learners' attitude to Physical Science and (b) the influence of the classroom environment in learning.

a) Learners' attitude to Physical Science

The first question sought information about the learners' attitudes to Physical Science. The science teacher pointed out that, generally boys show a keener interest in learning science compared to girls. This is illustrated by the following remarks: "Girls generally have a less favourable attitude towards Physical Science and tend to perceive it as a difficult subject." She supported her statement by pointing out that the most obvious problems with girls were the lack of confidence, shyness and poor self concept and that they consequently develop a negative attitude towards science. Asked to comment about the level of interest by girls to becoming future scientists, the teacher said : "The high drop out rate and poor performance by girls indicates that many girls have a low interest in becoming future scientists, one of the reasons perhaps been that there are no female science role models in this area."

b) The influence of the classroom environment in learning science

The teacher was asked to comment on the level of enthusiasm displayed by both boys and girls in science lessons. The teacher's response indicated that there are gender differences. This is indicated by the following comment: "What I have noticed is that girls are less active when compared to boys. Girls often show a fairly low confidence in the classroom in dealing with science problems and consequently they have lower achievements." Asked to comment about how she assigns duties in the classroom for both boys and girls she said, "I prefer to assign more responsibilities to boys because boys tend to be more active and responsible than girls."

4.3.3 Summary

From the learners' interview responses (both physical and non-physical science) the influence of family members and the belief that Physical Science is difficult, were generally the prime factors influencing girls' decisions about participation in science. However, friends tended to influence girls more than boys in their choices. When participating all learners have positive attitudes which change to negative if they do not achieve well. Girls indicate that this is a result of the subject being difficult but boys attribute this to a loss of interest in the subject. Most of the learners reported that they believe that Physical Science was for all learners. This was evident when the non-physical science learners supported the views of the physical science learners in an interview. From the science teacher's responses, it appears that gender difference do exist during teaching and learning as she perceived both genders differently. She regards girls as having less confidence in dealing with challenges in the classroom when compared to boys. From science teacher's views, the chances are that within the classroom situation, girls will not participate as much as boys. This supported the girls comments that the boys were generally favoured in the classroom by the teacher and they felt uncomfortable by the boys' actions toward them.

4.4 CLASSROOM OBSERVATION

The observation exercise took place over two days during two science lessons. My interest was in observing teacher-learner and learner-learner interactions. I was interested to see how girls were treated during science lessons in terms of opportunities for involvement. After observing two lessons, I analysed the observations and the data are presented in Table 4.6. The observation exercise took place in Grade 10A, the only Physical Science class in this grade. There were 75 learners in this class i.e. 51 boys and 24 girls with an age average of 16 years. The classroom had one chalkboard and a notice board at the back. The desks were arranged in conventional rows facing the front. Learners shared desks with peers of the same gender. The class had a nice comfortable atmosphere to me. Two lessons were observed and are described below.

Lesson 1: The lesson topic was chemical bonding. At the beginning of the lesson, the teacher referred to the section in the textbook dealing with the topic and wrote the heading on the chalkboard. She then explained using diagrams. As the lesson progressed, she posed several questions to the class. She then gave the learners a worksheet on which were about ten questions, all dealing with the topic. Some learners worked individually, others in groups of two or three. While the learners were working, the teacher moved around, interacting with them, suggesting things to do and answering questions. She kept control over the class behaviour.

Lesson 2: The next day, the science teacher revised what she had taught the previous day. She then went over the correct answers. She obtained some of the answers from the learners and others she told them. She then created a chalkboard summary which she asked them to copy into their exercise books. She then divided the class into nine groups having eight learners in each and one group which had eleven learners. She asked this group to occupy the position in front of the class. There were two groups with only girls and three with boys only. The rest were mixed groups. Learners were given a worksheet with exercises on chemical bonding. While the learners were working, the teacher moved around assisting those who needed help. Towards the end of the lesson, she summarized the lesson and gave the class their homework.

4.4.1 Analysis of interactions

The analysis of this data is provided in Table 4.6 below. This study uses the term interaction to refer to all verbal communications (asking questions, answering questions, general conversation). Examining Table 4.6 it can be seen that in total, there were 312 interactions. The teacher was involved in 205 and the learners had 107 amongst themselves. As data were collected from fifty-one boys and twenty-four girls, girls were outnumbered by boys approximately two to one. Therefore, for every interaction with a girl there should be two with the boys. On the whole interactions were reasonable equitable if the totals are looked at i.e. 80 for the girls and 177 for the boys. However, it is interesting to note that the teacher asked the boys proportionally more direct questions than the girls i.e. three to one ratio. Also, the girls asked proportionally far more questions than the boys i.e. they asked 25 questions so the boys should have asked 50 but in fact only

asked 36. They appear more "active" than the teacher indicated in her interview. However, the bias toward the boys from the teacher fits her understanding of the boys being more active.

Table 4.6 Analysis of classroom interactions

INTERACTIONS	General with Class	Girls with someone	Boys with someone
Girl to teacher		25	
Girl to class		15	
Girl to girl		10	
Girl to boy		8	
Teacher to girl		22	
Boy to teacher			36
Boy to class			33
Boy to boy			33
Boy to girl			8
Teacher to boy			67
Teacher to class	55		
TOTAL	55	80	177

Unfortunately, given the time and resources available for this study, it was not possible to analyse deeper, for example, to look at the effectiveness of interactions or the length of interactions. The study could also have looked at how many times the science teacher interacted with the same learner. In addition, the type of interaction could have been studied because there was a perception that the girls were shy and uncomfortable while the boys showed confidence. However, there is no data to support this assertion. In hindsight it would also have been useful to know how the differently constituted groups interacted e.g. did the questions for the teacher come from the all girl groups or from girls in the mixed groups.

CHAPTER 5
DISCUSSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter will focus on a summary of the main findings of the study based on data obtained from the questionnaires, interviews and classroom observations. In addition, I will discuss my findings with what the available literature on girls' participation is saying. In my discussion, I will be guided by the research questions and this will be followed by recommendations which suggest ways to improve the participation of girls in science in a rural high school.

5.2 SUMMARY OF THE MAIN FINDINGS

The study attempted to find answers to the following key research question: What influences girls in their decision to choose to study Physical Science? In order to answer this key question a number of sub questions were formulated and the findings associated with each are discussed below.

5.2.1 Is there any difference in participation between boys and girls?

In grade 10 within the school under study, there are approximately equal number of boys and girls. However, when it comes to examining the science class there was a two to one ratio with the girls in the minority. On the other hand, in a subject like accounting there was a majority of girls. The participation rates were definitely skewed toward a lack of participation on the part of the girls in Physical Science. This occurs despite their apparent interest in science in the earlier grades and agreement by all learners that girls should be encouraged to choose science because of its importance. This drop in enrolment in science is disappointing given the Government focus on equity and the encouragement it given to women to do science. The pattern continues to fit that of low enrolment found in other earlier studies such as Reddy (1998) and Haambokoma (2000).

compelling evidence that the same situation exists in this rural school and the classroom environment has a negative influence on girl's choice of Physical Science.

3. P*eer influence.* Peer influence has a major influence over the girls' subject choices. This was found in the response to the questionnaires where nearly half of girls indicated that they were persuaded by their friends to choose their subjects. When girls were interviewed, they indicated that they were influenced by what their friends were doing. A much lower percent indicated that their friends actively dissuaded them from taking science. However, boys did not indicate the same degree of influence by their friends. In interviews, they indicated some resistance to being told by their friends what to choose. Similar findings for girls were reported by Ditchfield and Scott (1989), and Forrest (1992) that peer pressure forces learners to follow their friends. Thus, peer influence is undoubtedly influential factor in girls' subject choice

4. *Female role models.* The shortage of women in scientific and technologically oriented jobs demotivates girls to choose science subjects. When I interviewed the science teacher, she mentioned this as a factor. In interviews with girls, they pointed out that this was an important reason why they are reluctant to pursue science related jobs as they do not know any local people who have successfully followed this route. If I look at the literature, this factor comes up a number of times. Backer (1998), Haambokoma (2002), Kelly (1994) and Reddy (1998) all mention the shortage of female scientists as role models as a contributing factor to the low participation of girls in science. Thus, I have no doubt that this is a contributing factor and has an indirect influence on their choice.

5.2.3 Were Grade 10 learners happy with their subject package choices made at end of grade 9?

Many girls appeared to be unhappy with their choices while most boys were absolutely happy. This was reflected in their responses in the questionnaires where 58% of girls wanted to change from a science package while 90% of boys were comfortable with their choices. Girls cited as their main reason that science was difficult and they were not achieving. This comes up a number of times in literature. Kahle and Meece (1994) pointed out that girls tend to rate themselves lower than boys in science subjects and thus develop a low morale and consequently perform poorly in these subjects. These claims are supported by Ditchfield and Scott (1987) who argued that the majority of girls, in a secondary school, develop a self-concept which underestimates their academic abilities.

From these claims, it is obvious that the girls' self-esteem and self-confidence will be low, their performance will be poor, and hence they will be unhappy with their choices.

5.3 RECOMMENDATIONS

Considering the findings of this study, I would I like to conclude this presentation of findings by giving a constructed scenario using an imaginary rural girl. In doing this, I will first look at the current situation at a rural school and secondly visualise what would be a preferable situation in the future. Taking as an example, a girl who lives in a rural community and decides to go to school, this is basically what would happen.

The current situation:. She comes to school and finds that in Grade 9 everybody does compulsory subjects including Natural Science which she finds interesting. During Grade 9, she now has to make a decision between History, Accounting and Science packages. In order to do this, she finds that the most influential people are her family members. When she asks for information about science from her parents at home, one of them says: "This not for a girl, you should be doing something like Home Economics so that you can be a good housewife, do not worry about science. It does not matter what you take because you will be at home. Whereas John who is a boy, needs to study science further because he needs it in his career". Her friends are all doing accounting so she follows the advice of family and does not choose science but is influenced by her friends choice to take the Accounting package. When she talks the following year to a friend who chose Physical Science, she finds that she is very unhappy with her choice as the science is very difficult with lots of calculations and she is getting low marks. It appears that the teacher is not very supportive. Within the class there are boys who are saying, "This is not for girls. This is too difficult" When lessons are taking place, she finds that the teacher asks the boys lots of questions to keep them involved. However, she does not want to ask questions because of the comments the boys will make.

Looking to the future: A girl living in a rural area speaks to her parents about choosing science and they say: "You know that science is an important subject for your career. If

you want to leave home and get a career, you need it. There are a lot of opportunities and technological careers in science. But even if you do not achieve that you will need science to be a good housewife and help you in your everyday life." Then when the girl arrives at school, she is encouraged by her teachers and is given reasons for choosing science. When talking about choosing science to her boyfriend, the boyfriend encourages her saying that she will earn a lot of money if she becomes a technologist. Science is for all not just boys. She goes to the classroom and does the subjects of her choice. The teacher asks everyone in the class questions and keeps them all involved in learning. When she finds it difficult, she finds encouraging teachers. Doing practical work, the boys and girls work cooperatively helping each other. There are textbooks which have lots of examples she can identify with and pictures and stories of women doing science related jobs. Despite the struggle, she is happy with her decision.

To move closer to the more improved future situation, I recommend the following:

1. *Staff development workshops.* It was found that the teacher was biased toward the boys in the class and not that encouraging girls in their choice of science. The class environment was one of the factors contributing to the low participation of girls in science. Staff development workshops on gender issues is one possible way of changing the environment and making it more supportive. These teachers will be taught how to handle the two genders in a satisfactory manner in a teaching and learning situation. Gender sensitisation programmes should be set up in school programmes. This will assist teachers to become aware of gender differences and to handle them with sensitivity. They will also be more aware of the many career opportunities for women in science and be able to provide better guidance.

2. *Community awareness workshops.* The study found that the family is a prime factor contributing to the low participation of girls in science. Consequently, we need to work with the community and re-educate families and show them that there is value in their girls studying science with a view to improving their quality of life and possibly taking up scientifically oriented jobs. One way of doing this is to have community workshops to make parents aware of the value of girls studying science both for a career and for life as a homemaker.

3. *Career guidance.* Girls were influenced by family and friends and not by the opportunities offered by studying science. They need to be made aware of these

opportunities through the inclusion of career guidance in all grades as part of school curriculum to enhance career awareness amongst learners. Career guidance would help all learners to learn more about the availability of opportunities in their environment and to understand the specific requirements needed to study further in particular fields. They also need to be made aware of the incentives that are being made available such as bursaries to study and job opportunities reserved for black females. The school could arrange for women from this and other communities who have made a successful career in science to give motivational talks.

4. *Establishment of girls' schools specialising in Science and Mathematics.* Given that girls reported that they felt uncomfortable with boys and the boys found them distracting, a possible solution could be separate classes or the establishment of single sex schools for girls specialising in science and mathematics. This is in line with Shymnsky's and Kyle's view cited in Monk and Amosum (2002). They revealed that in single-sex schools, girls achieve better in science than in mixed gender schools. Gender stereotyping may be eliminated in single-sex schools and girls are likely to be taught all subjects (including science) thus removing beliefs that subject such as Physical Science are for boys only.

5.4 LIMITATIONS

This study was limited by resources available to the researcher and the time he had to invest in the study. It could have studied a number of different cases of school in rural areas. Questionnaires and interviews could have been extended to other rural schools to confirm the reliability of the learners' responses if financial resources had not been a factor. The results, therefore, are limited in terms of generalisability. However, the study was meant to provide a case study of one school so that it could inspire further research in girls' participation in rural high schools and raise issues for research. Examples of areas that could be focussed on are the classroom interactions spoken about earlier. A detailed and long term study of classroom interactions might reveal interesting patterns in both rural and city schools. Further research should also be done on learners who are in same sex classrooms and schools. Although there are not many single sex schools in rural areas

examples do exist and these could be studied and eventually an experimental school constructed. In addition, learners coming from urbanised areas have more knowledge of the science careers available, possibly more contact with role models and the media which does promote these role models. Research could be done on the uptake of Physical Science among these learners. Overall, it is a very rich field for research and this study has drawn attention to some that need attention.

5.5 CONCLUSION

This study explored girls' participation in science in a rural high school. It has uncovered some challenges about girls' participation in science. However, it has made its modest contributions and developed fruitful lines of thought about gender differences in science subjects. The findings have provided some answers as to why the proportion of girls choosing science is smaller than that of boys and why girls are reluctant to participate in science. This study should provide the policy makers, curriculum developers, textbook authors and science teachers with information about the negative factors that demotivate girls in their choice of Physical Science. I hope that through this study teachers, parents and learners will benefit from the contribution I have made by revealing the negative factors contributing to low number of girls choosing to study science. This valuable information hopefully, will assist school management teams and science teachers of rural schools in knowing more about gender issues related to school curricula and factors adversely affecting the performance of girls in science.

To me as a science teacher and the headmaster of a rural school, the study has enabled me to contribute by raising the issue of girls' participation in science and exposing some of the main factors that contribute to the current state of affairs in a rural high school. My new understanding of the gender issues in science will hopefully be shared through publications in teacher journals and at conferences. This gap between girls' and boys' participation in science and the reasons for it, is a serious problem that needs to be addressed. Parents, teachers and the community at large should work hard together to review and change some of the rules and regulations in society that prevent women from participating fully in science education. Suggestions have been made as to how this could be approached. The time has come for everyone to change his/her attitude and let more

rural women participate in Physical Science. There is a great need for our country to increase the number of scientifically qualified women to be able to join the pool of future scientists and technologists.

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APPENDIX A

GRADE 9 QUESTIONNAIRE

QUESTIONNAIRE TO IDENTIFY POSSIBLE FACTORS THAT COULD INFLUENCE GENDER DIFFERENCES IN THE STUDY OF PHYSICAL SCIENCE AT NGIBONGELENI HIGH SCHOOL (NHS)

This is not a test. This questionnaire is to investigate the factors that lead to smaller number of girls choosing science as their future career subject.

NAME (optional).....

GRADE:.....

GENDER:.....

AGE:.....

QUESTION	RESPONSE
1. How many learning areas are you doing at this Grade?	.....
2. Which one of the subject given on the right do you intend to do in Grade 10 next year.	History..... Physical Science..... Accounting.....
3. Rank your interest using a scale 1 – 3 with 1 indicating the highest interest in the subject given on the right.	History ..... Physical Science ..... Accounting.....
4. Why do you choose to study the subject given in question 3 above. Choose from the reasons given on the right. You may choose more than one.	✓ My friends have influenced me..... ✓ Encouraged by my family..... ✓ Encourage by teachers..... ✓ Career requires it.....

APPENDIX B

GRADE 10 QUESTIONNAIRE

NON - PHYSICAL SCIENCE LEARNERS

QUESTIONNAIRE TO IDENTIFY POSSIBLE FACTORS THAT COULD INFLUENCE GENDER DIFFERENCES IN THE STUDY OF PHYSICAL SCIENCE AT NGIBONGELENI HIGH SCHOOL (NHS)

This is not a test. This questionnaires is to investigate the factors that lead to smaller number of girls choosing Science as their future career subject.

NAME (optional):.....

GRADE:.....

GENDER:.....

AGE:.....

QUESTION	RESPONSE
1. How many subjects do you do in this Grade?	.....
2. You did not choose Science. Why? Choose the reasons provided on the right. You may choose more than one	✓ I was discouraged by teachers..... ✓ I was discouraged by my family..... ✓ I was discouraged by my friends..... ✓ Physical Science is hard to do..... ✓ I had to interest in Physical Science..... ✓ I dislike the Physical Science.....
3. If you had an opportunity to change your choice, would you do? Why?	Yes..... No..... Reason..... .....

APPENDIX C

GRADE 10 (PHYSICAL SCIENCE) QUESTIONNAIRE

QUESTIONNAIRE TO IDENTIFY POSSIBLE FACTORS THAT COULD INFLUENCE GENDER DIFFERENCES IN THE STUDY OF PHYSICAL SCIENCE AT NGIBONGELENI HIGH SCHOOL.

This is not a test. This questionnaire is to investigate the factors that lead to smaller number of girls choosing Physical Science as their future career subject.

NAME (Option).....

GENDER:.....

AGE .....

You chose the Science stream and have been studying Physical Science this year.
Are you happy with your choice? Please explain

.....

.....

.....

.....

2. What advice would you give to help this year's Grade 9s to choose a right stream?

.....

.....

.....

.....

THANK YOU FOR YOUR TIME

APPENDIX D

INTERVIEW SCHEDULE
(PHYSICAL SCIENCE LEARNERS)

1. You chose to do physical science in Grade 10, why ?

2. Comment on your interest in physical science.

3. What do you enjoy most or least in physical science class ? When answering this question, please pay your attention to the treatment you receive from your co-learners and your science teacher.

4. Comment on the influence you received from home in choosing subjects you are doing now ?

5. What role was played by your friends in choosing the subjects you are doing now ?

6. Mention three to five names of persons whom you know resides around your home who did science and pursued a career in science.

APPENDIX E

INTERVIEW SCHEDULE
(NON-PHYSICAL SCIENCE LEARNERS)

1. You did not choose physical science in Grade 10, why ?

2. Comment on your interest in physical science.

3. Did the family members have influence in your subject choice ?

4. What are your views about the following statements :
   - Physical science is for boys only
   - Physical science is for smart learners only.

5. Mention three to five names of persons whom you know who resides around your home who did science and pursued a career in science.

APPENDIX F

INTERVIEW SCHEDULE
(SCIENCE TEACHER)

1. What are your views about girls attitude in learning physical science ?

2. Please comment about the girls' opportunities to become future scientists.

3. Evaluate the level of confidence displayed by both boys and girls in doing physical science activities in class.

4. Can you explain why you give more responsibilities to boys than girls in class.