HIGH SCHOOL LEARNERS' ATTITUDES TOWARDS PHYSICAL SCIENCES

By

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HIGH SCHOOL LEARNERS' ATTITUDES TOWARDS PHYSICAL SCIENCES IN NONGOMA CIRCUIT

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DECLARATION

Declaration by candidate

I acknowledge that I have read and understood the University's policies and rules applicable to postgraduate research, and I certify that I have, to the best of my knowledge and belief, complied with their requirements.

I declare that this research, save for the supervisory guidance received, is the product of my own work and effort. I have, to the best of my knowledge and belief, acknowledged all sources of information in line with normal academic conventions.

I further certify that the research is original, and that the material submitted for examination has not been submitted, either in whole or in part, for a degree at this or any other university.

I have subjected this document to the University's text-matching and/or similarity-checking procedures and I consider it to be free of any form of plagiarism.

Signature: ………………………… Date: ………………………………

Declaration by supervisor(s)

I am satisfied that I have given the candidate the necessary supervision in respect of this research and that it meets the University's requirements in respect of postgraduate research. I have read and approved the final version of this research and it is submitted with my consent.

Signature: ……………….. Print Name ………………..…………

Signature ………………… Print Name ……………………………

Date ………………………. Date……………………………

DEDICATION

This work is dedicated to my late mum, Madam Madudana, and my late dad, Chief Adam, whose wisdom and foresight has brought me this far. May their souls rest in perfect peace.

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ABSTRACT

The investigation of high school learners' attitudes towards physical science has been one of the prominent areas of research for the science education research community globally for some time now. However, its current importance in South Africa is emphasised by the mounting evidence of poor performance in physical science at matriculation level. Consequently, identifying the nature of learners' attitudes towards physical science, and promoting favourable attitudes towards physical science is increasingly a matter of concern. The present study therefore investigated high school learners' attitudes towards physical science and the relationship between their attitudes and learners' biographical data such as gender, age and grade level. Both systematic and stratified sampling techniques were used to select a sample size of 298 respondents from five high schools in the Nongoma circuit in KwaZulu-Natal province of South Africa. The research was based on descriptive research design to obtain information from respondents in their natural environment through the use of adopted attitude scale. Permission was sought and obtained through email to use the attitude scale. Descriptive and inferential statistics were used to present and analyse the data.

The findings from the present study suggest that majority of high school learners hold positive attitudes towards physical science. Findings with regard to the relationship between learners' attitudes and their biographical data reveal that there is no association between attitudes and learners' biographical data such as gender, age and grade level.

The findings from this study will add value to education policy pertaining to science education in the country. It will also contribute to the theory of attitudes towards physical science. However, there is a need in future to study ways of encouraging learners to have positive attitudes towards physical science.

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MOTIVATION AND PROBLEM STATEMENT FOR THE STUDY

1.1 INTRODUCTION

This research examined the attitudes of high school learners towards physical science in the Nongoma circuit in the KwaZulu-Natal province of South Africa.

The increasing advancement in technology and globalisation has caused a great demand for more people to study science, and this is particularly critical for South Africa, as evidence has suggested that the country among her peers is lagging behind in the quality of science and mathematics education (Campbell & Prew, 2014; Evans, 2013; Southern and Eastern Africa Consortium for Monitoring Educational Quality [SACMEQ], 2015; World Economic Forum [WEF], 2015).

A closer look at statistics from Education statistics South Africa's (2016) report on the National Census 2011, shows that, in the year 2001, about 2.7% of men, and 2% of women, between the ages 20 and above, who attained tertiary qualification in South Africa, had those qualifications in natural science, physical science and mathematical science. However, by the year 2011, these percentages dropped to 2% of men and 1.8% of women. Moreover, in the year 2012, of the 562 112 learners who wrote the matric examination, only 179 194 learners wrote physical science. When compared to 2011, the physical science candidates declined by 1 391 learners (Department of Basic Education [DBE], 2015). Although the education department reported a nominal increase in the number of learners who wrote the physical sciences exam in 2013, only 14.4% of the 184 383 learners, obtained 60% and above (DBE, 2016). The national pass rate in physical science declined from 67.4% in 2013 to 61.5% in 2014 and declined again to 58.6% in 2015. In 2017 the pass rate improved from 62% in 2016 to 65.1%. However the number of learners who wrote physical sciences dropped from 192 618 in 2016 to 179 561 with only 16.2% of them achieving 60% and above (DBE, 2017)

The South African government, and other stakeholders in science education, are aware of this trend of poor performance in physical science, and they have been working to avert this tendency of poor performance. The Department of Education over the past years has embarked on a number of interventions to improve science education in the country. Notably, these interventions include: expanding bursaries and scholarships for teachers, providing science laboratories and science kits to schools, and using media interventions such as SABC Education and Liberty Life programmes on science. However, the performance and participation in physical science at matric examination level is still at unacceptable levels (Campbell & Prew, 2014; DBE, 2017; Evans, 2013). It is therefore a prudent move for stakeholders in science education to help these learners to understand the importance of physical sciences and the significance of studying it as a subject. However, investigating the importance of physical sciences and/or the significance of learning it as a subject was not part of this study. Rather, investigating the attitudes of the high school learners towards physical sciences, and to determine if there is any association between learners' attitudes and their biographic characteristics, were the major focuses of this research.

1.2 BACKGROUND TO THE STUDY

The investigation of high school learners' attitudes towards physical science has been one of the prominent areas of research for the science education research community globally for some time now. However, its current importance in South Africa is emphasised by the mounting evidence of poor performance in physical science at matriculation level, and the proportionate decline in numbers of high school learners pursuing physical science and scientific careers (DBE, 2017; DBE, 2014; Evans, 2013). Consequently, identifying the nature of learners' attitudes towards physical sciences, and promoting favourable attitudes towards physical sciences is increasingly a matter of concern.

Many researches into science education have discovered a number of factors influencing leaners' attitudes towards physical sciences. Studies in this area suggested that there is a correlation in attitude towards physical science and gender, parental education, socio-economic status, age and grade level (Ali & Awan, 2013; Avi & Rachel. 2011; Bang, & Baker, 2013; Hacieminoglu, 2016; Narmandha & Chamundeswari, 2013; Sitotaw & Tadele 2016; Stefan & Ciomos, 2010; Zubair, Nasir, & Harrison, 2013). Furthermore, Ayuba (2017) argued that learner's effort, level of reasoning, motivation, quality of instruction, environment at home, school environment, and peer group outside the school all contributed to an individual's attitude towards physical science. Stefan and Ciomos (2010) argued that sex, race, home environment, amount of homework, and parents' education have an effect on learners' attitudes towards physical science. In addition, Joyosi and Zeidan (2015) noticed the effects of curriculum and leaners' self-concept on their attitudes towards physical science. There is therefore evidence that gender has an effect on learners' attitude towards science, but not very clear as to how the effect will vary in context and circumstances.

Complex measurements of learners' attitudes undertaken by Beaton, Martin, Mullis, Gonzalez, Smith, and Kelley (1996) revealed that, in England, 78% of the sampled learners like physical science, in Iran 93% of the sample like physical science. In Singapore 92% of the sample like physical science. Also, 90% in Thailand, 89% in Kuwait and 87% in Columbia like physical science. Similarly, the English Assessment of Performance Unit (1989), into why learners chose to study physical science, showed that the majority of 15-year-old learners find physical science both 'interesting' and 'useful for jobs', even though it is not considered easy. According to Osborne, Simon and Collins, (2003), an important discovery, from a large-scale market research survey conducted in the UK for the Institute of Electrical Engineers, based on a sample size of 1 552 learners, aged 14–16, revealed that learners saw physical sciences as useful (68%) and interesting (58%), and that there was no significant distinction between genders. Again, a large proportion saw the relevancy of physical science as a reason for studying it (53%), and that it offered better employment prospects (50%). Moreover, 87% of students rated physical science and technology as ‘important’ or ‘very important’ in everyday life. However, Beaton et al. (1996) did not see any influence of the learners’ age on their enthusiasm and interest in science.

Bang and Baker (2013) researched into the effect of high schools' gender organisation on Korean tenth-grade students’ science achievements, and their attitudes towards science. In that research, three schools, three principals, three science teachers, and 302 tenth-grade learners, from their respective school types, were sampled to respond to an initial survey, and then, eleven academically excellent learners were interviewed face to face. The results revealed a clear disparity between the male and female learners’ attitudes towards science, and a strong correlation between attitudes and achievements in science.

Zeidan (2010) investigated the relationship between the attitudes toward biology and perceptions of biology learning environment among Grade 11 students (N = 190) in Tulkarm district, Palestine. The study used a 30-item attitude toward biology questionnaire, and a 32-item learning environment questionnaire. The association between attitudes toward biology and biology learning environment was significant, with a correlation coefficient above 0.3. The results of that investigation indicated that there were significant gender differences in attitudes toward biology, favouring females.

Hofstein and Naaman (2011) revealed that boys have higher positive attitude towards science than girls, and group attitude towards science decreases as grade level increases. Similarly, Ali and Awan (2013) argued that favourable attitudes of both gender decreases as grade level increases, although they equally discover that girls have less interest in science than boys. Salta and Koulougliotis (2011) equally argued that there is a visible difference in enthusiasm between genders in both lower and higher grade level. In contrast, Nadji (2012) did not see gender differences in the attitudes among

103 students of 10th grade, from five randomly selected private secondary schools in Jerusalem, Israel.

It appeared, therefore, that there is a difference in attitude towards science that is linked to gender, but this does not remain unchanged over time, nor context. Sofeme and Zamenihena (2014) publicised that boys have more a positive attitude toward science subjects than girls, but age difference among boys and girls in the sampled secondary schools in Adamawa State in Nigeria does not have an influence on their attitudes toward the study of science subjects. Based on the results of Sofeme and Zamenihena's study, recommendations were given on how to improve and maintain learners' positive attitudes.

The studies outlined above only show learners' attitudes at a particular period, but do not give a vivid account of what experiences led to the formation of these attitudes, or whether they are stable and can be sustained in the long term or not. However, some longitudinal studies offer some explanations in this regard. Notably, Breakwell and Robertson (2001) discovered, in their longitudinal study to examine the change in learners' attitudes towards science over a period of ten years, that boys have more positive attitudes and better performance in science as compared to girls. Boys also participate more in extracurricular activities, and like science more at school than their girl counterparts. These observations were supported by Hacieminoglu, Yilmaz-Tuzun, and Ertepinar (2011).

Moreover, in an examination of data from 19 000 grade 8 learners, who participated in the national educational longitudinal study, Shringley (1990) found that males are more likely to look forward to science class, and to think science would be useful to their future, and are less afraid to ask questions in science classes than their female peers.

In another longitudinal study, Potvin and Abdel Karim (2014) argued that learners' interest and attitudes towards science generally decreases over the middle and high school years, and that boys have positive attitudes towards science, but these attitudes drop faster than girls.

Notwithstanding all these studies on leaners' attitude towards science, none of them were carried out in the province of KwaZulu-Natal, South Africa, and none of their findings and discussions is linked in any way to physical science education in KwaZulu-Natal, South Africa. It is for this reason that this study was conceptualised to investigate the attitudes of high school learners' towards physical sciences in the Nongoma circuit in KwaZulu-Natal, South Africa, and to determine whether or not there is any association between these attitudes and learners' biographical data, such as gender, age and grade level.

To further motivate the study, in the Eastern Cape province of South Africa, Semelani (2017), recognised the critical role of attitude in advancing science education, in particular designing curriculum, and choosing appropriate teaching methodologies and nurturing learners. Therefore, the findings in the current study will provide valuable insight into steps to be taken to promote and sustain learning of physical sciences in the country.

1.3 PROBLEM STATEMENT

The issue of high school learners' poor performance and low participation in physical sciences has been highlighted in South Africa for some time now, and has been a source of worry for all stake holders in education. It is therefore very important to investigate the attitudes of these learners towards the physical science and how these attitudes relates to their biographical factors such as gender, age and grade level.

1.4 RESEARCH QUESTIONS:

1.4.1 What are the attitudes of high school learners towards physical sciences?

1.4.2 Which biographical data influences these attitudes?

1.5 CONTRIBUTION OF THE STUDY TO THE BODY OF KNOWLEDGE

The study adds value to education policy pertaining to science education in the country. It also contributes to the theory of attitude towards physical science.

1.6 DEFINITIONS OF OPERATIONAL TERMS IN THIS RESEARCH

1.6.1 Attitude

Asiegbu, Powei and Iruka (2012) defined attitudes as outcomes of psychological processes which are not directly observable, but can only be inferred from what people say or do. In addition, McLeod (2017) defined attitude by classifying attitude as either a positive or negative emotional disposition towards an attitudinal object. However, for the purpose of the present research, the word attitude means a disposition of learners to respond favourably or unfavourably to the learning of physical sciences.

1.6.2 High school learners

For the purpose of this study, the term high school learners refer to all learners from grade 10 to grade 12.

1.6.3 Physical sciences

According to Curriculum Assessment Policy Statement (CAPS) 2011, Physical Sciences investigate physical and chemical phenomena. This is done through scientific inquiry, application of scientific models, theories and laws in order to explain and predict events in the physical environment. For the purpose of this research, the physical sciences refers to the subject composing of physics and chemistry which is taught from grade 10 to grade 12 in high schools.

1.7 AIMS OF THE RESEARCH

The aim for this research is to achieve the following:

1.7.1 To investigate the attitudes of high school learners towards physical science.

1.7.2 To determine if there is an association between attitude towards physical science and biographical data of high school learners such as gender, age and grade level.

1.8 RESEARCH HYPOTHESES.

The hypotheses for this research are:

H_0: There is no significant difference in learners' attitudes towards physical science.

H_1: There is a significant difference in learners' attitudes towards physical science.

H_0: There is no association between learners' attitudes and their biographical data such as gender, age and grade level.

H_1: There is an association between learners' attitudes and their biographical data such as gender, age and grade level

1.9 METHOD OF INVESTIGATION

1.9.1 Literature Review

The available literature related to the aims and the research questions were reviewed after a thoroughly discussed functionalist theory of attitudes formation to set as a theoretical framework for the study (see the details on chapter two).

1.9.2 Field Work

The study is based on quantitative research paradigm and a descriptive research design. Data was collected mainly through the use of questionnaire. The details of the nature of this instrument, how it was administered and scored are captured in chapter two.

1.10 ETHICAL CONSIDERATION

The researcher followed all research ethics throughout the process of this research and the study was ethically cleared by the education department and the Zululand University to conduct the research (See appendices D and E).

Information being very important, the researcher made efforts to collect the information, bearing in mind that the investigation was carried out in a manner that would not violate the rights of the participants. The researcher sought and obtained guardians and the participants' consents. Since High school learners involve minors, child participants forms were also issued with assurance of taking maximum protection of the child participants (see appendices F, G and H).

The respondents were taught to participate on voluntary bases. The researcher informed the participants about the aim of the study, and about the confidentiality of their responses. Also considering the respondents' rights to anonymity, they were given numbers in place of their names. They were also made to understand that at any time in the process of completing the questionnaire they had the right to refuse to continue if they wished to stop the survey.

A letter of consent, stating the purpose of the study, and requesting the subject voluntary participation, was attached to the front of every questionnaire.

1.11 ORGANISATION OF THE STUDY

Chapter one:

Chapter one of this research presents the introduction to the study, motivation for the study, problem statement, and the aims of the study, as well as the intended contribution of the study to the body of knowledge.

Chapter two:

Chapter two contains a relevant literature review, the hypothesis of the study and definition of terms of the research. The literature review is tailored in three sections, with each section focusing on a particular aim of the study.

Chapter three:

Chapter three describes the methodology of the study. This includes the research design, the sample design, research instrument, its scoring, data analysis, and description of procedure. Also, ethical consideration is discussed here.

Chapter four:

Chapter four is composed of data presentation and analysis.

Chapter five:

Chapter five contains the discussion of the results of the research. Also, the conclusion and recommendations of the study, as well as avenue for future research, are presented in this chapter.

1.12 CONCLUSION

This chapter presented an introductory outline of the study. The problem and The need to conduct this study are clearly explained in this chapter. The Research hypotheses, the research questions as well as operational terms are Also captured in this chapter.

CHAPTER TWO
REVIEW OF RELEVANT LITERATURE

2.1 INTRODUCTION

This chapter presents the literature review for this study. The chapter is divided into three main sections. The first section discusses the theoretical framework, where the functionalist theory of attitude formation is discussed contextually to support the study. Theoretical perspectives on the nature of attitude are also discussed in this section by logically probing on the different scholarly conceptualisations and definitions of the term attitude and how it's measured. This is followed by the second section which focuses on the relevant literature on high school learners' attitudes towards physical science. An explicit relationship, and/or connection, between the learners' attitudes and the learning of science are reviewed. Section three reviews relevant and related literature on the relationship between learners' attitudes towards physical sciences, and their biographic data such as age, gender and their grade levels.

2.2 THEORETICAL FRAMEWORK

There are many theories of attitudes formation, however functionalist theory of attitudes is identified as a suitable theory to give framework for the present study. The theory is discussed below.

2.2.1 Functionalist Theory of Attitudes Formation and change

Daniel Katz proposed a functionalist theory of attitudes formation. The theory takes the view that attitudes are determined by the functions they serve for us. People hold given attitudes because these attitudes help them achieve their basic goals. The theory distinguishes four types of psychological functions that attitudes meet. These are;

- **Instrumental:** We develop favourable attitudes towards things that aid or reward us. We want to maximize rewards and minimize penalties. In effect we develop attitudes that will help us achieve this goal. In the context of this study, the high school learners will favour subjects that they easily comprehend in class.

- **Knowledge:** Attitudes provide meaningful structured environment. In life, people seek some degree of order, clarity and stability in their personal frame of references. Attitudes help supply the people with standards of evaluation and through such attitudes as serotype they can bring order and clarity to the complexity of human life.
- **Value expressive:** Value expressive has to do with expression of basic values and reinforcing self-image. For instance if a high school learner sees himself or herself as a future scientist, he/her will reinforce that image by adopting scientific beliefs and values and will therefore cultivate an attitude to reflect such core values.
- **Ego-defensive:** Some attitudes serve to protect us from acknowledging basic truths about ourselves or the harsh realities of life. They serve as defence mechanisms. In the context, if a learner is always strangling in class to understand physical sciences lesson, either as a result of the educator's poor approach to teaching, luck of basic laboratory equipment to practicalises the lesson or due to any barrier to meaning learning, he/her could develop a feeling that physical sciences is a difficult subject and will subsequently develops an attitude accordingly.

2.2.2 Theoretical Perspectives

There are two main theoretical perspectives on the nature of attitudes in social psychology, and these schools of thought have made conscious attempts to explain the concept 'attitude', and how it can be measured. Accordingly, attitude is viewed by the multidimensional perspective, as made up of three distinct domains. These include affect, behaviour, and cognition. Supporters of this perspective are of the view that these three components of attitude are essential and that, when these three components join together, they construct an overall attitude towards an object (Smith, Walker & Hamidova 2013; Vishal, 2014; Zhang, & Campbell, 2010). According to Aalderen-Smeets Van and Walma van der Molen (2013), the affective component of an attitude refers to the emotions connected with the object, and could be either pleasing or displeasing, or liked or disliked. For example, in the context of the present research, high school learners' enjoyment of learning

physical science could lead to positive feelings towards physical science. The behavioural component includes the behavioural readiness associated with the attitude (Smith et al, 2013). Muhammad, Hafiz, and Christine (2012) explain that the behaviour component of attitude is the readiness to take action with respect to the object. Accordingly, if a high school learner has a favourable attitude towards physical science, then he or she may tend to read physical science textbooks, magazines, watch science movies, attend physical science group discussions, and/or associates stringently to any physical science activity in school and at home.
The cognitive component of attitude encompasses evaluative thoughts and beliefs a person has about the attitude object. Smith et al (2013) confirmed this assertion, and clearly explained that attitudes toward science subjects may include beliefs about the ways in which scientists and science influence everyday life, and about scientific events and concepts. In the context of the present study, high school learners' attitudes toward physical science may include beliefs about the ways in which scientists and science affect their everyday lives and about scientific events, such as an eclipse of the moon, depletion of ozone layer, or the validity of the physical science concepts learnt at school, such as collision theory and/or chemical equilibrium. According to Sofiani, Maulida, Fadhillah, and Sihite (2017), beliefs represent the information a person has about an object or idea. An object is linked to belief by some attribute associated with the object (Smith et al (2013). In this regard, the object "physical science" is linked with characteristics such as 'important' or 'useful'. The object, "money spent by government on physical science" is associated with an attribute 'worth spending'. That is to say, that belief statement assesses a person's opinion on the nature of the attitudinal object.

On the other hand, a one-dimensional perspective argues that attitude should be measured solely within the affective domain, whilst acknowledging that there are actually four domains, such as affect, cognition, behavioural intentions and behaviour. Researchers who support this perspective explain the difference between attitudes and beliefs by associating attitudes to the affective domain and beliefs to the cognitive domain (Ajzen & Fishbein, 1998; Francis & Geer, 1999b; Markle & Banion, 2014)

After an extensive review of literature, Kirikkaya (2011) gave an operational definition of attitudes as learned predispositions of response in a consistently favourable or unfavourable manner to a given attitudinal object or subject. Kirikkaya further explained that individuals learn or form beliefs about objects based on direct observation and information received from outside sources, or by way of various inference processes. That means an attitude formed may influence the formation of new beliefs. In the context of the present study therefore, if a high school learner continues to be confused in physical science lessons, she or he may end up developing a belief that physical science is not an easy subject, and will begin to feel bored during physical science lessons. In the same manner, performance of a particular behaviour may lead to a new belief about the attitudinal object, which may, in turn, influence the attitude. For example, if a learner performs excellently in a physical science class work or test, he or she may form a new belief that physical science is not that difficult, and may look forward to the next task. McLeod (2017) argued that attitudes are affective variables, and that should therefore be taken into consideration during its measurement. In that regard, if we want to determine learners' attitudes toward physical science learning, we need to assess their feelings, and not what they assume to be true about physical science. In other words, we should look for how they evaluate physical science personally through their behaviours.

However, after analysing the argument of the one-dimensional perspective of attitude, Smith et al, (2013) argued that belief and attitude are so intertwined and they cannot stand independently. David et al. further argued that beliefs are neither formed on the basis of direct experience with the object of the belief, or by some inferential process. For example, learners may have no direct experience with claims such as "South Africa needs to have many more scientists," or "physical science has done more harm than good". Instead, learners often receive ideas about an object or subject from outside sources, such as the media, parents, teachers, friends or classmates.

Whatever arguments are put forward by both multidimensional and one-dimensional perspectives, their meeting-point is that attitude as a concept is composed of different domains, and its measurement must cover all its constituents' domains. Consequently, many researchers have given their definitions of attitudes to reflect its multi-domain character.

The original definition of attitude by Allport (1935) focused on the effects of an individual's mental state on their behaviours within a particular situation. Subsequently, scholars have provided many and varied definitions which focus on the causal nature of attitude as evidenced by behaviour. Notably, Asiegbu, Powei and Iruka (2012) defined attitudes as outcomes of psychological processes which are not directly observable, but can only be inferred from what people say or do. After reviewing the various definitions of attitude towards science in literature, Sitotaw and Tadele (2016) defined attitude as favourable or unfavourable feelings about science as a school subject. Moreover, McLeod (2017) defined attitude by classifying attitude as either a positive or negative emotional disposition towards an attitudinal object.

However, there are other researchers who put forward some definitions in which multidimensionality of attitude is more prominent. For instance, Avi and Rachel (2011) referred to attitude towards science as liking or disliking science, a tendency to engage in or avoid science activities, a belief that one is good or bad in science, and a belief that science is useful or useless. In addition, Abudu and Gbadamosi (2014), with particular reference to literature, defined attitude as a complex mixture of feelings, desires, fears, convictions, prejudices, or other tendencies, that are ready to act on a person because of varied experiences.

Other researches have concluded that attitude is a habit, drive, trait, or motive (either favourable or unfavourable) which one can express towards the object in question (Vishal, 2014;). Another definition of attitude that is seen resonating in recent attitude studies is that attitude is a disposition to react favourably or unfavourably to a class of objects (Ayuba, 2017; Kibirige, Osodo, & Kgasago, 2013; Hacieminoglu, 2016; Sarkodie, 2017;).

Martino and Zan (2009), in their research paper entitled “Me and maths: towards a definition of attitude grounded on students’ narratives’’, argued that the different definitions of attitude is not detrimental to the researchers, but rather enriching researchers, since different research problems can require different definitions.

2.2.2.1 Physical sciences teaching and learning approaches

According to Bulger, Mohr and Walls (2002) teaching approach or strategy is an intervention used by a teacher to bring about student learning. The learning must have occurred as a function of the instructional operations performed by the teacher. Pedagogy begins when the learner responds to the teacher presentations, and continues when the teacher responds. What the student learns under true pedagogical operations is what the teacher sets out to teach. Teaching of physical science is a dynamic interaction among four components: the learner, the teacher, the curriculum, and the learned repertoire. The basic unit of pedagogy consists of the least divisible component of instruction that incorporates both learner and teacher interaction and it predicts new stimulus control for the learner, and that it is present when student learning occurs in teaching instructions, and when it is absent student learning does not occur.

Many factors such as the attention of learners to the concepts being taught, experience of the teacher, teaching environment, and traditional teaching styles such as conference, chalk and chalkboard are among the factors causing high school learners’ poor academic performance (Hacieminoglu, Yilmaz-Tuzun, & Ertepinar, 2011; Semelani, 2017). However, depending on the subject and the improving technology, new teaching styles are inevitable. For example, the subject of physical science requires well equipped laboratories and scientifically motivated environment for hands-on and practical lessons.

In the discussing of their research findings, Mji and Makgato (2006) referred to the common maxim in the educational profession that “one teaches the way one was taught”, and then made a conclusion that an educator who was educated in an incompetent manner will have learnt bad practices of teaching and is likely to use such in teaching others. In reflecting on this maxim, Semelani (2017) argued that individuals learn to teach, in part, by growing up in a culture of serving as passive apprentices for 12 years, or more, when they themselves were learners, and that when they face the reality of challenges in the classroom, they often abandon new practices and revert to the teaching methods their teachers used to teach them.

Moreover, Legotlo and Maaga (2002) explained that teaching and learning processes go hand in hand, and that the aim of education is fulfilled with better processes of teaching and learning. It therefore means that teaching is not effective if the learners have not learnt. Individual learners may be better suited to learning in a particular way, using distinctive models for thinking, relating and creativity, and that will have some implications on a teacher's teaching strategies, because preferred method of input and output differs from one individual to another (Abudu & Gbadamosi, 2014). In effect, it is very important that physical science teachers use a wide range of teaching pedagogies to effectively meet the needs of individual learners. It is also critical for teachers to understand the learning processes and styles of individual learners.

In addition, an association between problem based learning and learners' attitudes towards learning science was noticed among the learners in Qatar, a matter that was reflected on their achievement in national tests. To test if the use of problem based learning would improve the students' attitudes towards learning science, Faris (2009) selected a sample of 25 grade nine learners from Hamza school in Doha, who were motivated to plan their own investigations and to implement their projects assigned to them. A questionnaire was developed to measure the learners' attitudes. The analysis of the results showed that 22 learners, out of the total sample size of 25 learners, who participated in the project, had strong positive attitudes towards learning science, working in groups and participating in project based learning. They also performed better in science when compared to the three students who could not yet determine their educational needs.

Farihan (2016) aimed to investigate the impact of homogeneous versus heterogeneous, collaborative learning grouping, in multicultural classes, on the learners' attitudes toward learning science. He acquired heterogeneity through the cultural background, represented by the different nationalities present in the class, and the learners' different abilities. The interaction between these two groups, and their overall effect on the attitudes and achievements, were investigated. The study also considered an approach to provide quality teaching for a diverse group of learners by removing or reducing its negative effect. To achieve this, 100 grade nine learners from more than 10 countries, in a private preparatory school, also in Doha, were selected and put into four classes and distributed over the following learning groups: (1) Heterogeneous by ability, but homogeneous by nationality; (2) Heterogeneous by nationality, but homogeneous by ability; (3) Entirely heterogeneous by both the ability and the nationality, and (4) Entirely homogeneous by both the ability and the nationality. Farihan then used a diagnostic placement test, standardised pre-test and post-test, in addition to the regular school tests, to measure the achievement of the learners. A questionnaire was then designed to measure the attitudes of the learners towards learning science, as well as towards group working. At the end, the study noted that the positive effects of group structure on the learners' attitudes towards learning science were showed by the heterogeneous group. It affected all the attitude components, except the "working with students from different cultural backgrounds" dimension, where nearly all group types had the same effect. However, this positive attitude was enhanced when the effect of mixed ability classes was combined with the effect of multiculturalism. Having learners from different cultures in a mixed ability class yielded the best desired results. Consequently, Farihan's study highly recommended maximising the heterogeneity in a class in all possible ways. The implemented collaborative learning method made learning more fun and interesting, and enhanced learners' self-confidence, academic awareness, as well as their overall attitudes towards Science.

Furthermore, Ajaja (2009) argued that integrated science learning plays a vital role in the Nigerian Science Education Programme because it prepares learners at the junior secondary school level for the study of core science subjects at the senior secondary school level, which in turn brings about learners' positive attitudes towards science. Despite the South African government's efforts to encourage many learners to pursue physical science in high school, the enrolment and performance in physical sciences at matriculation level is still far below the expectation. Research reports have indicated that learner’s negative attitude was caused primarily by teachers' methods of handling learners in physical sciences lessons, with respect to their teaching and learning methods (Semelani, 2017). In view of this, the Curriculum Assessment Policy Statement (CAPS) 2011, has recommended that physical science educators in high schools should incorporate constructivist-based teaching strategy in their methods of teaching, largely to take advantage of promoting enthusiasm and learners’ positive attitudes towards learning of science.

A study was conducted by Ali and Awan (2013) to examine the relationship of attitudes of secondary school students towards science, with their achievements in the subjects of physics, chemistry, biology and mathematics. TOSRA was used to measure learners’ attitude towards science, and data was collected from 1 885 respondents in grade 10. Simple correlation (r), multiple regression analyses (R), and standardised regression coefficients (β) were used to investigate the relationships between attitude towards science and achievement in science. The results of the study indicated that a positive attitude towards science had a significantly positive relationship with the achievement of science learners at high school level. However, the differences in students’ attitudes was attributed to many factors including teachers’ management styles in classrooms.

There are several differences among learners when it comes to teaching and learning. Learners vary greatly in their knowledge, academic capabilities, approach to learning and social background, among others. The learners’ knowledge and academic capabilities are usually distributed with either small or large variations, and it is important for the teacher to know the average and variation of those qualities (Green & Condy, 2016). It therefore means that when these variations are wide, the classroom becomes a more difficult place for a teacher.

Mji and Makgoto (2006) discussed several types of teaching and learning approaches. However, the Curriculum Assessment Policy Statement (CAPS) has recommended the constructivists approach for teaching and learning of physical science in South African high schools. The proponents of this theory are of the view that learning is an active, internal process of constructing new conceptions, in which the newly constructed should be based on the existing understanding and experience of learners. In other cases, the construction of new thoughts substantially modifies the existing knowledge and improves it into a new, more coherent framework. This education philosophy proposes that meaning is not transmitted by direct instruction, rather it is created or constructed by the learners' learning activities (Hacieminoglu et al, 2011).

This perspective opposes the instructivists (objectivists) outlook of education that believes that knowledge exists independently of the knower, and understanding is based on what already exists. The constructivists argue that deep learning will take place only when the learners are actively participating in an activity, or when they mentally process the incoming stimuli. (Jayosi & Zeidan, 2015). Learners acquire knowledge, skill and attitudes actively through the process of active engagement. Laboratory practical work or experiments organised for physical science learners will therefore actively engage the learners and develop their enquiry and problem-solving skills. This view is widely supported in literature. For example, Hamidu, Ibrahim and Mohammed (2014) explained that quality education is achieved when the science laboratory, in the context of teaching and learning science, is made relevant regarding research issues, as well as developmental and implementation issues. Hamidu et al. (2014) further explained that the role of the science laboratory in science education includes enhancement of scientific practical skills and problem solving abilities, scientific habits of mind, understanding of how science and scientists work, as well as engendering interest and motivation.

It is obvious that the laboratory space should be available to the teacher during the planning and preparation period, and available to learners for special projects outside their regular class hours. However, research results have shown that most physical science teachers continue to teach using the lecture method, despite the recommended guided discovery/inquiry methods, and the acceptance of these methods by teachers at organised training and orientation courses. The inability of physical science teachers to apply guided discovery or inquiry approaches in their teaching is as a result of many factors including lack of science laboratories equipped with facilities in schools, large class sizes of science learners with very few teachers, and competency problems arising from the training of science teachers (Mji & Makgoto, 2006).

To combat this, the Ministry of Education in China made it compulsory a decade ago for all the key laboratories at colleges and universities to be open to primary and high schools' learners. This demonstrates the importance of practical lessons in science teaching.

In education, the importance of enquiry of learners stimulated to engage actively in the process of learning has been accepted widely in principle but only rarely put into practice. The profound concepts developed by John Dewey, but traceable back to the Swiss educator Jean Piaget, were aimed at establishing a scientific way of thinking as a goal for all learners.

The researcher in the present study, has observed as a physical science teacher that, in South Africa, unlike elsewhere such as United Kingdom, the assessment of physical science has no separate practical paper at matric examinations. In both Physics (Paper 1) and Chemistry (Paper 2), practical questions are incorporated and are answered theoretically. There is no hands-on practical paper for physical science in the matric examinations.

Professor Julia Buckingham, chair of Science Community Representing Education (SCORE), in her press release on 25 March 2015 to warn the UK government not to separate practical experiment from high school national examinations (A-level), recounted the importance of science practical experiments as follows:

> *"Practical work enables learners to experience for themselves the way in which knowledge and facts are discovered, bringing a greater understanding of scientific principles and concepts. It develops practical skills that are valuable for their own sake as well as for the learners' future lives and bring*

the subject alive engaging learners in ways that are impossible to achieve with purely theoretical learning" (Buckingham, 2015).

She then concluded that, ''at a time when the UK needs to be cultivating a scientifically skilled workforce, we're standing on the verge of depriving our children of a grounding in hands-on scientific experimentation''. This is an indication of how relevant hands-on-practical is, in the study of physical science. Prior to this warning, a unique school science project was lunched to investigate how primary and secondary schools in England resource practical work, and the impact this had on teaching and learning. This was to help provide a national picture of the state of resourcing, and to provide evidence to inform national and local policies on the resourcing requirements of science education. The survey was to measure how schools resourced practical science against a number of benchmarks, including the equipment they had and used, the funding of science within schools and the number of teaching and technician hours. The benchmarks for the survey were to be made available to schools to assist schools in resource planning. Unsurprisingly, many state-funded high schools and colleges were reported to lack sufficient equipment for basic practical work, and that inadequate facilities were limiting practical work that could take place in schools and sixth form colleges. Over a quarter of respondents across all schools and sixth form colleges are dissatisfied with their laboratory facilities.

In South Africa, the importance of practical work in the teaching and learning of physical science is greatly acknowledged. As elaborated earlier, the curriculum document outlines clearly the number and form of practical experiments that should be organised from grades 10 – 12. Although, these practical experiments are used as a form of formal assessment, there is no guarantee that physical science practical experiments are actually organised across all schools. The researcher, as a physical science teacher, has observed that there is no monitoring to verify whether the practical experiments are organised at schools. Subject advisors and heads of department inspect the assessment records for the formal practical assessment, but as to how it was conducted is observably not important to these officials. It is therefore not uncommon to see physical science teachers providing already existing data for learners to use in plotting graphs and to draw conclusions as the practical task. Drawing conclusions from pre-existing values defeats the purpose of practical work in physical science and kills the investigative spirit of science learners.

2.2.2.2 Medium of instruction in the teaching and learning of physical sciences

The medium of instruction in the teaching and learning of physical sciences creates positive feelings of belonging at school, and it presents a greater likelihood of learners engaging more meaningfully in the learning process. The interactive, learner-centred approach, recommended by educationalists, thrives in an environment where leaners are sufficiently proficient in the medium of instruction (Kioko, 2015). The use of the home language allows learners to make suggestions, ask questions, answer questions, and communicate new knowledge with enthusiasm, and that gives them confidence, and helps to affirm their cultural identity. This in turn has a positive impact on the way learners see the relevance of school in their lives.

Mufanechiya and Mufanechiya (2016) noted the negative effect of foreign language as a medium of instruction on learners' interest in school. The need to have all learners in the teaching and learning process as contributors in mastering knowledge and constructing understanding cannot be overemphasised. Kosonen (2005) observed that when learners' home language is used as a medium of instruction in the classroom, it creates the opportunity for the learners to develop positive attitudes towards learning, and encourages them to reflect and dialogue in a coherent manner. Kosonen (2005) further observed that whenever the English language as a medium of instruction fails to allow a teacher to maintain a rapport with learners, such a teacher often resorts to the mother tongue language of the class. Mother tongue language therefore manages to clear the problem and bring in fruitful meaningful communication in the classroom.

The Global Partnership for Education (2015) observed that using a foreign language as a medium of instruction does not only affect learners' attitudes towards the subject in particular and the school in general, but also the learners are not able to engage successfully in learning tasks.

Language plays an important role in learning. Anyone who has attempted any educational activity in a language other than her/his own knows this from personal experience. Since language is the main method of communicating meaning in most physical sciences concepts and activities in class, without a sufficient understanding of the instructional language, learners attitudes towards the subject could be tempered negatively, as compared to learners who are fully proficient in the language. This observation is consistent with literature. For instance, Kosonen (2005) discussed the role language plays in learners' attitudes towards learning, and particularly insisted on the findings that justify the use of the learner's mother tongue as the most beneficial medium of education.

Heba and Mahamoud (2012) conducted a study to explore the effect of using the native language on grammar achievement and learning attitudes of ninth grade Jordanian students. The results of that study revealed that there were significant differences between the two groups (experimental group and control group on the post-test) in the field of achievement. These differences were in favour of students in the experimental group who were taught in their mother tongue. The findings also suggest that using the learners' native language in the classroom helps them to raise their awareness and knowledge about the similarities and differences between foreign language and their native language. It also helps them to discover different methods to practice and to express themselves in the target language. It is therefore very important for physical science educators to know when and where code switching is suitable. Moreover, research findings in support of the usage of mother tongue language in South Africa as a medium of instruction is also available. Madoda (2014) argued, in research to establish the impact of the language of teaching and learning among learners in the Eastern Cape, that comprehension and achievement of learners taught in home language as a medium of instruction are significantly higher than those taught in Non-mother tongue.

Sufficient international research on bilingual education exists to suggest a rational and credible basis for the use of the learners' home language in building positive attitudes towards education (e.g Mufanechiya & Mufaneciya, 2016). Generally, the research shows that the mother tongue language is an essential foundation for all learning. Accordingly, Williams' (1998) study in two African countries provided credible evidence for the benefits of using learners' first language in early literacy and primary education. The study compared students after four years of schooling. The students in Malawi had received education through the medium of their home language, whereas the students in Zambia were taught through the medium of English, a common medium of instruction in many African countries including South Africa, but not the mother tongue of most children. Both groups of students were mother tongue speakers of basically the same language. The level of English reading proficiency was found to be about the same in both groups, but the attitudes towards schooling and reading skills in the mother tongue language were much better among Malawian students who received tuition in their mother tongue language. The use of the mother tongue language also decreased gender and rural-urban disparities.

A sizeable number of studies on bilingual education has been conducted in China (e.g Ho-kin & Yeng-seng, 2016). These studies provide meaningful support and concrete justification for the use of the mother tongue language as the medium of instruction in order to achieve bilingualism in a minority language and Mandarin. On the basis of their research, Chinese researchers suggest that a major reason for minority children's low attitudes towards schooling and their poor educational performance is that learners' mother tongue languages have not been used in schools. Further, the mother tongue language is considered to be the best medium for early learning, and essential for the development of minority students' intellectual ability (Blachford 1999; Ho-kin & Yeng- seng, 2016).

Additionally, with particular reference to credible, comparative studies that discuss the issue of mother tongue language, in reference to a number of developing countries, Kosonen (2005) argued that when learning is the goal, including that of learning a second language, the child's first language (i.e. his or her mother tongue) should be used as the medium of instruction in the early years of schooling. The first language is essential for the initial teaching of reading, and for the comprehension of subject matter. It is the necessary foundation for the cognitive development upon which acquisition of the second language is based. In this context, learners' perceived difficulty with physical science could be dictated by the medium of instruction in their early years of schooling.

In one seminal report, UNESCO (2015) provided well-grounded evidence in support of the use of learners' mother tongues in education by showing ample research findings that suggest that students are quicker to learn to read and acquire other academic skills, along with positive attitudes to learning, when first taught in their mother tongue. They also learn a second language quicker than those initially taught to read in an unfamiliar language, and that a sustained use of the mother tongue language as a medium of instruction enhances the learners' educational and cognitive development.

2.3 HIGH SCHOOL LEARNERS' ATTITUDES TOWARDS PHYSICAL SCIENCES

Learning physical science is not only a cognitive challenge, but also an affective one as well. Many scholars consider the relationship between cognition and emotion within the learning of science to be interdependent. Francis and Geer (1999b) explained that 'affect' plays a significant role in science learning and instruction, and accordingly suggests three categories of affect relating to science learning as beliefs, attitudes, and emotions. He considers beliefs to be completely cognitive and stable, emotions to be completely affective and unstable, and attitudes to be somewhere in between. Physical science educators often use the term attitude, in particular, to explain their learners' success or failure, as well as an excuse for not being able to help a learner, largely due to the positive correlation between attitudes and learners' science achievement (Legotlo, Maaga, & Sebego, 2002; Narmadha & Chamundeswari, 2013).

In this regard, high school leaners' attitudes towards physical science are some of the major concerns in science education (Bang & Baker, 2013; Ali & Awan, 2013;

Mji & Makgato, 2006). Positive attitudes towards physical science drives learners into the field of science, and gives them the motivation to fulfil their ambitions. It is explained in literature that the way learners perceive and evaluate their relationship with any kind of knowledge is very critical in their general learning process (Osborne, Simon & Collins, 2003; Salta & Koulougliotі, 2011). In this context, if learners are not interested in physical science, they tend not to make an effort to learn and understand the meaning of concepts that are being taught to them. It has been proven that the most effective factor contributing to learners' decisions to study science is their attitudes towards the subject (Potvin & Abdel Karim, 2014; Hofstein & Naaman, 2011). When learners feel that they are conversant with concepts or issues from their previous lessons, and feel confident enough to explain them in class, it affects their motivation, attitudes and achievements. Such data are very important for developing learning materials and for planning teaching strategies (Ajaja, 2009). Consequently, it is assumed that learners who are interested in physical science, and understand the scientific concepts, will have more positive attitudes towards physical science and science studies compared to those who have learning difficulties in the physical science disciplines. In a similar vein, Ali, Yager, Hacieminoglu, and Caliskan, (2013) referred to attitudes towards science and science learning and suggested that learners are more serious with learning science when they understand concepts better and want to take more science courses.

There are many problems with regards to the way physical science is taught in high schools in South Africa, and in Africa in general, more especially if learners who are not science oriented are considered as an important target population. Many science teachers have a habit of exposing many different facts with varied proportions to the learners with a hope that if learners will have access to knowledge, their ability to cope with the modern world, as well as their attitude towards science, will improve. Unfortunately, this hope is not being realized (Aalderen-Smeets Van et al, 2013). The researcher in the present study is of the view that, on a societal scale, schools would function more effectively if they covered less content, but in ways that would allow learners to build a deeper understanding of how scientific knowledge, claims and theories are constructed.

This would be of use to all learners in their decision making outside of school, and beneficial to those pursuing postsecondary studies.

There are some reports of learners' mixed attitudes towards science, and interventions designed to change attitudes (Ali et al, 2013; Hacieminoglu et al, 2011). Development of programmes to influence the likelihood of physical science and science–related attitudes is important because it is assumed that changes in attitudes will result in changes in behaviour. Unfortunately, few simple and clear generalisations can be made about how and why attitudes towards physical science change. This may be due to the relationship with the types of scales used in the measurement and the methodological designs, and/or the lack of variable control. For instance, some studies (Abudu & Gbadamosi, 2014; Ali & Awan, 2013; Bang & Baker, 2013) revealed a positive correlation and a causal relationship between achievement in science and attitude, whereas others revealed no clear relationship between attitudes towards learning science and achievement (Narmadha & Chamundeswari, 2013).

There is evidence that learners' attitudes towards scientific disciplines depend on the extent of their active participation in the learning process. When teachers show personal interest in their learners and support them, and the lesson is given with an encouraging attitude, learners opt to continue studying science (Ali & Awan, 2013; Muhammad, Hafiz, & Christine, 2012;). Learners' positive attitudes are related to teachers' support, enthusiasm, innovative teaching strategies, and the opportunity for learners' involvement (Hacieminoglu, et al, 2011)

It is therefore important for physical science educators, and other stakeholders in science education in South Africa, to identify and to encourage high school learners 'positive attitude towards physical science. This will result in a more skilled and productive work force, which will contribute to an internationally competitive environment in the country. This belief is reiterated frequently, for example in the South African White Paper for post-school education and training (2014), which states that science is considered to be among the requirements for creating wealth, and improving the quality of life.

Attitude has a significant role in influencing and guiding actions, emotions and in knowledge processes thereby shaping learning and the teaching processes. It is argued that effective teaching is based on the interactive system of subject matter knowledge, pedagogical knowledge, learners' knowledge, and environmental context knowledge. And in all these, attitude is a key factor (Ali, et al, 2013). Therefore, it is important for all stake holders in physical science education to understand learners' attitudes towards physical science, and respond to them appropriately.

Gugliotta (2010) argued that the learners' attitudes toward the teacher may be important in the formation of attitudes towards maths and science. This view has been shared by some researchers (Ayuba, 2017; Ali & Awan, 2013).

In another study, Hacieminoglu (2016) determined elementary school students' attitudes toward science and related variables among the seventh grade students. Questionnaires for that study were administered online to 3 598 seventh grade students in different regions and cities of Turkey. The convenience sampling method was used in that study and the correlation results revealed a positive relationship between attitudes toward science and the other variables. Further multiple regression analysis indicated that while students' meaningful learning, self-efficacy, and nature of science views had a positive contribution, rote learning contributed negatively to their attitudes. The findings also showed that parents' income and education level had a significant effect on students' attitude toward science.

In a different vein, Jayosi and Zeidan (2015) gave support for the assertion that learners' attitudes towards science can be improved through the use of cooperative learning methods. This indicates the need for further research on the specific circumstances which have positive effects on learners' affective experiences with physical science, especially in the Nongoma circuit in the KwaZulu-Natal province of South Africa. The implication here for physical science teachers is to pay closer attention to the affective responses of their learners. This has been necessitated by the evidence of a correlation between attitudes and science achievement.

With regard to the relationship between attitudes and achievement, Samikwo (2013) conducted a study aimed at finding out the attitudes of students towards science, and how the attitudes influence their performance in science, and also to ascertain the extent to which the availability of teaching/learning resources influences performance in science. A descriptive survey design was used and data collected by using questionnaires, observation checklists, interviews and document analysis. A stratified, random sampling design was used to select a sample size of 215 students from 15 secondary schools in Uasin Gishu, West District of Kenya. The data was analysed and the study findings revealed that students with positive attitudes towards the subject of biology register better performances in examinations, and also that the availability of teaching and learning resources in schools impacted positively on students' achievement in science examinations.

Psychological studies have equally demonstrated the fact that attitudes are basic to the dynamics of behaviour (McLeod, 2017), and largely determine what a learner learns and, to some extent, how a learner learns. Therefore, the change of attitudes of the learners towards the desired end should be the main concern in science education, and must be borne in mind by the physical science educators. Not only do physical science educators in the country want high school learners to study physical science, but they also want them to have favourable feelings towards the subject and eventually to act in accordance with these feelings.

Moreover, Mavrikaki, Koumparou, Kyriakoudi, Papacharalampous, and Trimandili (2012) revealed interesting results when they conducted a study to determine students' views on science. In that study, a sample size of 368 respondents, selected from 6 schools in Athens, was used. Of this sample, 249 were from the 8th grade (2nd year in the Greek high school), and 119 from the 12th grade (3rd year in the Greek high school). The learners in 8th grade were on average 12 years old, and those in 12th grade were an average of 17 years old. The data were collected in the form of written questionnaires over a period of about two years. The items in the questionnaire were in the form of Likert-type statements intended to measure the learners' intrinsic motivation, perceived difficulty and views, as well as interest in biology. These three qualities made up the three subscales of the instrument of that research. The construction of these statements was based on the relevant literature and the researchers' own experience.

Their instrument contained 24 items and were distributed among the three areas they measured, such that 11 items measured Intrinsic Motivation to learn biology (IM), eight items measured Interest in science (IN), and the five items measured Perceived difficulty and views about science teaching (DI). Their scoring was accomplished by assigning a score of 5 to "strongly agree" and a score of 1 to "strongly disagree" for all the positively phrased items, and then reversing this scoring for the negatively phrased items. Then after analysing their data, the results suggested that Greek secondary school students' views about science in general seemed to be neutral to marginally positive (M=3.27(±0.77)). Differences between students' answers in each of the sub-scales were also tested using Friedman's test. The medians were found to be the same ($MdnIM$=$MdnIM$=$MdnIM$=3.00), but there were significant differences between students' scores in each of the subscales ($\chi(2)2$= 39.823, p<.001). They then performed post-hoc analysis via the Wilcoxon Signed Ranks Test, and the differences between students' answers in the subscale measuring their interest in science, and the other subscales, were revealed (IM and DI) ($zIN\text{-}IM$= -6.438, p<.001, $zDI\text{-}IN$= -5.147, p<.001). Very few students had high scores in the interest subscale (26.4%) which indicated that secondary school students in Greek were not interested in science, With regard to the eighth and twelfth grade's students' views about science, the Mann Whitney U-test was performed and the findings revealed that boys and girls showed no significant statistical differences in any of the instrument's subscales (p>.05), whilst grade level was shown to be affecting only their perceived difficulty of sciences (DI ($\chi 1$2=14.94, p<.001). Students of the twelfth grade found science more difficult than students of the eighth grade. As students proceeded in the Greek upper secondary school, they perceived science subjects to be more difficult, whereas about half of the students of the eighth grade perceived science subjects as easy (49.34%). It was only about one third of older students (32.43%) that did the same.

Students' intrinsic motivation to learn science subjects was significantly correlated (*p*<.001) to students' interest in science subjects, and students' perceived difficulty of science (*rs*=.54 and *rs*=.45 respectively). Significantly correlated (*p*<.001) was also students' interest in science subjects, to the perceived difficulty of science subjects (*rs*=.49). That therefore meant that students' perceived difficulty in biology, their intrinsic motivation to learn science, and their interest in science subjects, were all positively correlated. Moreover, Kruskal-Wallis test for possible effects to *IN, IM* and *DI* was performed and the findings suggested that family is an important factor affecting Greek secondary school students' views about science subjects. When all other variables (parents' occupation and educational level - separately for mothers and fathers) were separately tested, the results indicated that it is only the parents' educational level that affect students' intrinsic motivation (*IM*), but not *IN or DI,* whereas the mother's educational level has a greater effect than the father's.

High school learners' attitudes towards studying science and science related courses further beyond high school have been the focus of some studies and findings in this suggestive of a great improvement in learners' knowledge about science, and the importance of sciences for life and career, but have also pointed out a significant drop in their interest in studying science further (Stefan & Ciomos, 2010). It is therefore very important to note, that in South Africa, the learners' convictions and attitudes towards physical science are critical for their participation in the study process in general, and for their willingness to pursue science and science carriers further.

Sarkodie (2017) argued, with particular reference to literature, that learners who value scientific research are confident in their abilities to engage in the scientific educational process, can solve scientific tasks efficiently, and are able to overcome difficulties in solving scientific problems, and use different perspectives in rational arguments. In other words, they exhibit positive attitudes and strong scientific abilities.

Positive attitudes towards science are associated with learners' feelings of success, enjoyment, interest and/or stimulation, whereas, negative attitudes towards science are associated with feelings of inadequacy, failure, and/or boredom (Ali & Awan, 2013). When referring to learners' attitudes, the study included the notion of enjoyment expressed in its "positive form" as interest, love, happiness, liking and fun, or in its "negative form" as boredom and hate (Stefan & Ciomos. 2010). The perceived value of science plays a role in determining the learners' attitudes towards physical science. According to Ali and Awan (2013), the perception that learners have in terms of how science will be useful and help them in their personal lives, as well as their professional lives, will influence the attitudes they develop towards the study of science. Some theories observe that people feel favourable towards activities or objects that are useful to their lives (McLeod, 2017). Therefore, if learners perceived physical science to be useful they will develop a positive attitude towards it, which will result in effective utilisation. In this regard, demonstrating a positive or negative attitude towards physical science partially depends on the learners perceived difficulties. Learners who often perceived physical science to be difficult are confronted with tension, fear, and difficulties in understanding concepts of the subject. Such learners often see physical science as stressful and will tend to form a negative attitude towards it.

In the studies of attitudes towards physical science education, researchers have made conscious attempts to explain why students strive for particular goals, how intensively they strive, how long they strive and what feelings and emotions characterise them in this process. Therefore, it is important for all stake holders in physical science education to understand learners' attitudes towards physical science so that appropriate actions can be taken. Gugliotta (2010) revealed that students' attitude toward the science teacher may be important in the formation of attitudes towards science. This is echoed by Avi and Rachel (2011) that learners' attitude toward science seems to be mostly influenced by teacher's quality, and the social-psychological dimension, whilst the management-organisation dimension shows no effect on learners' attitude, but may have had some influence on learner motivation. Lack of learner motivation and emotion have also been considered as factors of negative attitudes towards science (Lewis, 2014). Equally, Ornek (2016) found support for the assertion that learners' attitudes towards science can be improved through the use of cooperative learning methods. This brings light to the need for further research on the specific circumstances which have positive effects on learners' affective experiences with physical science. The implication here for teachers is to pay closer attention to the affective responses of their learners.

Kirikkaya, (2015) indicated that students' attitude and interests could play a substantial role among pupils studying science. Ali and Awan (2013) argued strongly that learners' positive attitudes towards science correlate highly with their science achievement. Again Ajaja (2009) revealed that using integrated science environment activities improved high school students' attitudes toward and awareness about the environment. In addition, Zubair, Nasir and Harrison (2013) concluded that students exposed to a programmed instruction recorded higher and more favourable attitudes toward science. This observation was supported by Udousoro (2014) after using computer and text assisted programmed instruction.
Interests are considered to be the most important motivational factors in learning and development.

The learners' level of science knowledge and their interest in studying sciences have been the object of some studies and research conducted at an individual level, by independent researchers, by project teams, and/or by organisations. The studies and researches carried out in this regard have revealed that leaners' positive attitudes towards science have been on the increase, but have also pointed out a significant drop in their interest in the study of science (Can & Boz, 2012; Kirikkaya, 2015; Stefan & Ciomos. 2010).

The data obtain by Organisation for Economic Co-operation and Development [OECD] (2015) in the evaluation of leaners' attitude towards natural Sciences and Mathematics, clearly revealed 'interest' as a significant predictor of learners' attitude towards class lessons, school results in science, or of pursuing a career in science-related areas. Again, they indicated that learners' attitudes are considerably the key component in the learners' appropriating their competences within the study of the natural sciences and mathematics, and they included the learners’ motivation, interest and sense of self-effectiveness.

The way learners examine their familiarity with any kind of knowledge is very important in their learning process. If learners are not interested in science, they tend not to make an effort to learn and understand the meaning of concepts that are being taught to them. It was shown that the most effective factor contributing towards learners’ decisions to study science is their interest in the subject (Stefan & Ciomos, 2010).

It is suggested that when learners feel that they are familiar with concepts or issues from their previous studies, and feel confident enough to explain them, it affects their motivation and achievements. Such data are very critical and most useful for designing learning materials, and for planning teaching methodologies for science lessons (Ornek, 2015). It is assumed that students who are interested in science, and understand the scientific concepts, will have more positive attitudes towards science and science studies compared to those who have learning difficulties in the science disciplines.

Ayuba (2017) referred to attitudes towards science and science learning and concluded that learners are committed to science and learning of science when they understand the science concepts taught in class.

2.4 RELATIONSHIP BETWEEN LEARNERS’ BIOGRAPHICAL DATA AND THEIR ATTITUDE TOWARD PHYSICAL SCIENCE

The literature examining attitude also deals widely with how learners’ biographical data relate to their attitudes toward science, and also expands on the role of learners’ attitudes in science education, as well as some recommended teaching/learning approaches to sustain learners’ positive attitudes. Grade levels, gender and age are some of the most investigated factors affecting high school learners’ attitudes toward science. For example, Muhammad, Hafiz and Christine (2012) conducted a study to examine students’ attitudes towards science, using a sample size of 3 526 students of 10th grade students (boys = 1914, girls = 1612) and the results depict a significant effect of gender on students' attitude towards science. Girls had significantly higher or positive attitude towards science than boys, on the total scale and on all sub-scales of TOSRA, with the exception of 'Career Interest in Science' subscale, in which boys were slightly higher than girls, but it was not significant.

Moreover, Sofeme and Zamnihena (2016) used a descriptive survey research to investigate the effects of gender and age on high school learners' attitudes towards science. The survey covered all of the five educational zones of Adamawa state, in Nigeria. A simple, stratified, random sampling was employed to select 250 science students of high schools across the five educational zones. The instrument used to collect data for their study was the Science Students' Attitude Questionnaire (SSAQ) with 20 items on a four (4) point Likert scale. Their data were then analysed to examine the effect of gender and age on the learners' attitudes towards the study of science. The conclusion from their data analysis was that gender has a significant effect on learners' attitudes towards science, whereas age has no association with attitudes. However, Narmadha and Chamundeswari (2013) argued differently: that girls are significantly better in their attitudes toward learning of science when compared to the boys, and are also better in their academic achievement in science than boys.

Apart from attitudes towards the importance of science lessons, the literature on attitude also introduced studies related to learners' enjoyment of science lessons. In reality, enjoyment of science had been associated with gender differences in most of the studies. Results of these studies were in two categories. in the first category, learners' attitudes towards science lessons did not vary between genders (Abulude 2009; Sofiani, Maulida, Fadhillah, & Sihite, 2017; Ayuba, 2017). Although there were no significant differences between the attitudes toward science according to gender. Ayuba (2017) argued that male students consider science as a subject more fun and interesting than female learners, in junior and senior grade schools. The second category saw a reasonable variation between girls' and boys' attitudes toward science in terms of the enjoyment of science lessons (Bang & Baker, 2013;

Potvin & Abdel-Karim, 2014; Sofeme & Zamnihena, 2015; Zubair, Nasir & Harrison, 2013)

A study to compare learners' attitudes and grade levels was conducted by Can and Boz (2012) and the results obtained are worth noting: a sample size of 197 respondents, made up of learners from grade 9 to 11, was selected using a convenient sampling design. An adopted attitude scale called Attitude Scale Towards Chemistry (ASTC) was then administered to collect the data. The Attitude Scale consists of 15 items in 5-point Likert type that ranged from "Completely Disagree" to "Completely Agree". The data were then analysed at different levels using descriptive and inferential statistics, and the findings revealed that students' attitudes changed across the grade levels in terms of both "enjoyment of chemistry" and "importance of chemistry" constructs.

In a study by Greenfield (1996) themes emerged from responses on the rating scales and questionnaire that, even when females planned to major in science, they were more interested than males in the people-oriented aspects of their planned majors. Females often planned a science major mainly because they needed a science background in order to enter a health profession such as medicine, nursing or pharmacy. Females generally found science uninteresting, and the scientific lifestyle is perceived by them to be unattractive. The differences that emerged from the study of Weinburg (1995) was that males were more positive in their enjoyment of science, motivation in science, and self-concept of science, whereas the females were more positive in their perception of the science teacher and the value of science to society.

Zubair, Nasir and Harrison, (2013) conducted research with an aim to determine the attitudes of Pakistani students towards science learning. The scale used to collect data was Attitude Towards Science Learning (ATSL), with Cronbach's alpha of 0.86. A sample of 1 233 respondents, drawn from 37 government schools of three districts was used, and the final results emerged to show that attitude towards science learning increased when grade level increases. The results also suggested that female students held more favourable attitudes towards science learning than male students. However, a father’s level of education, occupation and students’ locality have no effect on the learners’ attitudes towards science learning. However, mothers’ education and occupation are associated with attitudes towards learning of science.

Another finding confirming the inconsistency of attitudes towards science studies emerged from Stefan and Ciomos (2010). With an ultimate aim of discovering the existence of convergences, or divergences, among the attitudes of the students in eighth and ninth grade towards the study of physics, and towards the teacher’s role in studying physics, Stefan and Ciomos obtained results that showed no major differences but have allowed for the shaping of a profile for physics as a school subject. Thus, physics is considered to be a difficult but pleasant and interesting subject. The attitudes of the learners towards teachers’ role in their study of physics is also insignificant.

Furthermore, in a comprehensive review of the literature regarding gender issues related to chemistry education, Cheung (2009) discussed that the first study that was conducted on gender differences in high school was conducted in Israel by Hofstein, Ben-Zvi, Damuel, & Tamir, (1977) and that this study was conducted on 11th and 12th grade students using an adopted version of the Chemistry Attitude Scale. The study revealed that girls had a more favourable attitude towards studying chemistry than did boys.

Over twenty years literature on attitudes towards science was reviewed by Osborne, Simon, and Collins, (2003). The findings suggested that, regarding physical science education, girls have more positive attitudes compared with boys. In addition, in Nigeria, Narmadha and Chamundeswari (2013) reported that girls found science more enjoyable than boys. On the other hand, several studies conducted in United States of America by Gugliotta (2010) and Harvy and Stable (1986) in the UK, revealed the opposite, namely, that the attitudes of boys towards physical science were more positive than those of girls. With particular reference to literature, Ayuba (2017) suggested that the main reasons for these inconsistencies is related to the type of measure used by the researchers, the nature of the content and of the physical science curriculum, the instructional techniques often used in the physical science classrooms, and the learners' grade-level. Ayuba is of the view that gender differences may vary across levels.

On a strong note, Reiss (2004) argued that female students consistently perceived science to be less interesting than male learners did. In other related studies, Hacieminoglu (2016) observed that sciences are still considered non-traditional areas for females, in some parts of the world, and that some societal perceptions and expectations contribute to women's reduced interest in these fields.

In fact, from the experience of the present researcher as a physical science teacher, in both South Africa and Ghana, the most striking difference between males and females in physical science is not in their achievement, or in the opportunities to learn, but in their confidence. Even when females have a similar exposure to science and a similar achievement level, they are still less confident in their ability, feel less prepared, and lack interest in leading discussions in science lessons. This observation is consistent with recent studies. The findings of several recent studies have demonstrated that the overall trend for male learners' beliefs about the utility, necessity, and importance of science is positive (Potvin & Abdel Karim, 2014; Sofeme & Zamnihena, 2015; Wan & Lee, 2017). This means that male learners have positive attitudes towards physical science classes. However, there are some other studies indicating that females regard the physical science learning environment more favourably than male learners do (Muhammad, Hafiz & Christine, 2012; Narmandha & Chamundeswari, 2013).

Conversely, about two decades ago, Weinburgh (1995) noticed how little difference there was between the overall attitudes of girls towards science as reported in the literature, between 1970 and 1991. Commenting on this scenario, Weinburgh suggested that girls need to have positive attitudes to be motivated to achieve in science. In considering both past and recent literature, with regards to learners' attitudes towards science, the task of physical science teachers in South Africa therefore is to plan classroom activities that can bring success to girls in co-educational classes. Stark, (1999), reporting on data collected by the Assessment of Achievement Programme in Scotland, presented learners' preferences for different science activities, for learners from grade 7 to grade 12. The most popular activity for boys and girls alike, in all grades, was found to be working with apparatus and materials. The least popular for grade 7 was doing a science work card, whilst for grade 11 it was learning about famous scientists. Bang & Baker (2013) noticed no statistical significant differences between boys and girls in their liking for different activities. However, similar preference does not mean similar treatment. In this regard, Sofiani, Maulida, Fadhillah and Sihite, (2017) noted that if schools are co-educational, and equality of outcome is not to be gender biased, then physical science teachers need to adopt classroom practices that reduce differences, rather than increase them.

In another vein, Morrell and Lederman (1998) observed a significant mean difference on attitudes toward science as a school subject across Grade 9 to 12, based on the interplay of class room activities. More specifically, learners' attitudes changed across grade levels in terms of both "enjoyment of science", and "importance of science" constructs. Furthermore, in-depth analysis indicated that there was a significant mean difference between Grade 9 and Grade 10 learners' attitudes toward science and science activities. The noteworthy point of that study is that it took the dimensionality of the scale into account, that is, learners' "attitudes toward science as a school subject" was analysed with respect to two constructs, which enables more accurate results about the whole scenario.

There are many other informative studies related to the effect of grade level, gender, and the interaction of grade level and gender on various constructs of attitude towards science (Kirikkaya, 2015; Jayosi & Zeidan, 2015). For example, Jones, Howe, and Rua (2000) discussed that females enjoyed science laboratory work more than males. Cheung (2009), on the other hand, found that males liked science theory lessons more than females in grade 10 and grade 11. According to the findings of the study, the mean scores of grade 10 learners is the highest and grade 11 learners is the lowest.

Likewise, Akpınara, Yıldıza, Tatarb, and Ergina (2009) carried out research to determine whether the students' attitudes towards science varied in accordance with the grade levels and their findings revealed very interesting variations. A one-way, between-groups ANOVA, followed by Scheffe post hoc test, were used and the means were different from each other in terms of the factors, according to the grade levels. In their analysis of variance (ANOVA) results, there were significant differences among students' grade levels towards science in terms of four factors
The significant value of four factors ("enjoyment of science", "anxiety", "interest in science", and "enjoyment of science experiments") were found to be: F=28.62, p=.000; F=16.42; p=.000; F=11.70, p=.000; F=35.33, and p=.000 respectively. The Scheffe test showed that there was a significant grade level difference between sixth and eighth grade, in favour of sixth grade students, in terms of all factors. There was also significant difference between grade 7 and grade 8 learners in favour of grade 7 students in terms of the four factors. George (2006) observed a decline in attitudes as learners progressed from one grade to another, which he attributed to the type of science courses taken by students in each grade. He further argued that in most of the upper grades, science is often taught as a group of facts and vocabulary words that are to be memorised, and not as a way of investigation, and that it may be that the natural curiosity of children has been dampened as they move through the grades. This is a common problem for many countries. The reasons behind this problem can be listed as science curriculum, ineffective teaching methods and techniques, the belief that science is a difficult course, and the factors related with parents and social life. These reasons affect not only current, but also future learning experiences (Ayuba, 2017).

Ornek (2015) observed the association between gender and learners' attitudes towards science in a context of culture, and accordingly explained the influence of culture in three sub-categories such as: the influence of families, the influence of religion, and the influence of superstitions on students' attitudes towards science and science-related career choices. The influences of these sub-categories can be either positive or negative based on the culture of societies. Asian students preferred to study for degrees in science related careers such as medicine-related studies, engineering, or even mathematics. On the contrary, Afro-Caribbean students did not choose to study science or science-related studies, instead they preferred to pursue degrees in the social sciences, history or economics. Other students who choose to pursue science careers were purely influenced by their parents to do so. Therefore, parental involvement has a major role in influencing their children's attitudes towards science. Ornek (2015) further explained that religion also has a big influence on students' attitudes towards science and science related choices because the message of some religions is conveyed to society in an obstructive way, and this prevents both students and families from developing positive attitudes towards science and science-related career degrees. Cultural beliefs, including superstitions-taboos, omens, and witchcraft, impact negatively upon students' attitudes towards science learning, and their achievement in science, because students come to the science class with cultural beliefs pre-occupied in their minds, which can be opposite to what is known to be scientifically correct knowledge. Since their cultural beliefs are opposite to scientifically correct knowledge, they may not choose to study science-related careers (Ornek, 2015).

It is therefore critical for physical science educators to identify and replace their learners' unscientific knowledge that they hold as a result of their cultural beliefs with scientifically correct concepts. For example, the unscientific concept that both African men and women have that lightning can be sent by a witch doctor to strike other people should be replaced by the scientific explanation of the causes of lightning and thunder. This is particularly more important for physical sciences educators because it has been argued that both achievement in science and attitude toward science are the most important factors affecting learners' participation in learning of science (Ali & Awan, 2013). It is argued that effective teaching is based on the interactive system of subject matter knowledge, pedagogical knowledge, learners' knowledge and environmental context knowledge, and that attitude is a key factor in high school learners' learning in science and participation in all activities in the classroom (Ajaja, 2009; Ali & Awan, 2013).

There are other studies that have focused on learners' attitudes towards the individual science subjects such as physics, chemistry and biology. Accordingly, Cokadar and Kulce (2008) explained that learners' attitude towards the sciences differs from one subject to another and modifies with age. According to this source, the learners' attitude towards physics becomes more negative with age, while their attitude towards biology becomes more positive with age. More specifically, boys' attitude towards science changes significantly with age, becoming more positive towards physics than towards biology, while girls' preference for biology remains constant and at a high level.

Sitotaw and Tadele (2016) conducted a study to determine students' attitudes towards physics in primary and secondary schools, and the findings in that research have suggested that the attitudes of the students towards physics vary according to gender, and grade level. The findings particularly confirmed that in the lower grades, especially in grade seven and eight, female students have higher interest and positive attitudes towards physics than male students. The findings also revealed that female students in grade 7 and 8 enjoyed physics classes and that few female students in grade seven and eight did not understand physics more than other subjects, but liked the practical sections of physics rather than theoretical parts.

Taking into consideration the results of the above-mentioned studies, it can be said that there were differences between the results of the studies conducted to determine the effects of gender, grade level and achievement of learners on their attitudes towards science. Therefore, it was important to examine and identify the nature of the high school learners' attitudes towards physical science in the Nongoma circuit and to determine if really those attitudes of learners were associated with their biographical data such as their gender, age and grade level.
Other studies often investigated associations between learning outcomes and the nature of the classroom environment and findings in this regard suggested that the conditions of the learning environment affected learners' beliefs and success in physical science classes. Educational environments enhance learners' learning and improve their attitudes and academic achievement (Jayosi & Zeidan, 2015; Samikwo, 2013). A well-designed learning environment, with equipped science laboratories, aimed at providing effective instruction, enriches learning experiences,

and subsequently improves learners' attitudes towards physical science (Joyosi & Zeidan, 2015).

2.5 CONCLUSION

In this chapter, relevant literature for this study was reviewed comprehensively in three main section. The theoretical background of the study was discussed logically in the first section. The discussion was done by probing on the different scholarly conceptualisations and definitions of the term attitude and how it's measured. Literature was extensively reviewed in the second section and captured the most relevant literature on high school learners' attitudes towards physical sciences. The section delved into literature on various approaches to teaching physical sciences and the medium of instruction in relation to how they affect learning and attitudes of the learners. The third section contained relevant and related literature on the relationship between learners' attitudes towards physical science, and their biographic data such as age, gender and their grade levels. Methodology for the present study is discussed in the next chapter

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter examines the rationale behind the chosen methodology for this research. This includes the choice of research design, methods of data collection, the sampling procedure and research instruments, the nature of the research instrument in relation to the aims and objective of the present study, as well as the way in which data were analysed.

The chapter also describes, in detail, how the research was conducted. The purpose of this study was to examine the high school learners' attitudes towards physical science and to determine if there is any relationship between learners' attitudes and their biographic data such as gender, age, and grade level.

3.2 RESEARCH DESIGN

Research design, according to Sibaya (2014a), refers to the plan and structure of an investigation so conceived as to obtain answers to research questions, and that the research design helps investigators to obtain answers to questions of the research, and also helps them to control the experimental, extraneous and error variances of the particular research problem under study. Sibaya, further, warned that without stressing on the use of appropriate research design to help provide answers to research questions, any study can degenerate into an interesting, but a sterile technical exercise. Similarly, See and See (2013) argued that research design is the overall strategy; the researcher chooses to integrate the different components of a research in a coherent and logical way to ensure that the research problem is addressed. Moreover, Davis, Utts and Simon (2002) viewed the research design process as a series of decisions concerning what concepts would be studied, how these concepts would be measured, what approach would be used to study the problem, who would be studied, how the data would be collected and analysed, and, ultimately, how would the information that was collected be presented to solve the problems.

According to Sibaya (2014a), the available research designs should include: historical research, philosophical research, experimental research and descriptive research design. In all research, the central concern is to arrive at a credible solution to the research problem. In this light, the present study used descriptive research design. The present research aimed at precisely measuring and reporting the attitudes of high school learners under investigation. Ayuba (2017) explained, with particular reference to literature, that descriptive design was suitable for attitude studies since attitudes occur in natural settings. Furthermore, Govender (2002) explained that attitude studies usually required multiple data and that can only be adequately evaluated using descriptive design. Govender further argued that descriptive design helped to give an accurate quantitative account of a phenomenon rather than discovering the cause of it. It answers the question how and who, but not why. In effect, since investigating learners' attitude cannot be subjected to laboratory experimental inquiry, descriptive design provided quantitative data and description of accurate information about learners' attitudes to help achieve the aims of the present research.

3.3 DESCRIPTION OF POPULATION

The target population in the present study were mainly physical science learners in high schools. The study was carried out in the Nongoma circuit, which is in the north-eastern part of Zululand, in the KwaZulu-Natal province of South Africa. The researcher chose Nongoma circuit for the study because the researcher resides and work as a physical sciences teacher in Nongoma. There are about 54 high schools in the Nongoma circuit where physical sciences is taught as a subject.

3.4 SAMPLING DESIGN

According to See and See (2013), sampling design refers to the rules and procedures by which some elements of the population are included in the sample. Sibaya (2014a) identified the main types of sampling designs as simple random sampling, systematic sampling, and stratified sampling. In order to have a representative sample for the present study, both systematic and stratified sampling designs were used at different levels. Sibaya (2014a) explained that in systematic sampling, there should be an adequate list of the members of the population. In this context, the systematic sampling design was used to select five schools from fifty-four (54) high schools in the Nongoma circuit since the number of high schools in Nongoma circuit is known. This was done by creating a numerical list of all the fifty-four (54) high schools, and then dividing the fifty-four (54) by five (5), as a number of sampled schools, to get the interval of ten (10) as a whole number The name of the first school in the list, and every tenth name of school in the list, was selected until the five schools were selected. However, in selecting the subjects (learners), stratified random sampling was used. McMillan and Schumacher (1993) defined stratified random sampling as the procedure whereby the population is divided into subgroups or strata on the basis of a variable chosen by the researcher.

Sibaya (2014a) suggested that stratified sample could be used when the population is composed of subgroups or strata. In the context of the present research, learners in each of the five schools were grouped in various strata, namely, grade levels (grade 10, grade 11 and grade 12). Each grade level was again grouped into male and female learners, and then twenty (20) learners, made up of proportionately equal numbers of male and female learners, were selected in each grade level of all the five schools.

The researcher used the variables of gender and grade level so that the sample should consist of boys and girls in all the grade levels. The researcher saw the need to study both groups because both genders and grade levels view physical science differently, and they experience the study of physical science differently. This view was indicated in the literature reviewed (Ali & Awan, 2013; Avi & Rachel. 2011; Can & Boz, 2012; Hacieminoglu, 2016; Kirikkaya, 2011). In all, a sample size of 298 respondents, made up of 148 male and 150 female learners were used in the present research.

3.5 RESEARCH INSTRUMENT/METHOD OF DATA COLLECTION

In the study of attitudes towards physical sciences, many instruments have been developed based on various definitions of attitude. Attitude towards science was first measured by observation of actual and intended behaviours, but this technique of data collection was deemed inaccurate due to the potential misinterpretations that could occur (Dwyer, 1993). However, the most prominent contemporary, widely used method of measuring attitude towards science is the Attitude Towards Science (ATS) scale which was used in the present study. The ATS scale was adapted from Francis and Greer (1999b). The permission to use this ATS was sought and obtained through email (see appendix iii). The instrument contains 37 items on a 5-point Likert-type scale, ranging from 1 = strongly disagree, to 5 = strongly agree.

According to Francis and Greer (1999b), the 37 items of the scale were sieved from an original batch of 62 science-related questions. The initial 62 questions contained items indicative of cognitive and behavioural dimensions. For the purpose of the current study, the ATS scale had two sections: section A contained three (3) questions, and elicited biographical information of the respondents such as age, gender and the grade level, and that helped in relating learners' attitudes to their biographical data. Section B focused on the learners' attitudes towards physical science, and contained the 37 items on a 5 point Likert-type scale, ranging from strongly disagree to strongly agree. These 37 items expressed independent attitudinal statements, covering all domains of assessing attitude, including feelings, beliefs, and actions. Responses to items in section B provided information to achieve Aim number 1.6.1, which was to determine the attitudes of learners towards physical science. The items were designed to cover all the three domains of attitude which include belief, feeling and action-tendency. The distribution of the 37 items are in table 3.1 below.

TABLE 3. 1 Attitude scale statements distribution

STATEMENTS	Positive	Negative	Total
Belief component	**5**	**7**	**12**
Feeling component	**7**	**5**	**12**
Action tendency	**6**	**7**	**13**
TOTAL	**18**	**19**	**37**

A cross-tabulation of responses to Section A and Section B helped in a more direct way to achieve Aim number 1.6.2, which was to determine the relationship between learners' attitudes and their biographic data.

3.6 SCORING OF THE INSTRUMENT

Each biographical character in Section A was coded nominally. In this regard, the age range was coded 1 for 16 years or younger, 2 for 17-19 years, 3 for 20-22 years, and 4 for 23 years or older. Males and females were coded 1 and 2 respectively. Grade levels were coded 1-3 for grades 10, 11 and 12 respectively. The alternatives in Section B were arranged from strongly agree (SA), agree (A), not sure (NS), disagree (DA) to strongly disagree (SD). The scoring was 5, 4, 3, 2, and 1 for positive worded items. This scoring was reversed for negative worded items. The highest score in this scale used for measuring the high school learners 'attitudes towards physical science was 37 x 5 = 185 and the lowest score was 37 x 1 = 37. The average score (X) was obtained by adding all the total scores of the respondents (**Σx**) and dividing the sum by the total number of the respondents (N), i.e. **X=Σx/N**. The respondent who obtained the total score equal to and above the average had a positive attitude towards physical science. However, the respondents who obtained the total score below the average held negative attitudes towards physical science. The numbers of respondents who fell below and above the average were counted to get the frequency table.

A Chi-Square one sample test, two by two sample test, and for **K**- independent samples were used for data analysis to test the hypotheses, and the overall significance difference among various categories. The researcher preferred this test because the data were classificatory.

3.7 VALIDITY AND RELIABILITY OF THE INSTRUMENT

With regards to validity and reliability of the instrument, Francis and Greer (1999) explained that the items from the ATS scale were examined by computing internal consistency estimates of reliability and validity, via Cronbach's alpha coefficient (α), with 95% confidence intervals. The score of reliability for the entire scale was α = .90 (CI = .88, .92), and for the three subscales measuring attitudes was α = .92 (CI

= .90, .93). A recommended cut-off value for score reliability derived from survey research and/or used in applied settings was, α =.80 (Nunnally, 1978). Considering this, it signified that there was high internal consistency, and the items that comprised each factor shared a large percentage of the variance. Furthermore, the 37 items, out of the original 62 items, had validity coefficient more than 0.5 and were retained, whilst 25 items whose validity coefficients were less than 0.5, were deleted. Notwithstanding, the researcher submitted this adopted ATS scale to supervisors (experts) who established its validity.

3.8 DESCRIPTION OF PROCEDURES

The researcher sought and obtained permission from the Department of Basic Education and the University of Zululand to conduct the present research (See appendices D and E). Letters were sent to principals of various schools for their permissions. The participants consent, the guardian consent and the child participant consent were all obtained to conduct this research (See appendices F – H). A consent letter, indicating the purpose of the research, with a copy of the instrument, were sent to principals of all the selected high schools to obtain their consents to use the grade 10-12 learners in their respective schools. After obtaining the approval of the principals, the researcher made it clear to the respondents that participation was voluntary and all information they provided would be treated as confidential. The researcher then sought assistance from the class teachers in three of the five selected high schools to administer and retrieve the instrument. This decision was taken to help relieve the researcher of logistics and financial constraints. However, the instrument was administered face to face by the researcher in the other two schools. This was done because the researcher was teaching in a school closer to those schools. This technique of administering the questionnaires was very helpful and all the questionnaires were retrieved without any loss of data.

3.9 CONCLUSION

This chapter gave a detailed description of the research methodology that was used in this study. The rationale and theoretical support for the methodology and tools used was explained. The next chapter contains data presentation and analyses.

CHAPTER FOUR
PRESENTATION AND ANALYSIS OF DATA

4.1 INTRODUCTION

This study investigated high school learners' attitudes towards physical science. In order to achieve the aims, an Attitude Towards Science (ATS) scale (a 5-point Likert type scale) was used as a research instrument. This instrument was completed by high school learners in the Nongoma circuit. The mean score of the entire sample was calculated and found to be 138. All respondents whose score was equal to or greater than the mean (138) were regarded as having positive attitudes towards physical science, whilst all those who scored less than the mean score were considered as having negative attitudes towards physical science. Descriptive statistics were used to present the data in frequency tables. The presentation of the data was tailored according to the themes of the research aims. The descriptive statistics helped the researchers to gain an initial impression of data that were collected, and to determine whether relationships existed between variables.

The presentation and analysis of the data is divided into three sections. The first section concerns the presentation and analysis of the demographic data of the respondents. These include their gender, age and the grade level. The second section focuses on presentation and analysis of the data of the whole sample's attitudes towards physical science. This was done with particular reference to the mean score as a centre of the continuum. The third section focuses on the presentation and analysis of the data from the crossed tabulation of the learners' attitudes and their biographic characteristics. This was done systematically to determine the association between each of the biographic factors and the respondents' attitudes.

4.2 DATA PRESENTATION

Table 4.1 below displays the demographic information of the study sample. A sample size of 298 respondents was used in this research. The sample was made up of 49.66% males and 50.34% females. The majority of the respondents were between the ages of 17–19 years old (82.21%). Respondents with the age of 16 years and below constituted 6.71% of the sample. The fewest age groups among the respondents were those aged 23 years and above (2.01%). In terms of their grade levels, 32.89% of the respondents were in grade 10, whilst grade 11 and 12 made up 33.56% of the sample.

TABLE 4.1 Demographic characteristics of the study sample (N=298)

VARIABLE	NUMBER	PERCENTAGE
GENDER		
Male	148	49.66
Female	150	50.34
AGE		
≤ 16	20	6.71
17–19	245	82.21
20–22	27	9.06
≥ 23	6	2.01
GRADE LEVELS		
Grade 10	98	32.89
Grade 11	100	33.56
Grade 12	100	33.56

TABLE 4. 2 Distribution of responses in the study sample (N=298)

		ATTITUDE			
Main characteristic	Level	Negative	%	Positive	%
GENDER	Male	57	39	91	61
	Feme	50	33	100	67
AGE (YEARS)	≤16	6	30	14	70
	17-19	82	33	163	67
	20-22	12	44	15	56
	≥ 23	3	50	3	50
GRADE LEVELS	Grade 10	31	32	67	68
	Grade 11	34	34	66	66
	Grade 12	39	39	61	61

Table 4.2 above shows the distribution of responses in the sample and gives a clearer picture of the entire data collected. The data were then analysed further, in sequence, according to the aims of the research, using inferential statistics in the following section.

4.3 ANALYSIS OF DATA

Descriptive and inferential statistics were used to present and analyse the data. Descriptive analysis aims to describe data by investigating the distribution of scores on each variable, and whether scores on different variables are related (Sibaya, 2014b). In this context, the data in the present study were presented by the use of descriptive statistics (see Table 4.3, Table 4.4, Table 4.5 and Table 4.6). The descriptive statistics helped the researchers to gain an initial impression of data that were collected, and to determine whether relationships existed between the variables. Hypotheses were reiterated for each table of data and tested by using a chi-square test. A chi-square is the estimate of the degree to which the observed frequencies differ from the expected frequencies, if two variables are independent.

Sibaya (2014) explained the use of various statistical tools in a research, and concluded that a chi-square test is one of the most suitable when data were categorical. In this regard, a Chi-square test was used in the present study, since the data were recorded in mutually exclusive categories. The scientific community conventionally use alpha = 0.01, or alpha = 0, 05. In this light, 95% confidence in the results is generally the acceptable standard for explaining the social world. For the purpose of the present research, α = .05 was considered in all the statistical analysis.

TABLE 4. 3 Whole sample attitudes towards physical science (N=298)

ATTITUDE			
Negative	%	Positive	%
107	36	191	64

$\chi^2 = 23.68$ df=1 $p < .05$

NULL HYPOTHESIS

H_0: p=0 There is no significant difference in the learners' attitudes towards physical science.

H_1: $p \neq 0$ There is a significant difference in the learners' attitudes towards physical science.

A chi square(χ^2), one sample test was used to test the hypothesis since the data were categorical (see Table 4.3). Using a significant level of alpha = 0, 05 and degree of freedom (df) =1, a χ^2 value of 23.68 was obtained. A χ^2 = 23.68 at df= 1 is significant at .05 level. The hypothesis that there is no difference in high school learners' attitudes towards physical science is rejected with high degree of confidence. The observed difference is not due to chance factors. It is statistically significant. High school learners hold positive attitudes towards physical science.

TABLE 4. 4 Relationship between gender and attitudes

	ATTITUDE			
Gender	Negative	%	Positive	%
Male	57	39	91	61
Female	50	23	100	67
	χ^2 = .94	df=1	$p < .05$	

NULL HYPOTHESIS:

H_0:$p = 0$ There is no relationship between gender and attitudes towards physical science.

H_1:$p \neq 0$ There is a relationship between gender and attitudes towards physical science.

A chi-square, two by two, independent sample test was used to test the null hypothesis. The use of a 2 x 2 contingency table was of great value.

TABLE 4. 5 Relationship between age and attitudes towards physical science (N=298)

	ATTITUDE			
Age (in years)	Negative	%	Positive	%
≤16	6	30	14	70
17-19	82	33	163	67
20-22	12	44	15	56
≥ 23	3	50	3	50
	χ^2 = 2	df = 3	$p > .05$	

NULL HYPOTHESIS:

H_0: p = 0 There is no relationship between age and attitudes towards physical science.

H_1: p ≠0 There is a relationship between age and attitudes towards physical science.

To test for the relationship between learners' age and their attitudes towards physical science, a chi-square, k-independent sample test was used. The outcome of the statistical analysis was χ^2 .05 = 2.107 at df=3, which is statistically not significant. The χ^2 value of 2.107 is less than the table critical value of 7.815. This means that learners grouped according to their ages do not differ in their attitudes towards physical science. In effect, the hypothesis that age does not influence high school learners' attitudes towards physical sciences is upheld, whilst the alternative hypothesis is rejected. It is therefore conclusive that learners grouped according to their ages do not differ with respect to their attitudes towards physical science. The observed differences between the age groups are due to chance factors.

TABLE 4. 6 Relationship between grade level and attitudes towards physical sciences

		ATTITUDE		
Grade level	Negative	%	Positive	%
Grade 10	31	32	67	68
Grade 11	34	34	66	66
Grade 12	39	39	61	61

χ^2 = 2.234 df=3 p > .05

NULL HYPOTHESIS:

H_0:p =0 There is no relationship between grade level and attitudes towards physical science.

H_1:p ≠ 0 There is no relationship between grade level and attitudes towards physical science.

A test suitable for the significance of the difference among three or more unrelated groups was used. This test is a chi-square test for k-independent samples. A χ^2 value of 1.234 at df= 2 was obtained at a significant level of alpha = 0, 05. Since the χ^2 value of 1.234 is smaller than the table critical value of 5.991, the null hypothesis is upheld. This means that learners, grouped according to their grades levels, do not differ in their attitudes towards physical science. The alternative hypothesis is therefore rejected. More than 60% of respondents in each grade level have favourable attitudes towards physical science, and less than 40% in each grade have unfavourable attitudes towards physical science (Table 4). The differences observed between the various grades are due to a chance factor.

4.4 CONCLUSION

This chapter focused on the presentation and analysis of data for the present research. The presentation and analysis were done in two parts. The first section presented the data of the respondents' demographic characteristics in the form of table, and simple narration is used to interpret them logically. Descriptive statistics were used to present the distribution of responses in the entire sample.

In the second part, both descriptive and inferential statistics were used to analyse the data of the whole sample of attitudes towards physical science, and the data on the relationship between the learners' attitudes and their biographic characteristics, including gender, age and grade level.

CHAPTER FIVE
DISCUSSION OF FINDINGS

5.1 INTRODUCTION

In recent years, physical science has become more important, and learning physical science in a more interactive way is highly encouraged. Moreover, learning physical science is particularly beneficial as it has been linked with other subjects such as life science, history, geography, mathematics, and English, among others. The current study investigated the nature of high school learners' attitudes towards physical science, and how these attitudes are related to their biographic data such as gender, age, and grade level.

This chapter is structured into five sections. The first section presents a comprehensive summary of the study. The summary section gives a vivid account of the processes of the entire research in brief. The second section focuses on the discussion of the research findings. The discussion is tailored according to the themes of the research with logical references to the relevant literature reviewed. The third section gives recommendations with particular reference to the stakeholders in science education. The fourth section points out the limitations of the research and the last section, fifth section details avenues for further studies.

5.2 SUMMARY OF THE STUDY

The aims of the present research were to investigate the attitudes of high school learners towards physical science, as well as to determine if there was an association between attitudes towards physical science and biographical characteristics of the learners. To guide and give direction to the investigation, the research problem was clearly stated and the emerging questions categorically outlined as:

1. What are the attitudes of high school learners towards physical science?
2. Which biographical data influences these attitudes?

The study followed quantitative paradigm and made use of descriptive design. With regard to sampling, systematic sampling and stratified sampling designs were used to select a sample size of 298 learners from five high schools in the Nongoma circuit, in the KwaZulu-Natal province of South Africa. The main instrument used for the data collection was an adopted attitude scale. Permission was sought, and obtained through email, to use the scale.

The significance of this research is to add value to educational policies pertaining to science education in the country, and to contribute to the theory of attitude towards physical sciences. Considering these aspects, it was appropriate to examine relevant literature on the high school learners’ attitudes towards physical science, and how these attitudes related to their biographical data.

The findings from the present study suggested that high school learners hold positive attitudes towards physical science. Findings, with regard to the relationship between learners’ attitudes and their biographical data, revealed that there is no association between attitudes and learners’ biographic data. Both boys and girls proved to be more positively inclined towards physical science. Learners grouped according to their grade levels showed no significant difference in their attitudes towards physical science. With respect to the association between the learners’ age and their attitudes towards physical science, the findings suggested that there is no association between the two variables.

The whole research report was structured into five chapters: Chapter one contained motivation for the study, statement of the problem, aims of the study, hypotheses, and a plan for the organisation of the entire study. Chapter two focused on an extensive review of any previous work done in this area. Chapter three composed of research methodology adopted for the study. This comprised of research design, sampling design, and the research instrument, as well as description of the procedures. Chapter four contained a presentation and analysis of the data collected. Chapter five – the last chapter - consisted of a summary, recommendations, limitations of the study and avenue for future research.

5.3 DISCUSSION OF FINDINGS

5.3.1 Findings with regards to the nature of learners' attitudes towards physical sciences

The findings reveal that majority of learners (64%) have positive attitudes towards physical science, and only a few of the learners (36%) have negative attitudes towards physical science, as presented in table 4.1. Further analysis reveals that this difference in learners' attitudes towards physical science is statistically significant (i.e. $p < .05$), which is consistent with literature (Avi & Rachel, 2011; Ali & Awan, 2013; Anwar & Butta, 2014; Hacieminoglu, 2016; Kibirige et al, 2013; Potvin & Abdel Karim, 2014; Sofiani *et al,* 2017; Zeidan & Jayosi, 2015). However, the factors responsible for the learners' positive attitudes towards physical science, and for how long the learners will hold these positive attitudes, were not investigated in this research.

The findings in the present study would give physical science educators a strategic direction in the teaching and learning of physical science, largely to maximise the advantage of positive attitudes in teaching and learning. Attitudes are the best predictors of learners' achievements in physical science. A learner's favourable outlook or attitude towards a particular object or situation has an impact on his liking or disliking of it. Therefore, the positive attitudes of learners revealed in the present study suggest their level of learning towards the physical science as a subject. That is to say, learners with positive attitudes towards physical science are believed to be more enthusiastic to learn physical science compared to those who have negative attitudes towards the subject. It is for this reason that the Curriculum and Assessment Policy Statement (CAPS) document 2011, outlines how physical science teachers should use the hands-on-practical approach in teaching and learning physical science. The CAPS is formulated with a view that hands-on-practical teaching and learning will foster active and critical learning, which will enhance the learners attitudes and reasoning. Therefore, the overwhelming positive attitudes shown by the high school learners towards physical science in the present study could be as a result of a good implementation of the CAPS document, since all the respondents in the present research are direct beneficiaries of CAPS.

Though, the findings in the present study suggest that the high school learners hold positive attitudes toward physical science, their attitudes can be improved by targeting learning activities that involve practical base enquiry. In addition, the positive effect of laboratory work on learners’ attitudes toward science or chemistry has been confirmed by researchers (Hamidu, Ibrahim, & Mohammed, 2014). Jayosi, & Zeidan 2015; Mji & Makgato, 2006). Moreover, since literature has revealed that there is a strong correlation between attitudes and academic achievement (Ali & Awan, 2013; Narmadha & Chamundeswari, 2013), then it is worth noting that the positive attitudes of the learners revealed in the present study, would enhance the learners’ achievements in physical science, keeping in mind the importance of learning physical science.

However, the findings with regards to the learners’ attitudes towards physical science in the present study are inconsistent with Ayuba, (2017) and Bang and Baker, (2013).

5.3.2 Findings with regard to the association between learners’ attitude towards physical sciences and their biographical data such as gender, age, and grade levels

5.3.2.1 Gender

The present research’s findings, with regard to the relationship between gender and the learners’ attitudes towards physical science, reveal that there is no association between age and attitudes of the learners. The finding suggests that majority of both boys and girls hold positive attitudes towards physical science, which is not consistent with some literature (Bang & Baker, 2013; Narmandha & Chamundeswari, 2013; Potvin & Abdel Karim, 2014; Sofeme & Zamnihena, 2015 Zubair, Nasir, & Harrison, 2013). However, the finding is consistent with findings from other researchers such as Ayuba (2017), Sofiani *et al* (2017), Ali, Yager, Hacieminoglu and Caliskan (2013), Muhammad, Hafiz and Christine (2012), and Najdi (2012). The noteworthy point of this finding is that more than 60% of both genders equally hold favourable attitudes towards physical science, and that could serve as a sign of hope or success to the South African government and other non-governmental organisations who have been striving hard over the years to achieve gender parity in education and quality of education for all.

Notably, the United Nations Emergency Children Education Fund (UNICEF) is working with a coalition of United Nations (UN) agencies, and other non-governmental organisations, and governments, to mobilise new resources to build broad national consensus about the need to ensure gender parity in education and other sectors of the economy. Furthermore, on 9th May, 2003, South African minister of education lunched Girls Education Movement (GEM) in parliament in an attempt to accelerate policies and strategies to achieve gender parity in education, and to ensure quality education for both boys and girls. Consequently, the gender parity in attitudes towards physical science could be attributed to some of these efforts by the government and the non-governmental organisations. The implication from findings of the present study is that all programmes and policies aiming at parity in education should not be disbanded since they are showing results.

5.3.2.2 Age

The research findings with regards to the relationship between age and the learners' attitudes towards physical science show a slight decrease in attitude from the youngest age group to the oldest age group (see Table 4.3). However, the statistical analysis suggests that this decrease in attitudes from the youngest to the oldest is not significant. Hence, there is no association between the age and the learners' attitudes towards science. The findings reveal overwhelming positive attitudes across all year groupings, which is consistent with some previous research findings (Salta & Koulougliotis, 2011; Sofeme & Zamnihena, 2015). Nevertheless, the findings refute other research findings from the literature reviewed (Francis & Geer, 1999a; Hofstein & Naaman, 2011; Hacieminoglu, 2015). Although the differences in the findings has statistically been proven insignificant, physical sciences teachers and parents must continue nurturing their learners towards improving and sustaining their positive attitudes towards physical science.

5.3.2.3 Grade level

Findings with regard to the relationship between grade level and attitudes towards physical science suggest that there is no relationship between the two variables. Majority of learners across all grades hold favourable attitudes towards physical science, with only slight variation, which is not statistically significant. The findings in the present study therefore support some of the literature reviewed (Kirikkaya, 2015; Zubair et al, 2013) but refute findings from Sofeme and Zamnihena (2015) and Can and Boz (2011),

5.4 RECOMMENDATIONS

The research found that high school learners hold favourable attitudes towards physical sciences but the study did not reveal whether or not these attitudes will be sustained for a long period of time. The researcher therefore recommends that education department must intensify the implementation of policies, such as the provision of science laboratory equipment to schools so as to sustain these favourable attitudes of learners.

The Department of Education should use the favourable attitudes these learners have towards physical sciences as an advantage to reach out to many more learners in high schools to pursue physical science and science-related careers.

Physical sciences subject advisors should monitor closely the instructional methods of all teachers to make sure that the right instructional methods are used to sustain the favourable attitudes of learners.

Physical sciences teachers should use the majority of the learners who have favourable attitudes as a role models to help improve the attitudes of the few learners who have unfavourable attitudes towards the subject.

School governing bodies (SGBs) and the science teachers should increase science field trips for the physical science learners as a way to improve and sustain their positive inclination to physical science.

The physical sciences teachers, in collaboration with the SGB, should organise science fairs frequently so that the positive attitudes of the leaners are sustained to enable them choose science careers in future.

The education department should consider the need to employ a psychologist in each high school to help improve and sustain the positive attitudes of the learners towards physical science.
Government and non-governmental organisations should intensify the equal education for girls' campaign so as to sustain the parity in the learners' attitudes towards physical science in schools.

The Department of Education should consider organising in -service training for educators to update them on the appropriate instructional pedagogies that develop and sustain learners' favourable attitudes towards physical science.

School Governing Bodies (SGBs) and the School Management Teams (SMTs) should consider developing a policy in each high school named "Promotion of positive attitudes towards science policy". This policy will then guide each school on activities to promote learners' positive attitudes towards physical science.

The Department of Education must liaise with universities to increase symposiums, and host guidance exhibitions for high school learners to expose them to the importance and the need to study physical science. This will go a long way in promoting learners' positive attitudes towards physical science.

Parents should be educated on the importance of their wards' attitudes towards science so that they can help in their own ways to develop and sustain favourable attitudes in them.

The South African government should consider increasing the budgetary allocation for schools to enable the education department to provide an equipped laboratory for each high school. This is very important since literature has revealed the importance of a science laboratory in the formation of learners' favourable attitudes towards physical science.

Excursions and science field trips should be organised regularly for the learners to experience for themselves the beautiful application of science in real life. When learners are made to understand the usefulness of the subject in their lives, they certainly develop positive attitudes towards it.

The School Management Team (SMT) in each high school should invite a science motivational speaker weekly to motivate learners towards the need to study physical science. Giving motivational speeches on the importance of physical science to learners weekly will instil in them a long lasting feeling of wanting to study physical sciences

Physical sciences subject advisors should regularly visit their physical science educators in schools to ensure that the practical component of learning physical science indicated in the CAPS policy document is adhere to. The review of literature suggests that there is a strong correlation between learners' attitudes towards science, and the teaching and learning approach, particularly hand-on practical methods recommended by the CAPS. It is of the view that science practical work exposes learners to an everyday application of science, thereby raising learners' interest in the study of science.

5.5 LIMITATIONS

The aims of the present research have been achieved, but with some limitations as discussed below:

The questionnaires were administered in class by the various schools' class teachers who offered to help the researcher. The fact that learners answered the questions in the presence of their class teachers could have some impact on the research. This is because the answers of some respondents could be influenced by the teachers.

Financial and time constraints could not allow the researcher to visit all high schools in the Nongoma circuit. In effect, only five schools were visited as a sample in the present research. This suggests that the sample size is a limitation in the research.
The study investigated learners' attitudes in relation to their gender, age and grade level only, and did not consider the effects of learners' different cultural background on their attitudes.

The study was conducted in the Nongoma circuit only. It will therefore be unfair to generalise the findings for all high school learners in other parts of the country.
The adopted instrument used to collect data in the present study was designed a decade ago. The researcher therefore cannot be sure if the time lapsed will not have effect on its applicability.

All of the 37 items on the instrument used in the present study are closed ended questions, and respondents are restricted to respond within a given set of answers. Therefore, the researcher cannot guarantee that the same data collected for the present study would have been collected if the questions on instrument were open-ended.

5.6 AVENUES FOR FUTURE RESEARCH

The research avenues for future researcher could be that a study could be conducted using a different procedure of administering the questionnaire, instead of the physical science teachers. This is likely to come up with different results.
A future study on this same topic, with total coverage of the entire population, could provide a different result.

The study area of this problem concentrated only on the Nongoma circuit in KZN, South Africa. Future research can extend to cover all the nine provinces of South Africa or focus on other provinces.

There is a need to study ways of encouraging learners to have positive attitudes towards physical science. In any future study, the researcher could look at the effects of learners’ cultural backgrounds on their attitudes towards physical science

The relationship between learners' attitudes towards physical science and their achievement in the same study area of the current research is needed.
An investigation into learners' attitude towards physical science in multi-racial high schools is necessary in future.

Researchers in future should consider investigating how learners' attitudes towards physical science are formed.

Future research can focus on the relationship between teachers' attitudes and learners' attitudes towards physical science.
In future, there is a need to look at the influence of peer groups on the learners' attitudes towards physical science.

A study which could be conducted in the future is how the learners' attitudes towards physical science affect their attitudes in other subjects.

A comparative study of learners' attitudes towards physical science between blacks, whites, coloureds and Indians is necessary in the future.

5.7 CONCLUSION

The present study was conceptualised based on the general concerns about the poor state of physical sciences education in South Africa's high schools. Varied concerns are usually raised by different sections of the public, in particular it is not uncommon to hear the officials from the department of basic education questioning the commitments of the physical sciences teachers. The researcher observed as a physical sciences teacher, that most of the physical sciences educators usually use learners "attitudes" to justify the performance of their learners in physical sciences. This formed part of motivation to undertake this research, so as to delve into the high school learners' attitudes towards physical sciences and how their selected biographical dated influence this attitude. The findings from this study serve as a policy framing for Physical science education for both school level and the education departments level.

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APPENDIX A

UNIVERSITY OF ZULULAND

FACULTY OF EDUCATION

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

RESEARCH INSTRUMENT

(Adapted from Francis & Greer, 1999)

High School Learners Attitudes Towards Physical Sciences.

This questionnaire consists of two sections:

SECTION A:

BIOGRAPHYSICAL INFORMATION - <u>yourself</u>

Indicate by means of a tick *(...J)* your choice in the appropriate space

GENDER:

Male	
Female	

AGE:

16 years & below	
17– 19 years	
20 – 22 years	
23 years& above	

GRADE:

Grade 10	
Grade 11	
Grade 12	

SECTION B

In this section there are different statements about attitudes of high school learners towards physical science. Circle the response, which most closely represents your attitudes towards each statement. Answer all statements.

NOTE THE FOLLOWING ABBREVIATIONS:

SA means Strongly Agree. **A** means Agree. **NS** means Not Sure. **D** means Disagree. **SD** Strongly Disagree.

STATEMENT		**A**	**NS**	**D**	**SD**
1. I feel bored in physical sciences Lesson	SA	A	NS	D	SD
2. I enjoy studying physical sciences	SA	A	NS	D	SD
3. Physical sciences is difficult for me	SA	A	NS	D	SD
4. Studying physical sciences is fun	SA	A	NS	D	SD
5. I don’t have interest in physical sciences	SA	A	NS	D	SD
6. I believe learning physical science is a waste of time	SA	A	NS	D	SD
7. Physical science is relevant to everyday life	SA	A	NS	D	SD
8. Physical sciences do harm than good	SA	A	NS	D	SD
9. Physical sciences is important to the future of our country	SA	A	NS	D	SD
10. Physical sciences is the cause of many of world’s problems	SA	A	NS	D	SD
11. I don’t even mix with groups doing physical sciences	SA	A	NS	D	SD
12. I always try to understand the concepts of physical sciences	SA	A	NS	D	SD
13. Studying physical sciences has helped me to understand many natural phenomena	SA	A	NS	D	SD
14. I do my physical sciences homework before anything at home	SA	A	NS	D	SD
15. I don’t attend extra-physical sciences lesson	SA	A	NS	D	SD
16. I like learning physical sciences in the science laboratory	SA	A	NS	D	SD
17. I don’t like the mathematics part of physical sciences	SA	A	NS	D	SD
18. I hate physical sciences questions with diagrams	SA	A	NS	D	SD
19. Physical sciences should be made compulsory for every learner in high school	SA	A	NS	D	SD

20. There is no need doing physical sciences	SA	A	NS	D	SD
21. I like read physical sciences magazines	SA	A	NS	D	SD
22. I have no interest in reading physical sciences	SA	A	NS	D	SD
23. I switch of my tv when they are teaching physical sciences lesson	SA	A	NS	D	SD
24. I always sit to watch physical sciences in tv.	SA	A	NS	D	SD
25. I believe government should do more to promote learning of physical sciences in high schools	SA	A	NS	D	SD
26. Government is wasting a lot resources on physical sciences	SA	A	NS	D	SD
27. Physical sciences will add value to my future life	SA	A	NS	D	SD
28. Physical sciences is not very important like other subjects	SA	A	NS	D	SD
29. I avoid physical sciences practical lessons	SA	A	NS	D	SD
30. Physical sciences practical makes the subject interesting for learners	SA	A	NS	D	SD
31. I like physical sciences questions that come in the form of flow-charts	SA	A	NS	D	SD
32. Every form of question in physical sciences is difficult.	SA	A	NS	D	SD
33. The physical sciences four periods per week in high schools should be increased to five per week	SA	A	NS	D	SD
34. I hate attending physical sciences lessons everyday	SA	A	NS	D	SD
35. I usually try to solve physical sciences questions on previous papers when I am alone	SA	A	NS	D	SD
36. I enjoy learning physical sciences only when we are in a group	SA	A	NS	D	SD
37. It is important to do extra work in physical sciences	SA	A	NS	D	SD

APPENDIX B: Respondents' scores

Respondent Number	Grade Level; 1=Grade 10 2=Grade 11 3=Grade 12	Gender: 1=Boy 2=Girl	AGE (YEARS): 1= ≤16 2=17-19 3=20-22 3= ≥23	Total Score	A=Score Equal /Above X B= Score Below X
1	1	1	2	147	A
2	1	1	2	145	A
3	1	1	2	147	A
4	1	1	2	142	A
5	1	1	1	146	A
6	1	1	2	137	B
7	1	1	2	151	A
8	1	1	2	142	A
9	1	1	2	147	A
10	1	1	2	145	A
11	1	1	2	147	A
12	1	1	2	145	A
13	1	1	2	125	B
14	1	2	2	145	A
15	1	2	2	147	A
16	1	2	2	147	A
17	1	2	2	151	A
18	1	2	2	119	B
19	1	2	2	147	A
20	1	2	1	142	A
21	2	1	2	146	A
22	2	1	2	129	B
23	2	1	2	115	B
24	2	1	3	121	B
25	2	1	2	146	A
26	2	1	2	135	B
27	2	1	2	150	A
28	2	1	2	142	A
29	2	1	2	139	A
30	2	1	2	145	A
31	2	1	2	143	A
32	2	1	3	145	A
33	2	1	2	123	B
34	2	2	2	145	A
35	2	2	2	142	A
36	2	2	2	127	B
37	2	2	2	142	A

38	2	2	2	120	B
39	2	2	2	136	B
40	2	2	2	134	B
41	3	1	2	147	A
42	3	1	4	123	B
43	3	1	2	121	B
44	3	1	2	125	B
45	3	1	2	141	A
46	3	1	2	140	A
47	3	1	2	150	A
48	3	1	2	137	B
49	3	1	2	140	A
50	3	1	2	146	A
51	3	1	2	148	A
52	3	2	2	142	A
53	3	2	2	128	B
54	3	2	2	144	A
55	3	2	2	142	A
56	3	2	2	133	B
57	3	2	3	141	A
58	3	2	2	127	B
59	3	2	2	136	B
60	3	2	2	141	A
61	1	1	2	140	A
62	1	1	2	123	B
63	1	1	2	121	B
64	1	1	1	125	B
65	1	1	2	137	B
66	1	1	2	136	B
67	1	1	2	151	A
68	1	1	2	135	B
69	1	1	2	138	A
70	1	1	2	147	A
71	1	2	2	146	A
72	1	2	2	144	A
73	1	2	2	121	B
74	1	2	2	147	A
75	1	2	2	138	A
76	1	2	2	125	B
77	1	2	2	158	A
78	1	2	2	124	B
79	1	2	2	129	B
80	1	2	1	134	B
81	2	1	2	140	A
82	2	1	2	129	B

83	2	1	3	128	B
84	2	1	2	125	B
85	2	1	2	140	A
86	2	1	2	135	B
87	2	1	2	151	A
88	2	1	2	137	B
89	2	1	2	138	A
90	2	2	2	147	A
91	2	2	2	146	A
92	2	2	2	144	A
93	2	2	2	121	B
94	2	2	2	147	A
95	2	2	2	138	A
96	2	2	2	125	B
97	2	2	3	138	A
98	2	2	2	124	B
99	2	2	2	134	B
100	2	2	2	134	B
101	3	1	2	144	A
102	3	1	2	133	B
103	3	1	2	132	B
104	3	1	2	129	B
105	3	1	2	143	A
106	3	1	2	139	A
107	3	1	2	153	A
108	3	1	2	141	A
109	3	1	3	142	A
110	3	1	2	150	A
111	3	2	2	149	A
112	3	2	2	146	A
113	3	2	2	125	B
114	3	2	2	151	A
115	3	2	2	142	A
116	3	2	2	129	B
117	3	2	2	141	A
118	3	2	4	131	B
119	3	2	2	138	A
120	3	2	2	144	A
121	1	1	1	146	A
122	1	1	2	145	A
123	1	1	2	146	A
124	1	1	2	142	A
125	1	1	2	146	A
62	3	1	2	145	A
63	3	1	3	144	A

64	3	1	2	138	A
65	3	1	2	145	B
66	3	1	2	136	A
67	3	1	2	143	A
68	3	1	2	145	A
69	3	1	4	145	A
70	3	1	2	147	A
71	3	2	3	139	A
72	3	2	2	142	B
73	3	2	2	118	A
74	3	2	2	147	A
75	3	2	3	146	A
76	3	2	2	143	A
77	3	2	2	148	B
178	3	2	2	115	A
179	3	2	2	142	A
180	3	2	3	144	A
181	1	1	2	144	A
182	1	1	2	145	A
183	1	1	2	140	B
184	1	1	2	136	A
185	1	1	1	145	B
186	1	1	2	136	A
187	1	1	2	145	A
188	1	1	2	145	A
189	1	1	2	141	A
190	1	1	2	147	A
191	1	2	2	139	A
192	1	2	2	138	B
193	1	2	2	116	A
194	1	2	2	147	A
195	1	2	1	143	A
196	1	2	1	140	A
197	1	2	1	147	B
198	1	2	2	116	A
199	1	2	2	141	A
200	1	2	1	143	A
201	2	2	2	146	A
202	2	2	2	145	A
203	2	2	2	145	A
204	2	2	2	137	B
205	2	2	2	145	A
206	2	2	2	136	B
207	2	2	2	141	A
208	2	2	2	142	A

219	2	2	2	145	A
210	2	2	2	147	A
211	2	2	2	142	A
212	2	2	2	141	A
213	2	2	2	122	B
214	2	2	2	148	A
215	2	2	2	143	A
216	2	2	2	142	A
217	2	2	2	149	A
218	2	2	2	125	B
219	3	1	2	143	A
220	3	1	3	144	A
221	3	1	3	137	B
222	3	1	3	132	B
223	3	1	3	130	B
224	3	1	3	120	B
225	3	1	3	138	B
226	3	1	2	136	B
227	3	1	2	152	A
228	3	1	2	135	B
229	3	1	2	146	A
230	3	2	2	146	A
231	3	2	2	143	A
232	3	2	4	143	A
233	3	2	2	128	B
234	3	2	2	143	A
235	3	2	2	131	B
236	3	2	2	128	B
237	3	2	2	141	A
238	3	2	2	128	B
239	1	1	2	137	B
240	1	1	1	142	A
241	1	1	2	137	B
242	1	1	1	132	B
243	1	1	2	130	B
244	1	1	3	120	B
245	1	1	1	138	B
246	1	1	2	136	B
247	1	1	2	152	A
248	1	1	1	135	B
249	1	2	2	146	A
250	1	2	2	146	A
251	1	2	2	143	A
252	1	2	1	143	A
253	1	2	2	128	B

254	1	2	2	143	A
255	1	2	2	131	B
256	1	2	2	128	B
257	1	2	2	141	A
258	1	2	1	128	B
259	2	1	2	137	B
260	2	1	3	142	A
261	2	1	1	140	A
262	2	1	2	131	B
263	2	1	2	128	B
264	2	1	3	127	B
265	2	1	2	141	A
266	2	1	2	137	B
267	2	1	2	153	A
268	2	1	2	134	B
269	2	2	2	139	A
270	2	2	2	147	A
271	2	2	2	146	A
272	2	2	2	142	A
273	2	2	2	125	B
274	2	2	2	147	A
275	2	2	2	140	A
276	2	2	2	125	B
277	2	2	2	140	A
278	2	2	2	122	B
279	3	1	2	135	B
280	3	1	2	135	B
281	3	1	2	143	A
282	3	1	2	132	B
283	3	1	2	132	B
284	3	1	4	129	B
285	3	1	4	142	A
286	3	1	2	136	B
287	3	1	2	149	A
288	3	1	3	138	B
289	3	2	3	137	B
290	3	2	2	144	A
291	3	2	2	148	A
292	3	2	3	146	A
293	3	2	2	125	B
294	3	2	2	144	A
295	3	2	3	140	A
296	3	2	2	127	B
297	3	2	2	140	A
298	3	2	3	120	B

APPENDIX C

PERMISSION TO USE ATS SCALE

Mahama <mwundow@yahoo.com>

Hi, Prof.

I would be very grateful if you could grant me a permission to use your Attitude Towards Science (ATS) scale. My name is Mahama Wundow, a Master of Education student at University of Zululand, South Africa.

To

leslie.francis@warwick.ac.uk

11/16/14 at 11:30 AM

Francis, Leslie <Leslie.Francis@warwick.ac.uk> To

Mahama

11/16/14 at 9:15 PM

Dear Mahama

I am pleased to give you permission to use the scale, and I wish you well with your research. Best wishes

Leslie

The Revd Canon Professor Leslie J Francis

Professor of Religions and Education

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APPENDIX D: UNIZULU ETHICAL CLEARANCE CERT – UZURIC

APPENDIX E: KZN EDUCATION DEPARTMENT ETHICAL CLEARANCE LETTER

APPENDIX F: PROOF OF EDITING

APPENDIX G: PARENT AND GUARDIAN CONSENT FORM

APPENDIX H: PARTICIPANT CONSENT FORM

APPENDIX I: CHILD CONSENT FORM