A PSYCHO-EDUCATIONAL PROGRAMME FOR GRADE 10 LEARNERS TO FACILITATE A POSITIVE EXPERIENCE OF PHYSICAL SCIENCE

by

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SUMMARY

The goal of this research study was to provide psycho-educational guidelines that will facilitate a positive experience of physical science for grade 10 learners. The stakeholders in this research study were grade 10 physical science learners and grade 10 physical science educators.

A positive experience of physical science is important for various reasons. One reason is that there is a declining interest in learners pursuing scientific careers (Lepkowska, 1996:33). The main reason for this is that learners do not feel they are able to master the subject. They often do not understand what they are being taught in class and how it is applicable to their lives. Learners therefore experience a "love/hate" relationship with the subject – when they do well in the subject they like it and when they achieve poorly, they hate it. This complex relationship is often misunderstood by physical science educators. Educators often do not realise how they can change learners' experience of the subject. It was one of the main aims of this research study to provide educators with practical guidelines on how to facilitate a positive experience of physical science.

Three main themes were identified during the research:

1. Grade 10 learners' experience of physical science is related to the psychosocial characteristics of the learner and his/her interaction with the environment.

2. Grade 10 learners' experience of physical science is related to the method of instruction or the teaching method thereof in the classroom.

3. Grade 10 learners' experience of physical science is related to the educators' attitude, words and actions towards learners during the teaching of physical science.

These three themes can be further substantiated by the following categories:

- The feedback loop between the learners' ability to understand physical science and their self-image in the presence of other learners.

- Learners experience a love-hate relationship with physical science influenced by their ability to understand the subject.

- Implementing practical activities such as experiments, practical assignments and attending science outings makes the subject more interesting, fun and able to understand.

- Group activities in learning about physical science adds to the experience of it being fun and enable learners to learn more about others.

- Physical science taught by relating its meaning in the learners *"real life"* is more interesting and easier to understand.

- A context created where learners feel *"comfortable with the teacher"* promotes the approachability of the educator.

- Disrespectful practices demonstrated by educators, lead to a negative experience of physical science.

- Educators verbalising work pressure and showing stress related to the teaching of physical science increase the pressure and stress learners experience about the subject.

Recommendations that could assist learners' achievement in physical science should focus on facilitating a positive experience of the subject. It should take

the themes and categories of this study into consideration. Some important recommendations are:

- Further research is required to find appropriate ways to enable educators and curriculum designers to successfully build systematic understanding of science through everyday knowledge and interests of learners.

- The current physical science curriculum is national or universal but it should be locally defined. The curriculum should respond to local interests and needs. Science education will then be of immediate use to the learners and promote concept development that is more effective. It will also result in greater achievement of "critical outcomes" like problem solving, critical thinking, application of knowledge and teamwork.

- Further research is needed to explain the negative correlation between learners' attitude and perceptions towards physical science and their achievement in the subject.

- The context of the physical science classroom has to be investigated to identify what the nature and style of teaching and activities are that engage learners in physical science.

- More research is needed to examine instructional strategies in the classroom for improving all learners' experience of physical science and achievement in science.

The researcher experienced the research as very fulfilling and challenging. She realised that there are numerous possibilities within the physical science classroom where educators can influence their learners' achievement.

OPSOMMING

Die doel van hierdie navorsing was om psigo-opvoedkundige riglyne te ontwikkel wat ‘n positiewe ervaring van natuurwetenskap vir graad 10-leerders fasiliteer. Die belanghebbendes by die navorsing is graad 10-natuurwetenskapleerders en graad 10-natuurwetenskapopvoeders.

‘n Positiewe ervaring van natuurwetenskap is om verskeie redes belangrik. Een rede is die afnemende belangstelling wat leerders in wetenskaplike beroepe toon (Lepkowska, 1996:33). Die hoofrede hiervoor is dat leerders van mening is dat hulle die vak nie sal kan bemeester nie. Hulle verstaan dikwels nie dit wat hulle in die klas geleer is en hoe dit van toepassing op hulle lewens is nie. Dit lei daartoe dat leerders ‘n “liefde/haat”-verhouding met die vak ervaar – as hulle goed doen in die vak hou hulle daarvan, en as hulle swak presteer, haat hulle die vak. Natuurwetenskapopvoeders verstaan dikwels hierdie komplekse verhouding verkeerd. Opvoeders besef nie altyd hoe hulle leerders se ondervinding van die vak kan verander nie. Dit was een van die hoofdoelwitte van hierdie navorsingstudie om opvoeders van praktiese riglyne te voorsien oor hoe om ‘n positiewe ervaring van natuurwetenskap te fasiliteer.

Drie hooftemas is tydens die navorsing geïdentifiseer:

1. Graad 10-leerders se ervaring van natuurwetenskap hou verband met die psigososiale eienskappe van die leerder en sy/haar interaksie met die omgewing.

2. Graad 10-leerders se ervaring van natuurwetenskap hou verband met die onderrig-/onderwysmetode in die klaskamer.

3. Graad 10-leerders se ervaring van natuurwetenskap hou verband met die opvoeder se houding, woorde en optrede teenoor leerders gedurende die onderrig van natuurwetenskap.

Hierdie drie temas kan verder ondersteun word deur die volgende kategorieë:

- Die terugvoerketting tussen die leerders se vermoëns om natuurwetenskap te verstaan en hulle selfbeeld in die teenwoordigheid van ander leerders.

- Leerders ervaar ‘n liefde/haat-verhouding met natuurwetenskap wat beïnvloed word deur hulle vermoëns om die vak te verstaan.

- Die implementering van praktiese aktiwiteite soos eksperimente, praktiese werkopdragte en die bywoning van wetenskapuitstappies maak die vak interessanter, pret en makliker om te begryp.

- Groepswerk tydens leer oor wetenskap maak die ervaring van die vak pret en stel leerders in staat om meer oor ander te leer.

- Natuurwetenskap is meer interessant en makliker om te verstaan as dit met leerders se “*regte lewe*” in verband gebring word.

- ‘n Konteks waar leerders “*gemaklik met die onderwyser*” voel, bevorder die toeganklikheid van die opvoeder.

- Opvoeders se oneerbiedige praktyke lei tot ‘n negatiewe ervaring van natuurwetenskap.

- Die druk en stres wat leerders oor natuurwetenskap toon, verhoog wanneer opvoeders werkstres verbaliseer en tekens van stres toon wat met die onderrig van die vak verband hou.

Aanbevelings wat leerders se prestasie in natuurwetenskap kan verbeter, moet op die fasilitering van ‘n positiewe ervaring van die vak fokus. Die temas en kategorieë van hierdie studie moet ook in ag geneem word. ‘n Paar belangrike aanbevelings is:

- Verdere navorsing is nodig om toepaslike maniere te vind om opvoeders en kurrikulumontwerpers te bemagtig om begrip van wetenskap sistematies te bou deur gebruik te maak van die alledaagse kennis en belangstellings van leerders.

- Die huidige wetenskapkurrikulum is nasionaal of universeel maar dit moet plaaslik gedefinieer wees. Die kurrikulum moet op plaaslike belangstellings en behoeftes gerig wees. Dit sal daartoe lei dat wetenskaponderwys onmiddellik bruikbaar is vir leerders en konsepontwikkeling aanmoedig wat meer effektief is. Dit sal ook daartoe lei dat “kritiese uitkomste” soos probleemoplossing, kritiese denke, toepassing van kennis en spanwerk beter bereik word.

- Verdere navorsing is nodig om die negatiewe korrelasie tussen leerders se houdings en persepsies teenoor natuurwetenskap en hulle prestasie in die vak te verduidelik.

- Die konteks van die natuurwetenskapklaskamer moet ondersoek word om die aard en styl van onderrig en aktiwiteite wat leerders in natuurwetenskap betrek, te identifiseer.

- Verdere navorsing is nodig om die onderrigstrategieë in die klaskamer te ondersoek wat leerders se ervaring van en prestasie in natuurwetenskap verbeter.

Die navorser het die navorsing as baie interessant en vervullend ervaar. Sy het besef dat daar verskeie moontlikhede in die natuurwetenskapklaskamer is waar opvoeders hulle leerders se prestasie kan beïnvloed.

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CHAPTER 1

ORIENTATION OF THE STUDY

1.1 INTRODUCTION

Education has undergone many changes in the past decade. South Africa inherited a racially-based and fragmented educational system. It is radically breaking with this old system. We live in a time where Outcomes Based Education (OBE) and Curriculum 2005 are at the order of the day. Teaching in schools has become learner-orientated and aimed at equipping learners with the necessary skills for the future.

OBE has a dual focus. On the one hand it focuses on group work and on the other hand on acquiring life skills. Learners are taught how to co-operate well with others, how to make decisions and how to solve problems. Curriculum 2005 (C2500) aims at promoting scientific literacy and numeracy, producing independent lifelong learners, learning of relevant contextualised skills and understandings rather than rote-learned facts, and creating a flexible curriculum based on outcomes in place of the exam-orientated, content-driven curriculum of the past (Department of Education, 1995:5). This process is, however, slow and cumbersome and no quick results will be achieved (Rogan, 2003:742).

One reason why this process is taking so long, is the fact that It has to be kept in mind that the school is not the only place where children learn (Monteith, 1990:452-459). This has lead to many complaints about the present school system. According to Johnstone (2000:2) one of the most frequent complaints is that school education is removed from social and economic needs. Change is a part of life and Garret (2000:3) states that "…education should constantly be under review since as the world changes so does its needs".

The current education system focuses on independent, original and creative thought. The measurement of learning is based on skills or competencies demonstrated, rather than being content-based (Johnstone, 2000). It has, however, been said by many educators and parents that OBE does not place enough emphasis on the teaching and learning of important subjects like science and maths.

OBE is aimed at equipping learners with competencies like discipline and responsibility. Learners, however, seem to lack these skills and are unable to cope with the demands placed on them by subjects like physical science, the school, their parents and their future. This affects their achievement in school negatively and they are unlikely to reach their full potential in school. Often, learners that do not achieve in school, struggle in the workforce.

South Africa needs to empower its citizens to be more productive. This has to start with the self-development of children, not only “with-in” school but also “with-out” school (Myburgh & Poggenpoel, 2002:4-16).

According to Van Zyl (2003:3) there is a growing concern amongst employers and parents that the South African education system cannot adequately prepare learners for life and work in the twenty-first century. Consequently, the focus is moving away from inputs to end results or outputs (outcomes). Education is mostly controlled by government who provides national standards like curriculum frameworks and examinations (Parmanand, 1998:13). Every year fewer learners choose physical science as a subject because they think it is too difficult to pass in matric.

According to Lepkowska (1996:33) there is mounting evidence of a decline in the interest of learners in pursuing scientific careers. The decline of interest in physical science remains a serious matter of concern for South Africans that want to raise the standards of scientific literacy. This has lead to widespread

concern and debate. Concerns about attitudes to physical science are not new. The promotion of favourable attitudes towards physical science is very important. However, the concept of an attitude towards physical science is somewhat nebulous, often poorly articulated and not well understood.

The current situation necessitates the creation of encompassing, meaningful learning experiences for learners. This results in improved self-esteem and confidence and leads to better academic achievement in school.

Before this can happen, one of the most important tasks of the school remains the teaching of information. It is impossible for learners to memorise all the necessary information. They have to be guided towards taking responsibility for their own learning. Learners need to want to learn and be motivated to do so.

The school is in a position to provide the necessary opportunities for learners to gain self-confidence and equip learners with learning abilities. This is only possible if learners believe in themselves and their abilities. Learning can be seen as a process and not a product. Learners need skills to master and regulate themselves and the environment. This will lead to a better understanding of themselves and to the development of their talents to the fullest (Pajares & Schunk, 2001:18).

It is clear from the above that various factors influence learners' experience of physical science and that they have to be taken into account. It is important to take learners' alternative frameworks into account in schools and especially when teaching science. This is further underlined by the Personal Construct Psychology of Kelly (1955:58). These frameworks arise as learners strive to construct their own meaning and understanding of their learning experiences. These personally constructed frameworks interact with more widely accepted 'scientific' explanations offered by educators, and can affect how the learner responds to the things the educator says (Postlethwaite, 1993: 27). It can thus

be difficult to alter or change these frameworks, especially if learners experience physical science negatively.

Another factor that also affects learners' performance in physical science is general intelligence (Zigler & Seitz, 1982:598). Unfortunately, most educators' believe that learners with a lower Intelligence Quotient (IQ) are unable to perform in physical science. It is however only an indication that such learners must be dealt with differently. Some educators also treat high and low achievers in science differently (Howe, 2002:246). They have different expectations of low achievers and these expectations can discourage the learners and they may lose interest. These expectations become a self-fulfilling prophecy.

Motivation and attribution also influences learners' achievement in school. Educators are able to affect the attributions that learners make. It is especially important that learners must put in an effort as this leaves them with a sense of control over what might happen next and personal responsibility for the quality of their school work (Postlethwaite, 1993:72).

1.2 RATIONALE OF THE STUDY

Curriculum 2005 paved the way to many opportunities in physical science, as well as numerous problems. Educators are faced with new challenges every day and struggle with new problems every day. This often leads to frustration, aggression and depression. Some physical science educators are insecure in themselves and in their jobs. This could result in problems with learning in their classes.

It has been the researcher's experience that physical science teaching in South Africa mostly follows a 'textbook-centred' approach. The ideal is to have an 'educator-centred' approach (Glynn, Yeany & Bitton, 1991:4). In such an approach, the textbook still plays an important role but the educator has greater

control over the method of instruction. To follow this approach, the educator has to be knowledgeable about science, the methods of instruction and the way learners learn and develop. Learners are expected to develop an understanding of the 'changing and contested nature of knowledge in the natural sciences', thus the 'Nature of Science' (NOS). Since curriculum reform depends crucially on the educators, it is important to find out whether their understandings of NOS are in accordance with what they are required to teach. In most South African schools, this is not the case.

Science teachers in South Africa are known to be poorly qualified and to work in poor conditions (Kahn, 1995:443). The government tries its best to help educators to further their professional development by providing in-service training. The question is whether these programmes support educators adequately and whether educators can support their learners?

This research focused on increasing the achievement of learners in physical science by exploring their experience of physical science in grade 10. It outlined the ideas learners have regarding physical science and how to address these to facilitate better achievement in physical science. In short, the researcher focussed on what skills or competencies learners would need to achieve in physical science.

1.3 PROBLEM STATEMENT

1.3.1 General orientation to the problem statement

Physical science is a subject taken by numerous learners. It is a prerequisite for various fields of further tertiary study. In the researcher's experience as an educator and in working with learners on a one-to-one basis during remediation, it was of interest to investigate how learners experience physical science.

By observing the performance of learners in physical science, the researcher often wondered what it takes to achieve in physical science. It seems that achievement in physical science combines both learners' psychological and physical attributes.

It was to the researcher's interest to investigate learners' current achievement in physical science and how their achievement can be improved. It appeared that learners often do not achieve to their abilities in physical science.

1.3.2 Research questions

The following research questions were formulated:

- How do learners in grade 10 experience physical science?
- What can be done to assist learners in grade 10 to achieve in physical science?

1.4 RESEARCH OBJECTIVES

The objectives of this study were:

- to explore and describe the experience of physical science learners in grade 10 and
- to outline the skills (attributes) that assist learners in grade 10 in achieving in physical science.

1.5 PARADIGMATIC PERSPECTIVE

According to De Vos (1998:12), the model or pattern according to which scientists view their objects of research within their particular disciplines, is called a paradigm. The researcher's paradigm for this research study consisted of

metatheoretical, theoretical and methodological assumptions, which will now be discussed:

1.5.1 Metatheoretical assumptions

Physical science is part of our lives. For learners to prosper in the 21st century, they must understand the basic facts, principles and procedures of science. I believe that everyone has the ability to achieve in physical science. I also think that it is possible to change preconceived ideas and feelings that learners might have about physical science. Learners may experience physical science either positively or negatively. Their experience is influenced by their previous experiences of physical science.

I also think that the environment plays a role in learners' experience of physical science. The more encouraging and stimulating the learning environment, the more meaningful the learners' experience of the subject. Learners need to feel accepted, understood and respected in the classroom environment.

Education has to focus on learners' psychological well-being. Mental health will foster cognitive health. If learners' emotional needs are not met, they will not be able to concentrate on their school work. This will result in low academic performance which in turn will lead to a low self-esteem.

1.5.2 Theoretical assumptions

Various developmental psychologists (Piaget, Vygotsky and Erikson) emphasise that learning is the process of acquiring new knowledge in an active and complex way. This process is the result of interactive cognitive processes like perception, imagery, organisation and elaboration. They add that learners are not passive recipients of information. They are active consumers who are selective and subjective in their perception. Learners' prior knowledge, expectations and

experiences will influence what information will be learned. Clearly, listening to lectures and reading of texts are ineffective in teaching physical science. Learners need to participate and interact to understand and apply scientific knowledge.

According to Champagne and Bunce (1991:172) there are five psychological principles that underlie this theory. The principles state that scientific knowledge is complex, experts' knowledge is tacit, learners construct understanding, personal theories about the natural world influences the extent and quality of science learning and social interaction produces cognitive change. These principles emphasise the fact that information is always added to existing information and this may either facilitate or impede the integration of new information.

Vygotsky (1986:50) emphasises that cognitive abilities are socially transmitted, socially constrained, socially nurtured and socially encouraged. I am of the opinion that this plays a large role in learners' experience of science. Learners' spontaneous concepts or reflections of their everyday experiences, impact on their experience of physical science.

It is important to engage the learner in science teaching by assigning academic tasks. This is of great value because the learner can explore new information, change existing information, share information in groups and explore feelings. The educator then has an opportunity to give feedback and to give learners an opportunity to learn new skills.

I also believe in the importance of learners' conceptual frameworks. Learners' conceptual frameworks are influenced by sensory impression, everyday language, innate structures of the brain, learning in social environments and instruction (Duit, 1991:74). This has various implications for science teaching. In order to change learners' experience of physical science, a lot of changes have

to be made place. Some possible changes may include new aims for science teaching, new teaching aids, the changing of teaching strategies, the integration of cognitive and affective aspects of learning and employing strategies of metacognition.

The following concepts and clarifications in terms of theoretical assumptions of the research study will be discussed. Firstly, learning readiness of each individual as a function of a social role, rather than a biological level of development or academic pressure, because the subject content becomes relevant to the learner. Secondly, a problem-centred approach, rather than a subject-centred approach that focuses on the process rather than the product. Thirdly, intrinsic motivation as a driving force. Lastly, the potential of each learner and the intra-personal subsystems of the learner that consist of perceptions, cognition, emotions, attitude and self-concept (Jordaan, Jordaan & Niewoudt, 1989:40).

1.5.3 Methodological assumptions

The methodological assumptions are based on the approach to educational research, and focus on the value of the research and the application to education (McMillan & Schumacher, 1993:25). The educational purpose of this research was to form a basis of knowledge in relation to the experience of learners in physical science.

The research as such was to be conducted within the context of a private secondary school in South Africa. The results can be applied to schools and other academic institutions offering physical science as a subject.

Qualitative research describes the acceptance of post-modern sensibilities while capturing the individual's point of view and examining the constraints of everyday

life (Denzin & Lincoln, 1998:23). The understanding of the “lived experience” marks phenomenology as a method of research (Creswell, 1994:12). The method is constructivistic, interpretive and holistic in nature (De Vos, 1998:243). According to Denzin and Lincoln (1998:141) subjectivity is paramount because the scientific observer deals with how members of the life-world interpretively produce the recognisable forms that they treat as real, while remaining in a neutral attitude.

As a method the procedure involves studying a small number of participants, through prolonged engagement to develop patterns and relationships of meaning (Creswell, 1994:12). Qualitative researchers are subjective because they interact with the participants, trying to minimise the distance between themselves and those being researched (De Vos, 1998:234; Creswell, 1994:12).

Inter-subjectivity is an ongoing process (Denzin & Lincoln, 1998:141) wherein the qualitative researcher admits the value-laden nature of the study (Creswell, 1994:6).

1.6 RESEARCH DESIGN AND METHOD

The research design and method will be discussed in the next paragraph.

1.6.1 Research design

The research design used consisted of a qualitative, explorative, descriptive and contextual design. It is a method used to understand the unique, dynamic character of the person (Marshall & Rossman, 1989:46). Data were collected through phenomenological interviews.

1.6.2 Research method

The research consisted of two phases. In phase one the experience of physical science learners were explored and described. In phase two the qualities (attributes) that help learners achieve in physical science, were outlined. Measures to ensure trustworthiness in both phases will now be discussed.

1.6.2.1 Measures to ensure trustworthiness

According to Lincoln and Guba (1985:290-301) there are four criteria that more accurately reflect the assumptions of the qualitative paradigm and the establishment of trustworthiness (Marshall & Rossman, 1989:15). There are four criteria of trustworthiness that are relevant (Krefting, 1991:215).

1.6.2.1.1 Truth value:

Truth value asks whether the researcher has established confidence in the truth of the findings for the subjects or informants and the context in which the study was undertaken (Krefting, 1991:125).

1.6.2.1.2 Applicability:

This refers to the degree to which the findings can be applied to other contexts and settings or to other groups. It is the ability to transfer according to the findings and to extend to larger populations (Krefting, 1991:215; Marshall & Rossman, 1989:145).

1.6.2.1.3 Consistency:

Consistency indicates whether the findings would be consistent if the inquiry were replicated with the same participants or in a similar context (Krefting, 1991:215).

1.6.2.1.4 Neutrality:

Neutrality refers to the freedom from bias in the research procedure and results. It also refers to the degree in which the findings are a function solely of the participants and conditions of the research and not of other biases, motivations or perspectives (Krefting, 1991:215).

Four strategies were used in the research process to increase trustworthiness. The strategies are outlined in the model of Lincoln and Guba (1985:290-301) namely credibility, transferability, dependability and confirmability. The application of these strategies are illustrated in chapter 2.

PHASE 1: The exploration and description of learners' experience of physical science

During phase one the sampling method, data collection, data analysis and literature control took place.

1.6.2.2 Sampling

a) Population

Learners in grade 10 from a private secondary school in Gauteng were used for data collection in phase one to explore and describe their experiences of physical science.

b) Sampling method

A purposive sampling method was used in the research (Lincoln & Guba, 1985:201) by selecting participants that would provide the most meaningful and richest data. This was done by selecting both learners that failed physical science, learners that passed it and learners that did very well in the subject. In this way different insights were gained into how different learners experience the subject.

1.6.2.3 Data collection

Phenomenological interviews were conducted. A phenomenological interview as executed for the purpose of this research refers to an interview of which the purpose was to gather descriptions of the experience of the interviewee with respect to interpretation of the described phenomena (Kvale, 1983:171-196). The qualitative research interview that was used can be described as "semi-structured" because it was neither a free conversation nor a highly structured questionnaire (Poggenpoel, 1993:1-3). It was carried out by following an interview-guide that focussed on certain themes. The question that was asked was: "How is physical science for you?". The interview was taped and transcribed word for word. This constituted the material for the interpretation of meaning (Kvale, 1983:174).

Basic principles like empathy, understanding, warmth, honesty, sincerity and confidentiality should be adhered to during interviews (De Vos, 1998:308; Marshall, 1989:81). This is in accordance with the needs of both the interviewer and the interviewee and leads to the building of trusting relations in conjunction with gathering rich data.

There are certain techniques that can be used to enhance personal interaction and question framing (Marshall & Rossman, 1989:83; De Vos, 1998:309). These

include reflective listening, summarising and clarifying and probing (Johnson, 2000:149).

1.6.2.4 Data analysis

Data analysis was done during phase one by transcribing the interview recordings and analysing them with written dialogues according to Tesch's method (Creswell, 1994:155).

A protocol for analysis of the data was sent to an external data analyst to reach consensus between the researcher and the analyst of the results (Grobler, Myburgh & Poggenpoel, 1999:36). This will be described in more detail in Chapter Two.

1.6.3 Literature control

A literature control was conducted to identify the similarities and the uniqueness of the research and to verify results (Grobler et al., 1999:36; Poggenpoel, 1993:1).

PHASE 2: Outlining the skills (attributes) that assist learners' achievement in physical science

After completion of the literature control an outlining of the qualities that assist in the development of learners in physical science were identified, based on the results of phase one.

1.7 ETHICAL MEASURES

Marshall and Rossman (1989:69) point out that gaining liberty to enter a research setting and the accompanying ethical issues must be carefully observed and

managed in all setting. Researchers have an ethical obligation to ensure that they are competent and skilled to undertake the investigation that they have in mind (De Vos, 1998:31). Ethical issues include: maintaining confidentiality of data; preserving the anonymity of informants; protecting the rights of human subjects; and providing an explanation of the intended purpose of the research (Creswell, 1994:148; Marshall & Rossman, 1989:69).

To ensure that the ethical measures were adhered to, the researcher firstly applied for ethical clearance from the Department of Nursing Science's Committee for Academic Ethics. Before they could confirm that the research complies with the approved Ethical Research Standards of the University of Johannesburg, the researcher had to provide them with:

- a copy of the first chapter;
- a copy of the letter of the learners in which they give assent to their participation in the research;
- a copy of the letter for the parents in which they give consent to their children's participation in the research; and
- a copy of the letter of permission from the school's principal for the learners' participation in the research.

After ethical clearance was received the following ethical measures were adhered to:

1.7.1 Informed consent

Informed consent implies that all possible information, the goal of the investigation, the procedures that will be followed during the investigation, the possible advantages and dangers to which participants may be exposed to and the credibility of the researcher be rendered to the participants (De Vos, 1998:25).

The researcher must emphasise the autonomy of the individual. This implies that the participant has a free choice of participation and that, if necessary, the researcher should be able to change the nature of the research rather than expose the participants to harm (De Vos, 1998:25; Marshall & Rossman, 1989:75; Creswell, 1994:165; Denzin & Lincoln, 1998:103).

The importance of the research, being an investigation and understanding of the learner's experience of physical science, was explained at the inception of the research. The aims of the research were also explained namely to draw information and meaning from the findings to further research studies and to contribute to education and physical science.

1.7.2 Violation of privacy

The term "privacy" implies the element of personal privacy, while "confidentiality" indicates the handling of information in a confidential manner (De Vos, 1998:28). Participants' right to self-determination implies the right and competence to evaluate available information, weigh alternatives against one another and the making of decisions (Creswell, 1994:165; De Vos, 1998:28; Marshall & Rossman, 1989:75).

Working with learners exposed to other learners and educators in the school on a daily basis, made it necessary to preserve their privacy and to treat the information as confidential.

1.7.3 Freedom to withdraw without penalty

The participants' cooperation was respectfully requested. All participants had a free choice and the right to withdraw at any time without penalty (McMillan & Schumacher, 1993:182).

1.7.4 Benefits of the research and feedback to participants

The aim of this study was not to just benefit academic questions, but also to aim for practical results and feedback to be given back to participants at the closure of the study (McMillan & Schumacher, 1993:182).

1.8 DIVISION OF CHAPTERS

CHAPTER 1: Orientation of study

CHAPTER 2: Research design and method

CHAPTER 3: Grade 10 learners' experience of physical science

CHAPTER 4: Guidelines, conclusion, limitations, recommendations and application of research study.

1.9 CHAPTER SUMMARY

In this chapter the rationale, statement of the problem, purpose of the study, research design and method were briefly outlined.

CHAPTER 2

RESEARCH DESIGN AND METHOD

2.1 INTRODUCTION

In this chapter the researcher will discuss the research design and research method that were followed in the research process.

2.2 PURPOSE OF THE STUDY

The purpose of the study was

- to explore and describe the experience of physical science learners in grade 10 and
- to outline the skills (attributes) that assist learners in grade 10 in achieving in physical science.

2.3 RESEARCH DESIGN

The research design consisted of a qualitative, explorative, descriptive and contextual design. This design served as a foundation for the understanding of the participants' worlds and the meaning of shared experiences between the researcher and the participants in a given social context (Denzin & Lincoln, 1998:1).

2.3.1 Qualitative

Qualitative research has its roots in cultural anthropology and American sociology. According to Creswell (1994:161) and Denzin and Lincoln (1998:242), it is a field of inquiry in its own right. The qualitative intent of this study was committed to the naturalistic perspective – interpreting and understanding of

human experience in a particular complex social phenomenon through ongoing interaction (Creswell, 1994:161; Denzin & Lincoln, 1998:6; Marshall & Rossman, 1989:9).

The intent of qualitative research in this study was to obtain a holistic picture of the experiences of the participants of the study, it was an attempt to understand the multiple realities of experience of the learners and how these learners structure their world (Bryman, 1988:51; Creswell, 1994:163; Denzin & Lincoln, 1998:23).

Several articulated assumptions regarding the characteristics of qualitative research were mentioned by Creswell (1994:145,162), Bryman (1988:61-69) and Denzin and Lincoln (1998:23-25). They are:

- Qualitative researchers focus on the process, rather than the product. This emphasis can be seen as a response to the researcher's attempt to reflect the reality of everyday life, which according to them, takes the form of streams of interconnecting events. The qualitative researcher argues that this is exactly how people experience social reality. The researcher's inclination to emphasise the process rather than the product, is a product of the researcher's commitment to the participants' perspectives. Qualitative research conveys an image of social order as one of interconnection and change.

- Qualitative researchers are interested in the way people make sense of their lives; how they construct meaning. In this context the way the grade 10 learners' experiences of physical science was explored. The interpretive practice of making sense of one's findings is artful, suggesting that qualitative research is also creative and interpretive.

- In qualitative research, the researcher is the primary instrument for data collection and analysis. This means that data are mediated through the human instrument. This involves the express commitment to view events from the perspectives of the people being studies (in this case the physical science learner), entailing the capability to penetrate the frames of meaning with which the researcher operates, giving the research depth and quality.

- Field work is part of qualitative research. The researcher has to go to the people, the setting and the site in order to observe behaviour in a natural setting. In this study the natural setting was the physical science classroom, where learners daily have science lessons. The researcher had to create a field text consisting of field notes and documents from the field.

- Qualitative research is descriptive and the researcher is interested in the process, meaning and understanding of the phenomenon, which is the experience of the physical science learner.

- An inductive approach is followed in qualitative research. The researcher constructs abstractions, concepts, hypotheses and theories from details. The approach followed in this research was open and receptive.

Clark (2002:17) sees qualitative research as a full acceptance of the hermeneutical character of understanding. It entails empathetic understanding, rather than explanation; naturalistic observation, rather than controlled measurement. It also includes the subjective exploration of reality from the perspective of an insider through a process of deep attentiveness and not an outsider perspective. Lincoln and Guba (1985:16) refer to constructivism as the acknowledgement of social construct of knowledge. According to Clark

(2002:17), De Vos (1998:243), Denzin and Lincoln (1998:8) and Lincoln and Guba (1985:16) this leads the researcher to adopt particular views or preconceptions of the topic under investigation.

2.3.2 Explorative

Exploratory research is an investigation into inadequately understood phenomena. According to Marshall and Rossman (1989:78) it also means to identify and discover important variables to generate a hypothesis for further research.

This particular research study was investigative. It aimed to explore new insights about the experience of physical science by learners and can be classified as an "open" research with no boundaries or conceptualised ideas about the study of interest.

2.3.3 Descriptive

Marshall and Rossman (1989:22) emphasise that qualitative studies build rich descriptions of complex circumstances that are unexplored in the literature. Bryman (1988:63) adds that one of the main purposes of qualitative researchers' style is to provide detailed descriptions of the social setting that they investigate and to ensure that these descriptions are consistent with the perspectives of the participants in that particular social setting. Creswell (1994:162) notes that this emphasis on description entails attending to mundane detail and particulars.

Description is interpretive. According to Denzin and Lincoln (1998:29), Bryman (1988:63) and Creswell (1994:162) an important contribution of descriptive detail is the mapping out of a context for the understanding of a participant's interpretations through an interactional process of what is going on in a particular context and to provide clues and pointers to other layers of reality. Bryman

(1988:64) sees this as necessary for researchers to produce analyses and explanations. This does justice to the milieu in which their observations and interviews are being conducted. In this study the aim was to give an accurate description of the experience of physical science by grade 10 learners.

2.3.4 Contextual

Qualitative research exhibits a preference for contextualism because of its commitment to understand events in their context. According to Bryman (1988:64) it is almost inseparable from holism that entails an undertaking to examine social entities. De Vos (1998:2281) says that this focus on particular contexts usually means that, in contrast with quantitative work, holistic qualitative work is also small-scale or "micro" research.

Bryman (1988:64) and De Vos (1998:281) note that the implication of contextualism engenders a style of research in which the meanings that people ascribe to their own and others' behaviour, have to be set in the context of the values, practices and underlying structures of the appropriate entity as well as the multiple perceptions that pervade that entity.

The researcher's interest in the experience of physical science by learners in grade 10, necessitated that the context of the physical science classroom had to be viewed in concurrence with an educational perspective.

2.4 RESEARCH METHOD

The trustworthiness of the research as well as phase one and two will now be discussed.

2.4.1 Strategies to ensure tustworthiness

Lincoln and Guba (1985:290-301) proposed a model for assessing the trustworthiness of qualitative data (Krefting, 1991:215; Marshall & Rossman, 1989:145; De Vos, 1998:331). According to Krefting (1991:215) and De Vos (1998:331) this model defines different strategies of assessing these criteria and is important for researchers in designing ways of increasing the rigour of the qualitative study.

2.4.1.1 Truth value

De Vos (1998:331) and Krefting (1991:215) emphasise that truth value asks whether the researcher has established confidence in the truth of the findings for the participants and the context in which the study was undertaken. Marshall and Rossman (1989:145) see the strength of the qualitative study in that it aims to explore a problem or describe a setting, a process and pattern of interaction that will constitute its validity.

Krefting (1991:215) notes that truth value is obtained from the discovery of human experiences as they are lived and perceived by participants. Marshall and Rossman (1989:145) add that an in-depth description, showing the complexities of variables and interactions, will be so embedded with data derived from the setting that it cannot help but be valid.

In this study the aim was to discover grade 10 learners' experience of physical science as the learners live the experience and they perceive it. For this reason, the following strategies were applied to ensure truth value:

a) Prolonged engagement

An important strategy to ensure truth value is to spend an extended period of time with informants. Krefting (1991:215), Lincoln and Guba (1985:302) and Bryman (1988:96) include the importance of building a trusting relationship with the participants to support the importance of intensive participation.

Building a trusting relationship, in this case, especially with physical science learners in grade 10, includes explaining the purposes of the research and allowing the participants to become accustomed to support the importance of intensive participation. This suggests that it enhances research findings through intimate familiarity and the discovery of hidden fact (Krefting, 1991:221). The importance of this research study, being an investigation and understanding of learners' experience of physical science, was explained at the inception of the research. The aims of this study were to draw information and meaning from the findings to further research studies and to contribute to physical science education.

b) Reflexivity and persistent observation

According to Denzin and Lincoln (1998:280), Krefting (1991:219) and Bryman (1988:96) the qualitative approach is reflexive and the research situation is dynamic because the researcher is part of the vision of action and living inquiry. The researcher continuously observe the setting and interaction with an attention that interpenetrates the territories of intuitive process, intellectual strategy and behavioural expression, which determine whether the researcher is sampling all possible situations. Denzin and Lincoln (1998:280), Krefting (1991:218), Bryman (1988:56) and Lincoln and Guba (1985:304) add that persistent observation can be obtained by field notes which provide a depth to the findings.

De Vos (1998:285) views the addition of field notes as a technique for recording events while they occur or as soon thereafter as possible. Krefting (1991:218) and Merriam (1988:98) further add that they are a reflection of the researcher's thoughts, feelings, ideas and hypotheses generated by contact with informants, containing questions, awareness of biases, problems and frustrations concerning the whole research process.

Field notes are compiled by observational notes, giving an account of what happened and providing no interpretation. According to De Vos (1998:286) and Krefting (1991:218) theoretical notes are notes which provide systematic attempts by the researcher to derive meaning and methodological notes, resulting in critical notes by the self-reflexive researcher.

c) Triangulation

Various researchers (Denzin & Lincoln, 1998:4; De Vos, 1998:358; Marshall & Rossman, 1989:146; Bryman, 1988:131; Krefting, 1991:219) view triangulation as based on the idea that the researcher is likely to find greater confidence in the findings when they are derived from multiple methods of investigation. This ensures that all aspects of the phenomenon have been investigated and ensures an in-depth understanding of the phenomenon.

Objective reality can never be captured. Triangulation is used as an alternative to validation. Lincoln and Guba (1985:306) and Denzin and Lincoln (1998:4) define triangulation as the confirmation of a proposition by two or more measurement processes, thereby reducing uncertainty.

Data gathered on the experience of physical science by grade 10 learners included the multiple-method approach suggested by Bryman (1988:131) and Krefting (1991:219). It included a phenomenological interview, observation of the

informants and field notes that reflected the researcher's thoughts, feelings and ideas concerning the process.

According to Omrey (1983:57), Grobler et al (1999:36) and Denzin and Lincoln (1998:46) triangulation during data analysis includes the use of multiple perspectives to interpret a single set of data using an inductive descriptive approach as well as a consensus reached between the researcher and the external data analyst on the results. Grobler et al (1999:36) and Poggenpoel (1993:2) also suggest literature control as a method of triangulation or to identify similarities and the uniqueness of the research.

Briefly, triangulation methods used during this research were: data collection through phenomenological interviews, the collection of field notes, discussions with an independent coder during coding of data and truth value enhanced through literature control.

d) Peer examination and peer group evaluation

Peer group evaluation is a process of consensus with leaders of the study who have experience of qualitative methods. Krefting (1991:219) and Lincoln and Guba (1985:308) suggest that insights be discussed and problems presented as a form of debriefing. They further emphasise that it provides guidance for keeping the researcher objective, honest and open. The searching questions may contribute to deeper reflexive analysis by the researcher (Krefting, 1991:219; Lincoln & Guba, 1985:309).

Krefting (1991:219) further emphasises that study leaders or colleagues can also increase credibility by checking categories developed out of data and by looking for discomfort or negative cases. The researcher confirm and checked categories with an independent coder and with study leaders to reach consensus on themes and supporting categories.

e) Unique authority of the researcher

The “I was there” element in the research strengthens the idea of authority by viewing the researcher as a measurement tool (Krefting, 1991:220). Krefting (1991:220) further suggests that the degree of familiarity with the phenomenon and the setting under study is one of the characteristics necessary to assess the trustworthiness of the human instrument. The researcher worked as an educator with physical science learners on a daily basis in the setting of a school and also acted as a tutor on a one-to-one basis for learners who struggled with physical science.

Another important characteristic according to Krefting (1991:220) is a strong interest in conceptual or theoretical knowledge. It was the researcher’s interest to obtain an in-depth understanding and meaning of the world in which the researcher and the physical science learner function. With a multi-disciplinary approach, involved in public schooling and private tutoring at an educational psychology practice, the researcher was able to view the situation by accommodating both educational and psychological perspectives.

f) Member checking

This is a technique that consists of continually testing with informants the researcher’s data, analytical categories, interpretations and conclusions. Krefting (1991:219) says this strategy of revealing research materials to the informants ensures that the researcher has accurately translated the informants’ viewpoints into data.

This was done during this research study by individually discussing the analysis of the interviews with the participants. The researcher shared with each participant what she interpreted and concluded from their interview. She then asked them whether her interpretations and conclusions were correct according

to them. If the participants agreed, the researcher accepted her interpretations, if they did not agree, the researcher had a discussion with the participant to reach a consensus on the interview's interpretation and conclusion.

g) Structural coherence

Krefting (1991:220) defines the establishment of structural coherence as the insurance that there are no inconsistencies between the data and the interpretations. He further notes that credibility is supported when interviews, observations and interpretation of data are internally consistent. This is when there is a logical rationale about the same topic - in this case the experience of physical science by grade 10 learners - the same interview or observation.

2.4.1.2 Applicability

Applicability refers to the degree in which the findings of a specific investigation can be applied to other contexts and settings or with other groups and informants, whether it is fitting or transferable and how well the threads to external validity have been managed. According to De Vos (1998:331), Krefting (1991:216) and Lincoln and Guba (1985:290) it is the ability to generalise from the findings of the research to larger populations.

Qualitative research is always conducted in a natural setting with few controlled variables. This implies that each situation is unique and thus less amenable to generalisation (Krefting, 1991:216). Therefore applicability cannot be seen as relevant and generalisation is somewhat an illusion. The following strategies can however be applied to facilitate applicability of the research:

a) Transferability

Krefting (1991:216) sees transferability of a research study as the responsibility of the person who wants to transfer the findings to another situation and not the researcher of the original study. Krefting (1991:216) and Lincoln and Guba (1985:316) further add that providing and presenting the widest possible range of information and sufficient descriptive data by the researcher could be regarded as adequate for allowing comparison and facilitating transferability. The researcher used dense description of results with direct quotations from participants for this.

b) Sampling

This research used a purposive sampling method. This was used to select participants and situations that were most likely to provide particular information-rich data. As Denzin and Lincoln (1998:73) and De Vos (1998:255) emphasise, the participants themselves should be authorities as far as the particular experience under investigation is concerned. Krefting (1991:220) notes that it is necessary to provide dense background information about the participants and the research context and setting to allow others to assess how transferable the findings are.

In this research study grade 10 learners were selected to serve as a sample population. The whole physical science class was used as a population in order to include learners that failed the subject, learners that barely passed it and learners that achieved in it. This was done to see whether their experience of physical science differed.

2.4.1.3 Consistency

Krefting (1991:216) sees consistency as a criterion for trustworthiness by considering the consistency of data - whether the findings of this investigation with physical science learners would be consistent when replaced with the same participants or in a similar context. Consistency is defined in terms of dependability (Krefting, 1991:216).

a) Dependability

Marshall and Rossman (1989:147) view the criterium of dependability as the researcher's attempts to account for changing conditions in the phenomenon chosen for study as well as changes in the design created by increasingly refined understanding of the setting. De Vos (1998:331) is of opinion that dependability is attained by applying certain criteria when utilising audio-visual methods of research:

According to Lincoln and Guba (1985:317) dependability audit is established when the process and the product is described in detail. The research methods, which consisted of the phenomenological interview with physical science learners supported by relevant field notes, made dense descriptions of both the process and the product possible and consequently a dependability audit for this research could be established.

Stepwise replication means that the same steps were followed during each procedure of the interview. That was the relationship phase with the physical science learner, the description of the purpose of the study, the questions being asked and the consent to participation. (Refer to *Triangulation* as described in paragraph 2.4.1.1 (d).)

The code-recode procedure implies that a measure will provide the same data, or to an acceptable and significant extent the same data/results for which the measure had been administered in the first place, when and if re-administered by different people afterwards. Krefting (1991:216) says that the code-recode procedure, testing the equivalence of results, helps to determine whether the results have been produced or presented in a reliable way. For the purpose of this study a protocol for the analysis of data suggested by Grobler et al (1999:36) and Poggenpoel (1993:1) was followed. Data were sent to an external analyst where after consensus in connection with the results could be reached between the external data analyst and the researcher.

2.4.1.4 Neutrality

Krefting (1991:216) defines neutrality as the freedom from bias in the research procedure and results. Neutrality also refers to the degree to which findings can be ascribed solely to the actual functioning of the informants and to the actual conditions of the research and not to incorporated biases, motivations or perceptions. Krefting (1991:216), Lincoln and Guba (1985:300) and De Vos (1998:331) emphasise that this requires that the researcher's own perspectives and assumptions be neutral during the research process. They further view neutrality not as the researcher's objectivity but as data and interpretational confirmability. Certain techniques can be used to establish confirmability where audit strategy can be seen as the major technique.

a) Confirmability audit

This strategy involves an external auditor attempting to follow through the natural history or progression of events in order to understand why and how decisions were made. Krefting (1991:221) identifies the following categories of record:

- Raw data, including field notes and audio recordings;
- Data reduction and analysis procedure;

- Data reconstruction and synthesis products – thematic categories, interpretations and references;
- Process notes, notes on procedures, design strategies and trustworthiness;
- Materials related to intentions and dispositions; and
- Instrument development information – pilot forms, survey format and schedules.

Krefting (1991:221) also identifies a number of other strategies that are useful in the establishment of confirmability. They are: a reflexive journal which can be seen as a diary and which mirrors the researcher's ideas; feelings and thoughts on the progress of the research; and the awareness of the researcher's influence on the data.

Triangulation can also be seen as a strategy (paragraph 2.4.1.1 (d)). The researcher established confirmability through keeping a distance between the self and the learners to eliminate biasedness concerning research results and as a record of interviews, field notes were kept.

2.4.2 Ethical principles

De Vos (1998:24) sees ethics as a set of principles, which offer rules and behavioural expectations about the most correct conduct towards research participants. See Chapter One (1.7).

2.4.3 PHASE 1: The investigation and description of learners' experience of physical science

During this phase the sampling, data collection, data analysis and literature control will be discussed.

2.4.3.1 Sampling and population

- **Population :** The sample population consisted of grade 10 learners that take physical science in a private secondary school.
- **Sampling method :** A purposive sampling method was used in this research. Participants who would most likely render particularly information-rich data were selected (Denzin & Lincoln, 1998:73; De Vos, 1998:255; Marshall & Rossman, 1989:55).

2.4.3.2 Data-collection

The method of data-collection included the following:

a) Phenomenological interview

The phenomenological interview is an inductive, investigative and descriptive research method. According to Kvale (1983:175) the purpose of this interview is to describe the structure of the experience of the individual. An in-depth focus was placed on the specific central theme namely the experience of physical science by learners and the description of their experiences and opinions in their own words, as Kvale (1983:173) suggests. Kvale's (1983:175-177) presuppositionless approach of the researcher implies an openness to new and unexpected phenomena.

Accordingly the interview was semi-structured and contained central themes rather than exact questions (Kvale, 1983:173). The question "How is physical science for you?" was asked to each participant. This question reflected the investigative and open quality of research. The researcher made the question as

broad as possible rather than to prematurely delimit the study with a narrow question. As Denzin and Lincoln (1998:68) suggest, narrowness distracts the researcher from seeing the whole picture.

Questions that followed the central question were for clarification purposes. Like Lincoln and Guba (1985:202) suggest as soon as deemed appropriate the interview was terminated and follow-up interviews were not conducted, especially in cases where data repeated itself.

b) Role of the researcher

Denzin and Lincoln (1998:66) see qualitative research as being as good as the investigator. They further add that it is the researcher who, through skill, patience and wisdom, obtains the information necessary during data collection and fieldwork to produce a rich qualitative study.

The researcher used the "self" to respond to questions to deepen the quality of the research. Poggenpoel (1993), Okun (2002:81), Alvesson and Skoldberg (2001:277) and De Vos (1998:310) discuss certain communication techniques that can be used:

- Reflection of the content. This ensures that the individual is understood – both verbally and non-verbally.

- Paraphrasing is interchangeable with the learner's statement as some words may be synonyms. Paraphrasing is of great value because it clarifies concepts that the learner has stated.

- Summarising is used to synthesise what has been said or it highlights the cognitive themes. It also encourages the participants to share their feelings and also serves as a clarification mechanism.

- Clarifying is used to understand or to focus on the basic nature of the participant's statement.

- Probing is used as an open-ended attempt to obtain more information about a participant's statement. It includes a conversational rhythm which allows the participants to express themselves freely.

- Asking the participants to give examples or descriptions of what has been said.

Denzin and Lincoln (1998:67) further add that the ability of researchers to ensure success in an in-depth description in phenomenological research depends on the confidence in own interpretation and being able to revel in the intellectual world of making sense of their data. This includes both note-taking and field work. Field notes are notes of every observation that occurred at a given time and place.

Observation notes, according to De Vos (1998:285), give an account of what has happened. It is a piece of evidence for some proposition or a property of context or situation. Theoretical notes reflect systematic attempts to derive meaning from observational notes. De Vos (1998:286) adds that an interpretive quality will be present in these notes. Methodological notes include notes on the process, like reminders, instructions, time schedule and sequence. De Vos (1998:285-286) and Lincoln and Guba (1985:184-185) are of the opinion that personal notes include reflections on the researcher's experience of the study and self.

2.4.3.3 Data analysis

Data analysis is done by transcribing the various interviews and field notes. Creswell (1994:153) sees written dialogues, according to Tesch's method, as an important part of the analysis process. Creswell (1994:154-155) further adds that the researcher has to be focused by looking at information without prepositional convention, starting by reading through each individual transcription and getting a sense of the whole picture.

The second step is reading the transcripts while underlying individual themes that are identified. A list of all the themes, as well as similar or related themes, can then be compiled. The most descriptive word for the identified theme is then sought and used for clarifying the information into various categories and sub-categories. Creswell (1994:155) and Grobler et al (1999:36) suggest that field notes should be used to make inferences to themes pertaining to these categories and sub-categories. These steps were followed while the present investigation was conducted. A protocol for analysis of the data and results were forwarded to an independent coder. Consensus between the researcher and the independent coder could be reached like Lincoln and Guba (1985:180) suggest.

2.4.3.4 Literature control

A literature control was done as suggested by Grobler et al (1999:36) and Poggenpoel (1993:2). This was done to identify similarities and the uniqueness of the research.

2.4.4 PHASE 2: Outlining the qualities and attributes that assist learners' achievement in physical science

The qualities that assist learners' achievement in physical science, based on the findings in phase 1, will be discussed in Chapter Three . At the end of the

research conclusions and possible recommendations to the findings of the research were made. The limitations of the research were also outlined.

2.5 CHAPTER SUMMARY

In this chapter the research method and design were discussed. The phases of the research process were outlined. Strategies to ensure trustworthiness were discussed namely truth value, applicability, consistency and neutrality. In Chapter Three, the researcher discussed the experience of physical science learners and compared discussions to relevant literature.

CHAPTER 3

GRADE 10 LEARNERS' EXPERIENCE OF PHYSICAL SCIENCE

3.1 INTRODUCTION

In this chapter the results of the research were presented and discussed. It was then evaluated and integrated with relevant literature.

3.2 ANALYSIS OF THE DATA

Interviews were conducted with five grade 10 physical science learners (A, B, C, D, and E) from a private secondary school in Pretoria. The school followed the Gauteng Department of Education's syllabus for grade 10 science. English was used as medium of instruction during the course of the interviews. The data analysis was done according to Tesch's method (Creswell, 1994: 155-159) and field notes were taken and integrated in the discussion. The initial question asked was: "*How is physical science for you?*". Coding was done by listing categories and themes after identifying words and themes that were related. Field notes were used to make inferences on themes that pertain to categories and sub-categories. A protocol was then sent to an independent coder. Consensus on the results was reached between the researcher and the independent coder. A literature control was also conducted to identify similarities of the research with other research and the uniqueness of the research (Creswell, 1994:155).

3.3 REALISATION OF SAMPLE

A purposive sampling method was used in this research and this was carried out by the researcher's conscious selection of certain subjects or elements in the study (Denzin & Lincoln, 1998:73). Sampling was done according to the following criteria: the learner had to be in grade 10 and had physical science as a subject; the age of the grade 10 physical science learner had to be between 15 and 17 years; both female and male learners were interviewed; learners achieved different results in physical science – some did very well, some average and some very bad; learners took physical science as a subject because it was a prerequisite for further tertiary study; and learners all attend the same school.

3.4 DISCUSSION OF THE RESULTS

The information and literature were integrated throughout. The researcher found that the learners' experience of physical science is related to:

- the psychosocial characteristics of the learner and his or her interaction with the environment;
- the method of instruction in the classroom; and
- the educator's attitude, words and actions toward the learners during the teaching of physical science.

In view of the above, it became clear that the social environment of the classroom (where grade 10 learners are taught physical science) influence their experience of science positively or negatively. In this environment the educator and other learners are present and are part of the process of learning physical science.

When educators are approachable, understanding is promoted but when educators demonstrate practices of disrespect or show signs of stress and pressure, it affects the grade 10 learners' experience of physical science negatively. Learners are afraid of looking *"Stupid or dumb"* in front of other learners and this also affects their experience of the subject negatively. When physical science is not understood, or if the learners' marks are *"bad"* they tend to *"hate"* the subject and vice versa.

Being involved during the learning process promotes the learners' understanding of the subject and makes the subject more fun for them.

Thus, three themes were identified and discussed: grade 10 learners' experience of physical science is related to the psychosocial characteristics of the learner and his or her interaction with the environment; grade 10 learners' experience of physical science is related to the method of instruction or the teaching method in the classroom and grade 10 learners' experience of physical science is related to the educator's attitude, words and actions towards learners during the teaching of physical science.

The themes and sub-categories are summarised in Table 1.

Table 1: Tabular representation of grade 10 learners' experience of physical science

THEME	CATEGORIES
1. Grade 10 learners' experience of physical science related to the **psychosocial characteristics of the learner** and his/her **interaction with the environment.**	1.1 The feedback loop between the learners' ability to **understand physical science and their self-image** in the presence of other learners. • Not understanding physical sciences result in learners labelling themselves as *"dumb, stupid".* • Learners are afraid to *"look stupid in front of friends"* and the educator when they do not understand physical science. 1.2 Learners experience a **love-hate relationship** with physical science influenced by their ability to understand the subject.
2. Grade 10 learners' experience of physical science related to the **method of instruction/ teaching method** thereof in the classroom.	2. Implementing **practical activities** such as experiments, practical assignments and attending science outings make the subject more interesting, fun and understandable. 2.2 **Group activities** in learning about physical science add to the experience of it being fun and enable learners to learn more about others. 2.3 Physical science taught by relating its **meaning in the learner's *"real life"*** is more interesting and easier to understand.
3. Grade 10 learners' experience of physical science relates to the **educator's attitude, words and actions** toward learners during teaching of physical science.	3.1 A context created where learners feel ***"comfortable with the teacher"*** promotes **approachability** of the educator. Qualities of an approachable educator include: • Enthusiasm • Being knowledgeable • Patience • Belief in the learner's abilities • Motivation of learners. 3.2 **Disrespectful practises** demonstrated by educators leading to a negative experience of physical science by learners are: • Favouritism • Anger, irritability, rudeness and being blunt • Prejudices toward female learners 3.3 Educators **verbalising work pressure and showing stress** related to the teaching of physical science increase the pressure and stress learner experience regarding the subject.

3.4.1 THEME 1: Grade 10 learners' experience of physical science is related to the psychosocial characteristics of the learners and their interaction with the environment

The following aspects concerning the grade 10 physical science learners were found to be central to the learners' contexts: 1) The feedback loop between the learners' ability to understand physical science and their self-image in the presence of other learners; 2) Learners experience a love-hate relationship with physical science which is influenced by their ability to understand the subject.

3.4.1.1 The feedback loop between the learners' ability to understand physical science and their self-image in the presence of other learners

The researcher found that grade 10 physical science learners, that do not understand physical science label themselves as *"dumb/stupid".* This can be proved by the following statements: **(Participant A)** *"Sometimes after the teacher explained something, you ask the same question because you still don't understand. It really makes me feel dumb and too stupid to take science when this happens".* **(Participant C)** *"…I don't understand the work… I feel stupid for not always understanding the work".* **(Participant D)** *"It took all my courage to tell her that I didn't understand some of the work".* **(Participant E)** *"…afraid to tell the teacher I do not understand and look stupid".*

The researcher found that learners are often afraid to *"look stupid in front of friends"* and the educator when they do not understand physical science. Statements that underline this are the following: **(A)** *"I am then too afraid to ask a question because I am afraid of looking stupid in front of my friends"; "...all my courage to tell her I did not understand".* **(E)** *"I have never considered getting extra help because I am afraid of what people might think of me. I don't want*

anyone to know how dumb I am because I don't understand the work. So I go on struggling". **(C)** *"I have never considered getting extra help because I am afraid of what people might think of me. I don't want anyone to know how dumb I am because I don't understand the work. So I rather go on struggling". "It's just not always easy for me to ask for extra help and my teacher is under a lot of pressure and I don't want to bother her with my problems. I don't want her to see me as a constant pain in the butt".*

The social environment also plays a large role in how learners experience physical science. The social context of science is largely ignored in mainstream schools. Social constructivism recognizes the social and personal aspects of learning (Vygotsky, 1978:25). Vygotsky (1986:100) is further of the opinion that each individual's ability to think and learn is dependent on the activities and social contexts which he/she is a part of. McRobbie (1997:200) sees learning as personal and subjective and that it exists in the mind of the knower. There are various ways in which a learner may construct meaning in the physical science classroom. It has to be kept in mind that a learner's knowledge is personally constructed and that the constructed knowledge is socially mediated as a result of cultural experiences, personal history, interactions with others and the collective experiences of the class. This places importance on the context in which learning occurs.

The construction of meaning and mental models is thus influenced by internal as well as external factors. Bloom (1995:170) explored ways in which personal experiences and interpretive frameworks impact on the way learners construct knowledge. He found that learners' personal frameworks are largely shaped by (and contribute to) the 'social knowledge' of the classrooms in which learners participate.

Lauzon (1999:263) views learning as being most effective in the context in which knowledge is created and used. In order to acquire knowledge, learners must

become actively involved and socially participate in the physical science classroom.

Lave (1997:21) views learning as the development of identity in a social practice. Lave and Wenger (1991:108) emphasises that it is important for learners to become part of a community. This will then lead to their active participation. Stears, Malcolm and Kowlas (2003:109) also point out to the importance of socio-cultural knowledge. They add that if this is ignored, learners will feel alienated from school.

Linking learners' science learning to their everyday experiences is widely advocated in science education, research and policy. An increasing body of research points to the importance of learners' socio-cultural knowledge (Cobern & Aikenhead, 1998; Linkson, 1999).

Words and terms that are used during the teaching of physical science, acquire meaning in the context that they are used. Säljö (1996:85) adds that the construction of meaning is always a social process that depends on the people who interact. He further says that meaning is always relative to options and constraints that are present in social situations. The social community (in this case the classroom) is decisive for how a question, a problem or a statement will be interpreted and what learners see as interesting, pertinent and objective (Schoultz & Hultman, 2004:22).

The teaching of physical science in schools is a social and cultural activity. Learning science is about being a participator in activities that offer a scientific way of thinking and acting. This is not easy and perhaps not even possible in a school context.

3.4.1.2 *Learners experience a love-hate relationship with physical science which is influenced by their ability to understand the subject*

It became clear to the researcher that learners experience a love-hate relationship with physical science and that this is greatly influenced by their ability to understand physical science. Comments that illustrate this were: **(A)** *"When I don't understand something, naturally I become negative about the subject".* **(B)** *"I hated it when I did not understand certain work we did…I also disliked science when I was tired because I always had to focus otherwise I would never understand the work".* **(C)** *"I like science to an extent but it depends on whether I understand the work or not. If I do understand the work then I enjoy it because it's interesting…as soon as I struggle with something, I become very negative and tell myself that I don't like science and that I can't do it. This influences my marks negatively. So then I get bad marks and I hate science..".* **(D)** *"I like science when I understand the work and I am able to answer questions on the work…as soon as I struggle with something or don't understand something, I become very negative and tell myself that I don't like science and that I can't do it. This influences my marks very negatively. So then I get bad marks and I hate science…I know I should constantly work hard in science but it's hard when I don't understand something or it's not interesting for me…but it would be much easier if I understood everything we do. I really want to do well in science".* **(E)** *"…most of the time I like physical science…but some times I hate it…this mostly happens if I don't understand the work…I don't understand anything…I hate science".*

During the research it became clear to the researcher that learners have different perceptions on physical science. If learners do not understand the subject, they experience various emotions linked to their perceptions. These emotions influence their experience of physical science negatively, namely negativity, hate

and frustration. They are also petrified, pressurised, afraid or scared and stressed.

- Negativity – *learners become negative if they do not understand physical science*

The first emotion that various learners experience if they do not understand physical science, is negativity. Various comments made by the interviewees highlight this: **(A)** *"When I don't understand something, naturally I become negative about the subject".* **(D)** *"…as soon as I struggle with something, I become very negative".*

- Hate – *when learners do not achieve to their full potential they hate physical science*

The second emotion learners experience in physical science, is hate: **(D)** *"…I get bad marks and I hate science".*

- Frustration – *when learners do not understand physical science, they get frustrated*

The third emotion is frustration: *"I got so frustrated…made me feel that it was a waste to even try because I am a girl and I will never 'get' it".* **(C)** *"…I just really struggle with science".* **(E)** *"This makes me frustrated and then I become very negative towards science".*

- Petrified – *learners are afraid of physical science*

Most learners are also petrified if they do not understand physical science: **(B)** *"I used to be petrified of writing science tests because I never knew what to expect".* **(D)** *"I was too scared to say that I didn't understand some of the work".*

- Pressurised – *learners experience pressure in the physical science classroom*

Learners also often feel pressurised: **(C)** *" I always feel pressurised in the science class".*

- Fear – *learners are scared in the physical science classroom*

Learners are often afraid or scared: **(D)** *"I was too afraid to tell my teacher that I didn't understand…I was afraid she might realise just how stupid I am…I was too scared to say that I didn't understand some of the work".*

- Stress – *learners find physical science stressful*

Learners even sometimes experience stress in the physical science classroom: **(E)** *"…that makes me stressed as well".* The researcher found that learning about physical science is a process of building on previous knowledge that was established in previous grades. If this is not the case, learners experience stress. As one interviewee commented: **(D)** *"…you need to understand the theories and be able to apply them in exams or tests".*

Hendley, Parkinson, Stables and Tanner (1995) also concluded in their research that science is a 'love-hate' subject that elicits strong feelings in learners.

Psychologists and motivating theorists (Harter, 1981; Bandura, 1994) have long believed that learners' positive attitude towards learning and positive self-perception of their competence have a great impact on their motivation and enhances their academic achievement. If learners have a negative attitude towards physical science, it will impact on their motivation and their achievement in the subject.

There is a continuous feedback loop between learners' self-evaluation, self-efficacy beliefs, intrinsic interest, motivation and accomplishment "(Schunk, 1991; Brown, Lent & Larkin, 1989; Locke & Latham, 1990; Multon, Brown & Lent, 1991; Zimmerman, Bandura & Martinez-Pons, 1992; Zimmerman & Bandura, 1994). These studies and motivating theories are however the products of Western culture and society. The conceptions of self may vary from culture to culture (Triandis, 1989; Markus & Kitayama, 1991). There has been various research done in non-Western societies on the relationship between self-esteem and academic achievement (Heine, Lehman, Markus & Kitayama, 1999; Wong & Watkins, 2001). It is important to determine the relationship between learners' achievement in physical science and their self-perceptions.

Shen (2002:176) also found that there is a negative relationship between achievement and learners' self-perceptions. Learners' self-perceptions have transcended individual characteristics and reflect South Africa's educational, cultural and social contexts, which have gradually created learners' attitudes, values and beliefs. Learners' positive or negative attitude towards physical science is also often related to their educational and career aspirations in science (Singh, Granville & Dika, 2002:323).

3.4.2 THEME 2: Grade 10 learners' experience of physical science is related to the method of instruction or the teaching method in the classroom

The researcher found that grade 10 learners' experience of physical science is related to: 1) Implementing practical activities such as experiments, practical assignments and attending science outings make the subject more interesting, fun and able to understand; 2) Group activities in learning physical science add to the experience of it as being fun. It also enables learners to learn more about

others; 3) Physical science taught by relating its meaning to the learners' *"real life"* and past experiences, is more interesting and easier to understand.

3.4.2.1 Implementing practical activities such as experiments, practical assignments and attending science outings make the subject more interesting, fun and able to understand

The researcher found that practical activities improve learners' understanding of physical science. Statements that prove this are the following: **(A)** *"I like doing experiments because I feel that when I do something practically, I understand better and it also brings fun into the subject…what has also helped me is that we do a lot of experiments this year…this made science fun and interesting".* **(C)** *"…hardly ever have enough time to do experiments…I really like doing experiments…nothing to look forward to…same old boring routine".* **(D)** *"I also like it when we do experiments and go on science outings. That's always lots of fun and very interesting! After we have done an experiment I am always more interested in the work because it's exciting".*

Schoultz and Hultman (2004:28) also says that practical, experimental work has an important place in science teaching.

3.4.2.2 Group activities in learning physical science ads to the experience of it as being fun and enables learners to learn more about others

The researcher found that group activities are very important in the teaching of physical science. It makes science fun for learners and they get to know others better. Comments that highlight this are the following: **(A)** *"I also like it when my teacher gives us assignments on interesting topics…we were divided into groups and we had to work together as a group to succeed…I got to know a lot of people better".*

A significant determinant of the experience of physical science is the attitude of peers and friends (Breakwell & Beardsell, 1992:185). Adolescence is a period of moratorium where the learner is attempting to establish self-identity and is more influenced by the normative expectations of peers. In a study by Myers and Fouts (1992:931) it was found that the most positive experiences of physical science, were associated with a high level of involvement, a very high level of personal support, strong positive relationships with classmates and the use of a variety of teaching strategies and unusual learning activities. Group work is clearly very important for learners.

3.4.2.3 Physical science taught by relating its meaning to the learners' "real life" and past experiences, is more interesting and easier to understand

The researcher found that the doors to understanding are opened through the study of physical science: **(B)** *"..I liked the fact that science made everything clear to me and answered many questions I used to ask myself…it is interesting ... and some of the stuff you can relate to real-life and it makes you want to investigate and find the answers".* **(E)** *"…science plays a role in everything we do. We are dependent on science to understand our world and our daily lives. Every day new things are discovered in science that makes our lives easier".*

Science related to learners' own lives improves their understanding of the subject: **(B)** *"I also think she's great because she relates science to our real-life situations…this makes it much easier to understand because I can see how it helps us in everyday life…she also uses what we learned in previous grades. Science then doesn't feel so far removed from my own reality. Because it is then applicable to my life, it's much more interesting and easier to understand".* **(C)** *"I can also not understand how science will benefit me. It's not applicable to my*

life. It's far removed from me and it will never affect me so why should I bother with it? Nothing I have learned in previous grades in science has helped me understand what we are doing now. Nothing we are doing now seems related to what we did in previous grades". **(E)** *"I just struggle sometimes to understand how what we do is applicable to my life".*

Rollnick, Green, White, Mumba and Bennett (2001:25) found that learners' attitude towards their learning are the products of their previous educational experiences. Educators have the opportunity to change their experience of physical science but ultimately it is the learners who have to balance new experiences with previous learning experiences.

The emphasis is on the influence of learners' personal frameworks – formed by their socio-economic conditions, their environment and the circumstances of their lives (including poverty, family/support structures and illness).

Ledbetter (1993:615) reported on ways in which learners' conceptions in science depend on their previous experience, including the ways in which they link formal science to their everyday lives. There is evidence that suggests that learners differentiate between 'school science' and 'out of school science'. This differentiation is reminiscent of Vygotsky's 'spontaneous' and 'scientific' conceptions or Moll's (2001:12) 'spontaneous' and 'systemised' concepts. This causes learners not to relate classroom science to their own lives and learners then fail to understand physical science.

Stears, Malcolm and Kowlas (2003:109) found in their research that greater connectedness of school science with learners' interests and experiences, promote deeper engagement for the learners with each other and the content. They also found that the greater the degree of connectedness with the learning material, the deeper learners engage with each other and other learners. Learners enjoy making links between their different experiences.

Marková (1982:2) sees learners' past learning experiences as leading to different ways of seeing the world and consequently leading to different beliefs concerning their apprehension of the world.

The distance between the everyday world of the learner and the "scientific world" of the school, is often so great that learners cannot benefit from the teaching (Jakobsson, 2001). This urgently has to change.

3.4.3 THEME 3: Grade 10 learners' experience of physical science is related to the educator's attitude, words and actions towards learners during the teaching of physical science

The researcher found that: 1) A context where learners feel *"comfortable with the teacher"* promotes approachability of the educator; 2) Disrespectful practices demonstrated by educators lead to a negative experience of physical science by learners; 3) Educators verbalising work pressure and showing stress related to the teaching of physical science increase the pressure and stress learners experience about the subject.

3.4.3.1 A context where learners feel "comfortable with the teacher" promotes approachability of the educator

It became clear to the researcher that how learners' experience physical science, depends on the educator: **(A)** *"I feel that how you experience science all depends on your teacher and how he/she explains it".* **(C)** *"I believe that you need a good teacher".* **(E)** *"I guess it all has to do with your attitude and your teacher".*

Certain qualities make physical science educators more approachable. These include: enthusiasm, being knowledgeable, patience, belief in the learner's ability, motivating learners and respect.

- Enthusiasm – *the educator is excited about physical science*

Enthusiasm is very important to learners: **(A)** *"If the teacher is enthusiastic about the subject, the learners are also enthusiastic about it".* **(B)** *"…I actually enjoyed the subject in a way because she never made class boring".* **(E)** *"Some teachers make science interesting".*

- Knowledge – *educators should know what they are talking about*

Educators should be knowledgeable on the subject: **(A)** *"I also think that a teacher should be knowledgeable about science".*

- Patience – *educators should not get angry*

Learners feel more comfortable if a educator is patient: **(A)** *"She always takes time to explain everything in detail till everyone – even me - understands".* **(B)** *"…she always asked if we understand the work…she really went through a lot of trouble to help me with science…she explained some things to me over and over again till I understood…she never got angry with me…no question is stupid".* **(D)** "…*she listened to me*"; *"…explains over and over again"* .

- Believe – *educators have to believe in learners*

Physical science educators need to believe in the learner's ability: **(B)** *"She remained positive and kept on believing in me"; "I mean, she did not think I could do science, so why should I bother doing my homework and study for tests?".* **(D)** *"…my teacher helped me try and understand and in the end it paid of".*

- Motivation – *educators have to be able to motivate learners*

It is also important that educators motivate learners **(A)** *"She praised all my attempts at answering and told me that I can do science".* **(B)** *"…excited about class and she gave me some motivation towards the subject".*

- Respect – *educators should show respect for learners*

Educators should respect their learners: **(A)** *"She has never chased me away or accused me of not paying attention or made me feel stupid".* **(B)** *"…she never made negative comments or suggestions…we have such a good relationship and I feel so comfortable with her".*

3.4.3.2 Disrespectful practices demonstrated by educators lead to a negative experience of physical science by learners

The researcher found that certain disrespectful practices by physical science educators, add to learners' negative experience of the subject. These practices include: favouritism, anger, irritability, rudeness, bluntness, prejudice and disbelief in learners.

- Favouritism – *educators handle different learners differently*

The first practice that learners experience very negatively, is favouritism: **(A)** *"Some teachers like some learners and other not".*

- Anger, irritability, rudeness – *educators get upset with learners*

Learners feel uncomfortable if educators are angry, irritable, rude and blunt: **(A)** *"Sometimes teachers also make remarks like 'that's a stupid question' or 'how many times do I have to explain that to you…It also doesn't help if a teacher gets irritated if you ask a question"; "…she was rude and blunt when I asked her a question about something. It made me feel stupid and I started to think that I will never be able to do science"*.

- Prejudices/disbelief – *educators have perceptions about their learners*

Prejudices/disbelief in learners also has a very negative impact on physical science learners: **(A)** *"Even though I am a girl, I like science although a lot of people say girls don't like science and can't do science".* **(B)** *"girls can't do science…cannot think logical…feel demotivated…someone told me it was really hard…made comments like: 'girls can't do science because they can't be logical".* **(C)** *"my teacher thinks that I am lazy and that I don't do my homework or study for exams because I am just too lazy".*

Studies show that girls exhibit less positive attitudes towards science than boys (AAUW, 1992:18). They also achieve lower marks than boys. Kahle (1996:60) hypothesised that this is due to differential treatment and instruction that boys and girls receive in the classroom. McComas (1996:81) suggested that evidence is accumulating that girls' experience of physical science can be changed by instruction.

3.4.3.3 Educators verbalising work pressure and showing stress related to the teaching of physical science increase the pressure and stress learners experience about the subject

The researcher found that educators' experiencing stress, cause learners to also experience stress, which leads to learners experiencing the subject negatively: **(C)** *"…the teacher constantly complains about how much work we still have to do*

and that we will never get through the syllabus in this year". **(D)** *"It's just not always easy for me to ask for extra help and my teacher is under a lot of pressure and I don't want to bother her with my problems. I don't want her to see me as a constant pain in the butt!".* **(E)** *"There is always so much work that has to be covered in one term, that there is hardly ever time to do fun things…teachers are also nearly always stressed because of all the work that still has to be done".*

Learners feel rejected by educators who make them feel as if they are a nuisance. This gives rise to a dislike of physical science. Sundberg, Dini and Li (1994:680) found that the most important variable affecting learners' experience of physical science was the kind of teaching they experience. The educator plays a very significant role. Most comments made by learners for not liking physical science, were educator-related.

3.5 CONCLUSION

In this chapter the researcher discussed the results in three main categories:

3.5.1 Grade 10 learners' experience of physical science is related to the psychosocial characteristics of the learners and their interaction with the environment

The researcher found that the grade 10 learners' experience of physical science is influenced by their ability to understand and their self-image in the presence of classmates. Some learners call themselves "dumb" because they do not understand the subject. They are strongly influenced by what their classmates think of them and would rather keep quiet when they do not understand something than ask a question and 'look stupid'. Learners experience a love-hate relationship with physical science. They like the subjects as long as they do well in the subject, but hate it if they do not understand the work or do poorly in a

test. The researcher concluded that grade 10 learners' experience of physical science is influenced by both internal factors (the learner's self-image and perceptions) and external factors (interaction with classmates). All these factors contribute positively or negatively to learners' experience.

3.5.2 Grade 10 learners' experience of physical science is related to the method of instruction in the classroom

The researcher found that learners' experience of physical science is influenced by practical activities (like experiments, assignments and outings), group activities and learners' previous knowledge. All of these make physical science more interesting, fun and exciting for learners. Learners find physical science easier to understand if they have the opportunity to do 'hands-on' activities in class and if they are able to apply what they learn in the classroom to their own lives. Learners value interaction with other learners and the educator in the physical science classroom because the educator and learners help each other to understand the subject. They also gain acceptance in a group.

3.5.3 Grade 10 learners' experience of physical science is related to the educators' attitude, words and actions towards learners during the teaching of physical science

The researcher found that the educator plays a very important role in how learners experience physical science. Learners want to feel comfortable with their physical science educator. They need to be able to approach her or him. The researcher found that certain qualities make an educator more approachable. These are: enthusiasm, knowledge, patience, belief in the learner's ability, motivation and respect. Educators that act disrespectful may have the result that learners experience the subject very negatively. Learners find favouritism, anger, irritability, rudeness, bluntness, prejudice and disbelief disrespectful. Learners also feel stressed when an educator is under stress.

Learners see educators as being under stress because of their workload, a broad curriculum and time limitations. This contributes to learners experiencing physical science negatively.

CHAPTER 4

SUMMARY, LIMITATIONS, RECOMMENDATIONS AND CONCLUSION

4.1 INTRODUCTION

In Chapter Three the results of the research study were discussed. In this chapter qualities that could assist achievement in physical science will be outlined. These qualities will be discussed with reference to the problems that were identified in Chapter Three.

4.2 CONCLUSION AND GUIDELINES TO ASSIST WITH GRADE 10 LEARNERS' ACHIEVEMENT IN PHYSICAL SCIENCE

4.2.1 Conclusion and summary of the results of the research study

The results of the research study are summarised in three themes:

- **Theme One:** Grade 10 learners' experience of physical science is related to the psychosocial characteristics of the learner and their interaction with the environment

- **Theme Two:** Grade 10 learners' experience of physical science is related to the method of instruction or the teaching method in the classroom

- **Theme Three:** Grade 10 learners' experience of physical science is related to the educator's attitude, words and actions towards learners during the teaching of physical science.

It is interesting to note that South Africa is among the low-performing countries in science (Shen, 2002:178). The standards in this country are lower than in other countries. For this reason, learners might like physical science more because they do pretty well in the subject and find it easy. It is thus important to raise academic standards gradually. The marks learners achieve are artificially high and it leads them to believe that their achievements are better than it really is. Learners consequently will then have less motivation and set lower goals to improve their performance. The academic standards in South Africa should be risen to improve achievement in physical science by improving the way learners' experience the subject. The way learners learn physical science should be changed.

According to Lemke (1990:1) learning science means to communicate in the language of science and act as a member of the science classroom. Language is a very important tool for creating understanding and for being understood. It is a way for learners to converse with other learners and the educator. Educators have to help learners to cross the language barrier in order for learners to achieve in physical science.

The researcher agrees with Ramsden (1992:44) who said that: "an approach describes a relation between the student and the learning he or she is doing". To change learners' experience of physical science and improve their achievements, their experiences and perceptions have to be changed. This can be done by changing the way learners experience physical science in the classroom

The experience in the physical science classroom depends on the interaction of learners, educators and materials. The learner, the educator and the material are not components which can be described separately. They are variables which affect each other and at the same time form a whole, which is affected by the surrounding milieu.

After interpreting the data from the research, Figure 4.1 was compiled to identify the influences that affect learners' experience of physical science. This was done to carry the themes that were identified in the research through to the guidelines. These influences can lead to learners either experiencing physical science positively or negatively, which in turn impacts on learners' achievement in physical science.

Figure 4.1 : Influences on learners' experience of physical science

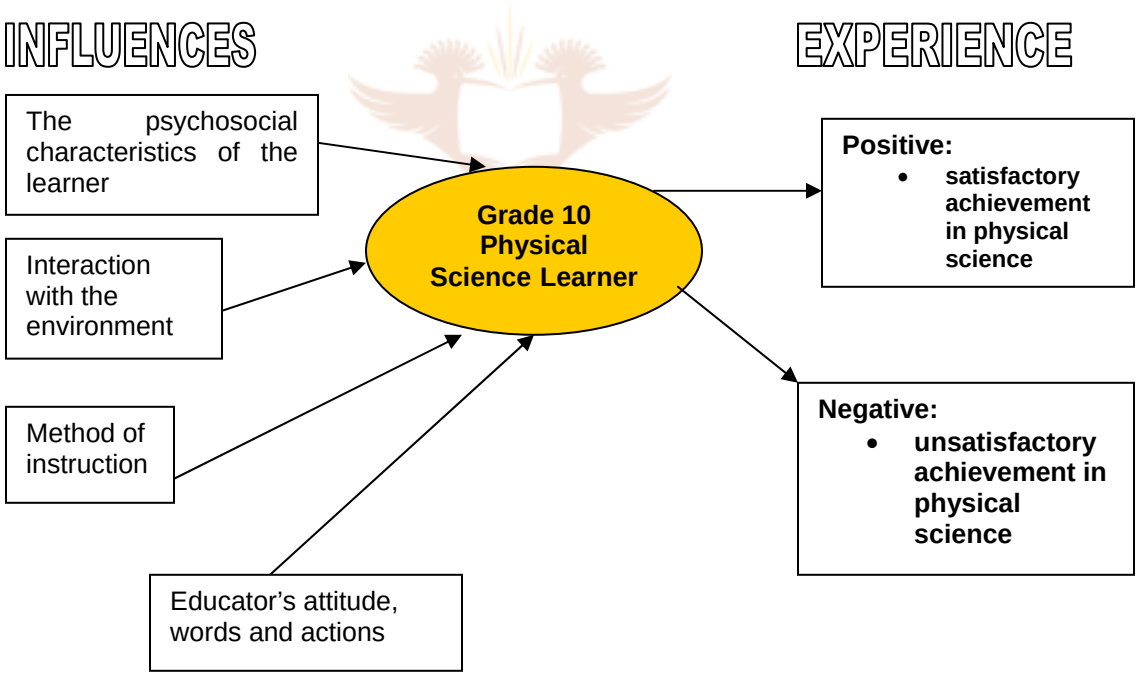
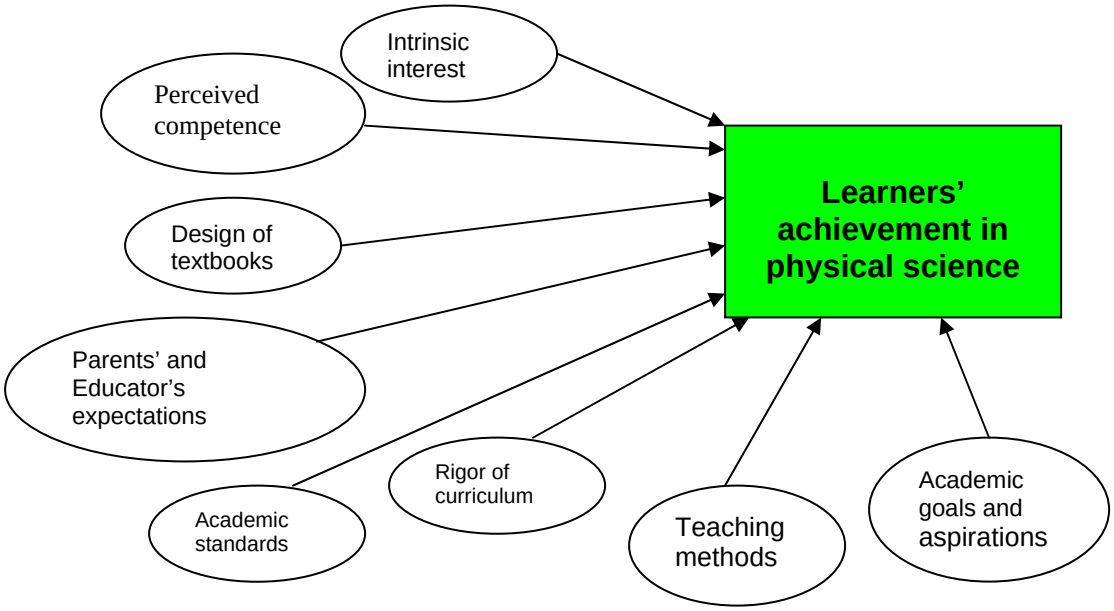


Figure 4.1 can be broken down to identify some factors that could help learners achieve in physical science. Figure 4.2. illustrates this:

Figure 4.2 Factors that help learners to achieve in physical science



From the above it is clear that the main factor that influence learners' achievement in physical science, is attitude. Ajzen and Fishbein (1980) note that attitudes are formed by experiences and once formed, they are enduring and difficult to change (Ajzen & Fishbein, 1980:146). Attitudes towards physical science are the feelings, beliefs and values about the subject. There is also a strong relationship between attitude, intention and behaviour (Osborne, 2003:1054). To change learners' attitude towards physical science, one needs to change their experience of it.

4.2.2 Guidelines to assist learners' achievement in physical science

4.2.2.1 Grade 10 learners' experience of physical science is related to the psychosocial characteristics of the learner and their interaction with the environment

Learners' academic goals and aspirations

This is determined in physical science by whether learners feel motivated. They need opportunities to choose, challenge and have control over what they learn in the physical science classroom.

Learners' perceived competence

This is influenced by their **past experiences** and the **usefulness of the subject.** Physical science educators should provide learners with science they can use in their everyday lives and build on their previous experiences, interests and prior knowledge. Various authors agree with this (Duit & Treagust, 1998:15; Department of Education, 1995:45). The educator should create contexts that give learners motivates learners so that they have a desire to learn. Meaningfulness for learners lies in the larger whole than is usually covered in the physical science classroom and curriculum.

Physical science educators have to pay specific attention to **girls' needs** in the physical science classroom. Kahle (1988:83) suggests that girls have to be given the opportunity to handle science equipment, perform experiments and participate in science-related activities. Girls will then develop greater confidence in their physical science abilities and be more interested in the subject.

Girls can become more involved by using strategies that make use of a clear emphasis on the 'doing of science' and the use of hands-on experiences. These have been proved to be a successful intervention technique in girls' experience of physical science (Anderson, 1993:33; Doran, Boorman, Chan & Hejaily, 1993:1122). These activities enable girls to see the relevance in the application of science, therefore making it important for them to learn. This will also lead to better achievement in physical science (Shakeshaft, 1995:79). Kahle (1996:95) notes that failure to achieve in physical science may be based on learners' failure to participate in the classroom.

There are various strategies to overcome and remove the obstacles to gender equity in physical science education. Kahle (1985:58) found that educators who are successful in encouraging girls in physical science had certain characteristics. They:

- maintained attractive, well-equipped classrooms;
- actively involved all learners in science experiments and activities in class; and
- made use of laboratory-based science teaching.

Educators should ensure that laboratory groups are structured so all learners of the class have opportunities to do physical science. Girls prefer a teaching style that makes use of learner-centred experiments and activities (Freedman, 2002:193).

4.2.2.2 Grade 10 learners' experience of physical science is related to the method of instruction or the teaching method in the classroom

To change learners' experience of physical science and their achievement in the subject, educators need to change:

- learners' interest in the subject;
- their teaching methods;
- the design of textbooks;
- the academic standards; and
- the curriculum.

Learners' interest in the subject

This can be changed by changing the **instruction methods** followed in the physical science classroom.

Teaching methods

One of the most important parts of physical science instruction, is experiments. Most educators and learners are of the opinion that science relies solely on experiments and that experiments 'prove' rather than support scientific claims (Dekker & Mnisi, 2003:32). Laws are seen as certain and not disputable. This goes against the nature of Science.

Experiments can be used as a forum for discussion where concepts and terms are used in a functional way, for example in a situation where learners have an opportunity to use and familiarise themselves with terms and expressions from physical science.

The educator plays a very important role when experiments are carried out. The educator has to assist learners to break down described experiments into sub-tasks. Educators also have to realise that in some themes the most important thing is not to understand a certain scientific concept. It is sufficient that learners learn to observe and describe what they see. The learners have to be able to discuss what they have done with other classmates in order to be able to make a whole unit of knowledge out of the different pieces (Schoultz & Hultman, 2004:29).

It is, however, not reasonable to assume that the activities of learners will lead to their discovering and acquiring scientific knowledge. Solomon (1999:68) emphasises the importance of the educator by saying: "…teachers need to help students change what is seen into a vivid illustration of scientific ideas with the capacity for further action". Experimental-material with 'hand-on kits' and activity books is no self-sufficient material. It requires an educator that is active, knowledgeable and sensitive and who is willing to help the learner.

Often during experiments too much time is spent on doing the experiment and too little time is left for reflection and discussion. Vygotsky (1986:67) further underlies the educator's role. He sees effective instruction as an educator helping a learner with the solution. Scientific concepts evolve under conditions of systematic co-operation between the learner and the educator. It is in interaction and discussions that learners become familiar with terms and concepts. In most classrooms in South Africa, learners are left on their own and conversation with the educator is infrequent.

Sjøberg (2000:394) comments on this: "…if the goal of teaching is to acquire the concepts and theories of science, it is rather doubtful if practical work is particularly effective". Learners find it stimulating to do experiments, but it is not always easy for learners to know what the educator expects of them. It is obvious to the educator, but not to the learner (Bergquist, 1990).

It is clear that hands-on physical science experiments increases achievement in the subject (Freedman, 2002:198). It also influences learners' attitudes towards the subject. For this reason, educators in South Africa have to make use of laboratory instruction to improve the experience of and achievement in physical science.

Other instruction methods also play a big role in learners' achievement in physical science. There are common aspects of instruction that are effective in changing learners' experience of physical science. These are:

- clear goals;
- clarity of communication;
- use of preview and review of lesson content;
- helping learners to contextualise content in terms of their own experience and knowledge;
- willingness to have learner input;

- a supportive social context to help learners feel accepted, cared for and valued; and
- a willingness to take into account learners' circumstances and to modify/pace/structure tasks accordingly.

Activities that enhance 'task value' might make a significant contribution to how learners experience physical science. Eccles and Wigfield (1995:220) describe 'task value' as the degree to which a learner believes that a particular task is able to fulfil personal needs or goals and consists of three components:

- interest or the enjoyment that a learner derives from engaging in a task;
- importance or the degree to which a learner thinks it is important to do well in a task; and
- utility or the degree to which an individual thinks a task is useful in reaching some future goal.

The rigour of the curriculum

This influences learners' **achievement**. Learners often feel alienated from physical science. This alienation can be seen as a failure of curriculum and instruction to respect and respond to the learners and their lives. Fleer (1997:15) pleads for a curriculum that incorporates multiple worldviews of learners. Linkson (1992:43) adds that educators and curriculum developers should work collaboratively to write materials that are appropriate. Thomas (1997:21) also refers to a 'culture-sensitive' pedagogy that will actively reflect and clearly prescribe culture-specific (classroom specific) knowledge, behaviours, attitudes and skills.

Learners' everyday knowledge can be used in a number of ways in the curriculum. It can be used as a starting point for learning science, as a reference point for thinking about the nature of science and as a context for applying scientific knowledge and skills. For this to happen, the current physical science curriculum has to change.

The curriculum should be structured in a learning cycle that first takes learners' past experiences and everyday knowledge into account and uses it in building more formalised structures, and then links the formal knowledge back to particular contexts in learners' lives. During each phase, there should be room for learners to be critical in thinking about knowledge and meaning. This process is consistent with constructivist learning and recognises prior learning. It also crosses between different ways of knowing. At the same time it underlies broader outcomes such as understanding science as a human activity, critical thinking and problem solving (Department of Education, 1995:56).

This type of collateral learning is necessary for learners and they need to relate cultural knowledge and science by finding relationships between the two (Jegede, 1999:100). Lessons should be designed to promote linkage, critique and integration. This can be a problem because most educators see 'school science' as separate from learners' lives and are unable to handle diversity in the science classroom.

It is of central importance in South Africa to integrate learners' experience with physical science by using Indigenous Knowledge and Technology as integral parts of the science curriculum (Department of Education, 2002:89). Local and traditional technology and knowledge has to be brought into the physical science classroom (Emereole & Maripe, 2003:564). This can be done by using examples of projects in their own community that use basic science and technology principles, like water purifiers, solar energy stations etc.

Osborne and Collins (2000:12) suggest that the contemporary curriculum may suffer from the obverse problem with too much emphasis on understanding activities like recall and copying and too little emphasis on learners' 'hands-on' experience.

4.2.2.3 Grade 10 learners' experience of physical science is related to the educator's attitude, words and actions towards learners during the teaching of physical science

Educators' expectations depend on what science educators teach. This depends on:

- their scientific understandings and skills;
- what they are able and willing teach; and
- on what they believe they are required to teach.

It is important that the professional development of educators should start with an exploration of educators' perceptions. Development needs to start from educators' current understandings (Rens & Dekker, 2001). When educators' understandings change, their instruction method will invariably also change.

Educators have to ask more open-ended questions in the class. However, educators have to be cautionary. Too many open-ended questions and instructions can confuse learners and the educator has to present and provide support and sum up after every lesson or experiment. Educators need to change the content and style of teaching to show a greater interest in learners. This will lead to a significant increase in the choice of physical science as a subject by learners in grade 10. Even though physical science is a compulsory subject for grade 9 learners, educators have to market the subject for grade 10 learners (Munro & Elsom, 2000:6). Attempts to persuade learners to take physical science, need to emphasise lost career and educational opportunities rather than emphasising the benefits of careers in science.

Educators need to be:

- well-qualified;
- enthusiastic;
- knowledgeable;

- able to set physical science in everyday contexts;
- able to run well-ordered and stimulating science lessons;
- sympathetic; and
- willing to spend time with learners (in and out of classroom) to discuss careers and individual problems.

It is of great importance for schools to recruit and keep able, bright enthusiastic physical science educators as they play even a bigger role in learners' experience of physical science, than the curriculum.

It is thus possible to change learners' experience of physical science and their achievement in the subject. It will have to be a group effort in which educators play a determining role.

4.3 LIMITATIONS OF THE STUDY

Interviews were conducted during learners' off classes at school. In some cases there were problems with time and being on time on the part of the learners as well as the researcher.

Other researchers using a different sample of participants might arrive at different conclusions if they carry out this research study.

4.4 RECOMMENDATIONS AND APPLICATION

Recommendations are made in relation to the application of the research and the indication for further research.

- Further research is required to find appropriate ways to enable educators and curriculum designers to successfully build systematic science understanding through everyday knowledge and interests of learners.

- The current physical science curriculum is national or universal but it should be locally defined. The curriculum should respond to local interests and needs. This will enable science education to be of immediate use to learners and promote concept development that is more effective, greater achievement of “critical outcomes” like problem solving, critical thinking, application of knowledge and teamwork.

- Further research is needed to explain the negative correlation between learners’ attitude and perceptions towards physical science and their achievement in the subject.

- The context of the physical science classroom should be researched to identify what the nature and style of teaching and activities are that engage learners in physical science.

- More research is needed to examine in-class instructional strategies for improving all learners’ experience of physical science and achievement in science.

4.7 CONCLUSION

The importance of this research, being an exploration of grade 10 physical science learners’ experience of the subject and outlining attributes/qualities that assist a positive experience of physical science, is that it alerts an awareness of what has to be done to facilitate grade 10 learners’ positive experience of physical science. It is vital to not only focus on the learner, but also on the educator, classmates and curriculum in an attempt to change learners’ experience of physical science. If this research were to be reworked I would use a larger sample of participants from a public school to ensure that all my findings can be transferred to all schools in South Africa.

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APPENDICES

APPENDIX A: Letter of approval of the Ethics Committee

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Telephone : (011) 489-2649
Fax : (011) 489-2257

2004-11-22

Reference Number: 49/05/04

TO WHOM IT MAY CONCERN

TITLE OF RESEARCH PROJECT: "Grade 10 learners' experience of Physical Science."

RESEARCHER: **L. van der Merwe**

SUPERVISOR(S): **Prof. C.P.H. Myburgh**
Prof. M. Poggenpoel

The Academic Ethics Committee of the Faculty of Education and Nursing of the Rand Afrikaans University evaluated the research proposal and consent letters of the above research project and confirms that it complies with the approved Ethical Research Standards of the Rand Afrikaans University. Permission was granted for research to continue on 22 November 2004.

The researcher demonstrated his/her intent to comply with the approved Ethical Research Standards during conduct of the research project.

Recommendations were made by the committee which will be conveyed to you and, if complied with, will improve the quality of your proposal.

Yours sincerely

Marie Poggenpoel

MARIE POGGENPOEL (PROF)
CHAIRPERSON: FACULTY COMMITTEE FOR ACADEMIC ETHICS

APPENDIX B: Letter of consent to participate in a research project

RANDSE AFRIKAANSE UNIVERSITEIT
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DEPARTMENT OF EDUCATION SCIENCE
Telephone: (011) 489-2860

Dear Parent

PARTICIPATION IN A RESEARCH PROJECT

I, Lize van der Merwe, am a M.Ed (Psychology of Education) student at the Rand Afrikaans University. I wish to conduct a research project entitled **"Grade 10 learners' experience of physical science"**. My supervisors are Prof CPH Myburgh and Prof M Poggenpoel. The aim is to describe qualities/attributes that contribute to achievement in physical science.

Your child is hereby invited to participate in this research.

An interview will be held with your child, where he/she would describe his/her experience with regard to physical science. With their permission, a tape recorder will be used for purposes of facilitating data analysis. Strict measures will be taken in order to protect their autonomy and confidentiality. The tapes will be kept under lock and key and only I will have access to them. Participation in this study is voluntary, and they have the right to withdraw their participation at any stage of the research should they wish to do so. Their human rights will be respected at all times. The benefits are that they will have the opportunity to share their experience and in so doing help to support other learners. The research results will be made available to you on request.

Should you agree, you hereby give consent to their participation in the research.

Signed at _____on the _____ day of _____ 2004.

SIGNATURE : PARENT/GUARDIAN

Ms L van der Merwe (Cell no: 082 782 1537)
MEd (Psychology of Education) Student
Researcher

Prof CPH Myburgh – Supervisor

Prof M Poggenpoel – Co-supervisor

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Dear Grade 10 Physical Science learner,

PARTICIPATION IN A RESEARCH PROJECT

I, Lize van der Merwe, am a M.Ed (Psychology of Education) student at the Rand Afrikaans University. I wish to conduct a research project entitled **"Grade 10 learners' experience of physical science"**. My supervisors are Prof CPH Myburgh and Prof M Poggenpoel. The aim is to describe qualities/attributes that contribute to achievement in physical science.

You are hereby invited to participate in the above-mentioned research.

An interview will be held with you, where you would describe your experience with regard to physical science. With your permission, a tape recorder will be used for purposes of facilitating data analysis. Strict measures will be taken in order to protect your autonomy and confidentiality. The tapes will be kept under lock and key and only I will have access to them. All tapes will be destroyed after the research and your name will not be mentioned. Participation in this study is voluntary, and you have the right to withdraw your participation at any stage of the research should you wish to do so. Your human rights will be respected at all times. The benefits are that you will have the opportunity to share your

experience and in so doing help to support other learners. The research results will be made available to you on request.

Should you agree, you hereby give informed assent to your participation in the research.

Thank you for your co-operation.

Signed at _____ on the _____ day of _____ 2004.

SIGNATURE : LEARNER

Ms L van der Merwe (Cell no: 082 782 1537)
MEd (Psychology of Education) Student
Researcher

Prof CPH Myburgh – Supervisor

Prof M Poggenpoel – Co-supervisor

APPENDIX C: Phenomenological interviews

TRANSCRIBED INTERVIEWS

How is Physical Science for you?

Overall I like Physical Science. I like physics more than chemistry because I feel that physics is more logical than chemistry and it is much easier to understand. I feel that how you experience Science all depends on your teacher and how he/she explains it. I think that Science is more of an understanding subject than a study subject. If you pay attention in class you have already done 60% of your studying and the rest is basically just revision. I think it depends on the person whether or not you like Science. Science is the kind of subject that you can't fall behind in because the work follow on each other and if you lose a part of the

work you won't understand the rest. Even though I am a girl, I like Science although a lot of people say girls don't like Science and can't do Science. I feel that they are wrong and making assumptions. I like doing experiments bacause I feel that when I do something practically, I understand better and it also brings fun into the subject. When I don't understand something naturally I become negative about the subject but then I usually try and figure it out for myself or get extra help from the teacher.. When I think back to when I had to choose my subjects, I don't regret choosing Physical Science as one of my subjects for one second. If you are prepared to work very hard, Science can be a lot of fun.But it is also true that Science is not easy. It also helps to make a subject fun when your attitude is right.

Tell me more about making Science 'fun'.

I think your teacher makes Science fun or dreadful. If the teacher is enthusiastic about the subject, the learners are also enthusiastic about it. I also think that a teacher should be knowledgeable about Science. I have had teachers in the past who couldn't answer some of the questions learners asked them and then pretended not to have heard the question. That made the teacher look stupid and as if they don't care. I am not saying that teachers should have all the answers, I just think that if they don't know the answer or are unsure, they should say so and then find out what the answer is and get back to the learner with an answer. Sometimes teachers also make remarks like: 'that's a stupid question' or 'how many times do I have to explain that to you!". I am then too afraid to ask a question because I am afraid of looking stupid in front of my friends. It also doesn't help if a teacher gets irritated if you ask a question. Sometimes after the teacher explained something, you ask the same question because you still don't

understand. It really makes me feel dumb and too stupid to take Science when this happens. Sometimes teachers will explain one thing twenty times to some learners if they don't understand but if another learner asks a question, they are told that they don't listen and aren't paying attention. Some teachers like some learners and others not. I had a teacher last year who didn't like me. I don't know why she didn't like me but she was always rude and blunt when I asked her a question about something. It made me feel stupid and I started to think that I will never be able to do Science. I basically failed Science because I thought it was a waste of time to try or to even study. I mean, she didn't think I could do Science, so why should I bother doing my homework and studying for tests? This year I have a different teacher. She always takes time to explain everything in detail till everyone – even me – understands. I have gone to her after some classes and asked things I were unsure of or did not understand. She has never chased me away or accused me of not paying attention or made me feel stupid. She praised all my attempts at answering the questions and told me that I can do Science; I just have to give it my best and work hard at it. At the moment I have a B average for Science, which is a huge improvement for me! What has also helped me is that we do a lot of experiments this year. Last year we never had time for experiments because of all the portfolio work that we had to do. But this year we did a lot of experiments on waves, light, lenses and a lot of other topics. This made Science fun and interesting and I can never wait for my Science period to see what we are going to know next. I know its going to be fun. My teacher also allows us to design and do some of the experiments on our own. We write the whole thing up and then present it in the class for marks. I love that because I always learn something new. I even started to think that maybe Science isn't so bad! I also like it when my teacher gives us assignments on interesting topics. Like we had do design our own periscope and make it and it had to work! This was challenging and real fun because we were divided into groups and we had to work together as a group to succeed. I got to know a lot of people better, people I never used to mix with or talk to. I actually found out that

they are not so bad after all! But you also make Science fun for yourself by remaining interested and doing your part. Both in the class and at home.

How is Physical Science for you?

When I walked into my Science classroom for the first time, I was very unsure if I wanted to take the subject because someone told me it was really hard, but I took it anyway. I thought it was going to be the biggest dread of my life, but fortunately I was blessed with a great teacher and supportive classmates. When my teacher started teaching me, I actually enjoyed the subject in a way, because she never made class boring. I was always excited about class and she gave met some motivation towards the subject. What I liked about her class was that she always asked if we understand the work and we would nod our heads but then she gave us activities to do and we storm to her desk in confusion. This helped me improve my capabilities and gave me practise in all type of questions. I also liked the fact that Science made everything clear to me and answered many questions I used to ask myself. What I did not like about Science was most ot the physics. I liked chemistry more, it was more challenging. I hated it when I did not understand certain work we did. I got so frustrated even though she explained everything so clearly. I also disliked Science when I was tired because I always had to focus in class, otherwise I would never understand the work. Science takes hard work, dedication and a lot of stress and late nights but in the end it all pays off. Science challenges you in many ways and I personally think that patience and practice can lead you to great marks. I truly enjoy this subject and would recommend it to anyone who feels like a challenge. Some people may take the easy road through life. Maybe Science is one of the stops on the more challenging road.

Explain to me in more detail what you mean by a 'great teacher'.

In my old school I had a male Science teacher. He always made comments like: 'girls can't do Science because they can't be logical'. This made me feel that it was a waste to even try because I'm a girl and I will never 'get' it. But when I came to this school, I got a female Science teacher. She really went through a lot of trouble to help me with Science. She made appointments with me before or after school to make sure that I catch up all the work I had missed. She explained some things to me over and over again till I understood. She never got angry with me and she never made negative comments or suggestions. She remained positive and kept on believing in me. We have such a good relationship and I feel so comfortable with her that I am starting to believe that girls can do Science – just as good or even better – than boys. My teacher is never too busy to help anyone and everyone knows that they are more than welcome to ask her anything – no question is stupid. I also think she is great because she gives us lots of exercises on the work. She also gives us questions from past papers. This helps me a lot because then I know how the work is normally asked in tests or exams and how to prepare for the exams. I use to be petrified of writing Science tests because I never knew what to expect and even though I studied very hard it never helped because they don't ask it as I studied it. But now I know how the work will be asked and on what to focus in the preparing for the exams. I now don't turn blank during the exams or can't remember anything. I also think she's great because she relates Science to our real-life situations. Whenever she does a chapter of the work, she also describes in detail where this is used in real-life. This makes it much easier to understand because I can then see how it helps us in everyday life. She also uses what we learned in previous grades. Science then doesn't feel so far removed from my own reality. Because it is then applicable to my life, it's much more interesting and easier to understand. My teacher also gives us information on what careers require Science and on what part of Science each study field focuses. This has helped me a lot because I never knew if I needed Science to study Physiotherapy and whether I needed it on higher or standard grade. I also found

out that we will do a lot of chemistry at university. I used to be very afraid of studying further because I didn't know what the course was about and what I would need for it. Now I know what to expect.

How is Physical Science for you?

Science is a subject of complexity and that takes lots of thinking. I like Science to an extent but it depends on whether I understand the work of not. If I do understand the work, then I enjoy it because it's interesting. I prefer physics because it is interesting and some of the stuff you can relate to real-life and it makes you want to investigate and find the answers. I hate chemistry because I don't find it interesting and I just don't enjoy it. Some of the equations and theories don't interest me and I'd rather do physics. Science is almost like Maths, if you miss something or don't understand something, you get lost along the way. It takes lots of hard work and concentration. Cruising through it is not an option because you need to be able to understand the theories and be able to apply them in exams or tests. Science doesn't really grab me. I've never really enjoyed it for some reason. It's a very complicated subject and if I could, I would avoid it. I think I used to like Science more when I was younger because mixtures and potions intrigued me and I thought it was so easy. My grades were high till I came to High School. It never dropped dramatically but it was difficult to try and do as well as I did before. Now Science isn't just about blowing things up. The problem is figuring out which substances you need to blow things up. Science is one of my matric subjects and I would probably have to study it at university. It is one of the subjects that almost all the study areas require. Chemistry is especially hard at university. I believe that you need a good teacher. Not only in Science, but also in Maths and Accounting. Science is intense and to handle getting through all the work without a teacher, is impossible. I once had a teacher that never knew how to teach Science. She was brilliant but she couldn't get the stuff across to us and I failed a few tests with

her. I once got an A+_ for a test I really worked hard for. I had been struggling with the work and my teacher helped met try and understand and in the end it paid off. I think Maths and Science go well together and in certain parts Maths also apply in Science.

Tell me more about why Science doesn't 'grab' you.

I always feel pressurised in the Science class. The teacher constantly complains about how much work we still have to do and that we will never get through the syllabus in this year. There are some sections of the work that we don't spend a lot of time on and I don't understand that work. There is never time in class to ask my teacher for help and feel stupid for not always understanding the work. Some of my friends also don't understand the work but they get extra lessons after school from another teacher. I have never considered getting extra help because I am afraid of what people might think of me. I don't want anyone to know how dumb I am because I don't understand the work. So I rather go on struggling. My teacher thinks that I am lazy and that I don't do my homework or study for exams because I am just too lazy. But that's not true… I just really struggle with Science. We also hardly ever have enough time to do experiments in class. Some learners in the class didn't pay attention when we did an experiment last term, so my teacher decided not to waste time by doing any other experiments. I really like doing experiments but know there is nothing to look forward to in the Science class. It's just always the same old boring routine. Nothing changes. I can also not understand how Science will benefit me. It's not applicable to my life. It's far removed from me and it will never affect me so why should I bother with it? It's just a waste of time and energy! No one seems to use any Science in their careers. Not that I know of…and even though it's a requirement for a lot of study fields, I still don't know why! It feels as if Science is a distant planet that will never favour me in anything I do. Nothing I have learned

in previous grades in Science has helped me understand what we are doing now. Nothing we are doing now seems related to what we did in previous grades.

How is Physical Science for you?

Well, sometimes I like it and sometimes I don't. I can remember the first time I walked into my grade 10 Science classroom. The teacher took one look at me and said: 'You shouldn't have any problems with Science because you are very intelligent'. So I felt like a real fool the first time I didn't understand something. I mean, I was supposed to understand everything! I was too afraid to tell my teacher that I didn't understand. I was afraid she might realise just how stupid I am. So I went on, never saying anything. After we wrote our first test, she called me to her desk. She told me that she was very disappointed in the mark I got. She also said that I am underachieving and she doesn't understand why. I was too scared to say that I didn't understand some of the work. I just nodded and promised to do better next time. But in the next test I did even worse. She called me into her office this time and asked me if there were any problems at home that were distracting my attention. It took all my courage to tell her that I didn't understand some of the work. She listened to me and then offered to give me a couple of extra lessons after school. After attending two extra lessons, my marks improved dramatically and I felt as if I could actually do Science. But as soon as I didn't understand something, my marks dropped.

Explain to me why you sometimes like Science and other times not.

I like Science when I understand the work and I am able to answer questions on the work. I also like it when we do experiments and go on Science outings. That's always lots of fun and very interesting! After we have done an experiment I am always more interested in the work because it's exciting. But as soon as I

struggle with something or don't understand something, I become very negative and tell myself that I don't like Science and that I can't do it. This influences my marks very negatively. So then I get bad marks and I hate Science. As soon as I am interested again after we went on a Science outing, I start working harder and paying more attention in class and then I do better in my tests and exams. My marks are always up the one moment and down the next. I know I should constantly work hard in Science but it's hard when I don't understand something or it's not interesting for me. I realise that I might need extra help sometimes. It's just not always easy for me to ask for extra help and my teacher is under a lot of pressure and I don't want to bother her with my problems. I don't want her to see me as a constant pain in the butt! But it would be much easier if I understood everything we do. I really want to do well in Science.

APPENDIX D: Protocol for the independent coder

PROTOCOL FOR THE INDEPENDENT CODER

The method that was used for purposes of data analysis pertaining to this study is based on the descriptive analysis model of Tesch (in Creswell, 1994:155). Below is a summary of the steps that were followed while processing the analysis according to interview responses which were transcribed by the researcher.

STEP 1: The researcher carefully reads through all the transcriptions several times in order to compose an overall mental picture of the contents.

STEP 2: One of the transcriptions is selected at random for close reading. As this reading proceeds, notes are taken in writing.

STEP 3: While keeping the relevant interview questions in mind, notes are inserted alongside the margin.

STEP 4: Umbrella categories, representative of the broader spectrum, are identified.

STEP 5: Once these categories have been determined and formulated, another reading of all the transcriptions takes place. During the course of this reading all the units which bear relevance to the umbrella categories are underlined.

STEP 6: Meaningful units contain specific words by means of which thoughts, perceptions or feelings are expressed, especially related or equivalent words of frequent occurrence. These words are an indication for identifying certain themes present in the contents.

- Thoughts: Thoughts result from thinking and can be defined as being ideas, judgements or opinions.
- Perceptions: A perception is the product of an observation or awareness. It is a subjective and conscious experience and processing in the mind of the recipient of information received from the internal and external environment. Previous experience features strongly when perceptions are made.
- Feelings: Feelings are related to lived-through experiences and they form part of emotions.

STEP 7: A list, indicating all the meaningful units and umbrella categories, is compiled. At the same time subcategories are identified and added to the list.

STEP 8: All the transcriptions are compared to establish similarities in connection with words or themes mentioned by the participants.

STEP 9: Relations between the categories and subcategories are identified and linked. The relations are expressed as theories or hypotheses.

STEP 10: Such insights as have been gained by the researcher during the course of the analysis are reflected in descriptive structure.