FACTORS INFLUENCING ADOLESCENTS’

ATTITUDE TOWARDS BIOLOGY

IN GAZANKULU

by

HLENGANI THOMAS MANGANYE

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Supervisor: Dr S Schulze

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SUMMARY

The purpose of this study was to investigate if teacher, pupil, curriculum and classroom environment variables were significantly related to adolescents' attitudes towards Biology. The study also investigated whether certain factors (as moderator variables) significantly influenced the relationships between pupils' attitudes towards Biology and each of the independent variables. For the investigation a sample of 426 standard eight, nine and ten pupils from three school-types completed an attitude questionnaire. Parametric statistics were used to analyse the results. Findings from the correlation and stepwise regression analysis revealed that the curriculum was the strongest correlate of attitude and accounted for most of the variance in pupils' attitudes towards Biology. An analysis of variance revealed no significant difference in pupils' attitudes towards Biology when gender, standard, parental levels of formal education and type of school were used as moderator variables. These findings suggest a complete restructuring of the Biology curriculum.

KEYWORDS

attitude towards Biology; Biology; adolescent; questionnaire; teacher factors; pupil factors; curriculum factors; classroom factors.
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My wife, my brother Daniel and my sister: This is the result of hours of hard work through many days and nights. Your patience and support are deeply appreciated.

Finally, to all my colleagues at the Giyani Science Centre, and in particular to Dr. A.W. Pell, I wish to thank you for the trouble you took to occasionally come up with suggestions which led to the final form of the present document.
DEDICATION

This research is dedicated to my Mother, Mhlava Manganye
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CHAPTER 1

The research problem: statement and definition of concepts
1.1 INTRODUCTION

The school is a place of teaching and learning, with the classroom being the integral, basic and functional unit of our education systems. Pupils at schools are in a constant interaction with one another, their teachers and the curriculum. It is these interactions which create an environment that affects the pupils' behaviour, attitude and performance (Talton and Simpson 1987: 507; Simpson and Troost 1982: 768).

A successful implementation of a curriculum is believed to depend on the extent to which its spirit is conveyed to pupils by teachers. The inculcation of positive attitudes and aiding their growth should be seen as an important part of Science education (Koballa 1992: 64). Dreyfus et al (1985: 83) point out that the form of Science education taking place in schools largely depends on the teachers' scientific beliefs, knowledge and methods and that badly prepared or overanxious teachers are the first line of opposition to pupils. This results in the formation of negative attitudes to Science in pupils.

However, it is worth pointing out from the beginning that Science teaching, and particularly the teaching of Biology in our schools seems to be in no way aimed at provoking and assisting the development of the pupils' inquiry and problem solving skills. Isaac (1990: 325) maintains that the achievement of the objectives concerned with the aims of inquiry skills, positive attitudes and values are much more important for the majority of pupils because they are content-free and have transfer potential.

Moulder, as cited by Slabbert (1990: 67), maintains that our current Biology syllabi are crammed with detail that prohibits the mastery of relevant content and necessary skills. Yet, it is the mastery of these skills which is believed to aid the
pupils’ development of an accurate conception of scientific phenomena and how they relate to his everyday life, that facilitates the promotion of positive attitudes towards Science as a human endeavour (Woerner et al 1991: 50).

Scientific attitudes, such as feeling the need to verify data, a willingness to have one’s ideas questioned, and the willingness to change an idea or concept when new evidence is presented, should be an outcome of proper Science teaching (Woerner et al 1991: 500). As may also be true for many other school subjects, Biology teaching in our schools is highly influenced by external examinations (Degenaar 1986: 43; Charoux 1993: 10). Therefore, much time in Biology classes is admittedly spent on passive transfer of knowledge emphasising the short-term memory and reproduction of this information even if this might be redundant tomorrow (Slabbert 1990: 67).

Teachers thus tend to teach according to how examination papers are set and in this way, external examinations become the first priority. However, although external examinations cannot be completely done away with, Degenaar argues that their objectives, didactical and pedagogical aims, as well as their relevance and value should be viewed against the overall educational aims (Degenaar 1986: 45).

It is also generally felt that pupils in our schools possess inadequate Science conceptions or powers of scientific reasoning. An investigation into pupils’ conceptions of Biology concepts by Westbrook indicates that pupils possess incomplete or alternative conceptions of many concepts basic to a knowledge of Biology (Westbook and Mark 1992: 51). In an article of 1986, Jackson focussed much attention on learning difficulties and pupil misconceptions in Biology. According to this researcher, the basic problem in Biology education is to be found in the day-to-day classroom teaching, probably due to large numbers of unqualified or underqualified teachers (Degenaar 1986: 47).
A report by the National Science Foundation on critical issues in Science, Mathematics, and Engineering education indicates that the acquisition of scientific, creative and critical reasoning skills should be seen as a central objective for Biology instruction (Lawson 1992: 339). However, it would seem that most of the teachers in our schools do not assist pupils in developing these skills and in fact, pay too much attention in turning out what Jackson called "factual banks" or "memory mines" for the purpose of passing examinations (Degenaar 1986: 44).

With regard to attitudes, teachers seem to attach little or no significance to the development of positive attitudes in their pupils towards Biology. Charoux (1993) conducted research to investigate the teachers' views about the objectives of Biology teaching. The main categories of objectives investigated were "knowledge", "skills" and "attitudes". Results of this study revealed that of the three objective categories investigated, the attitudinal objectives both on importance and achievement, were rated the least by teachers (p 11).

Therefore, these faulty teaching procedures and the teachers' neglect of the affective domain while teaching, could account for the problems Biology pupils experience. This may also result in pupils developing negative attitudes towards Biology which, according to Tamir and Amir (Charoux 1993: 12), may in turn lead to poor achievement.

The idea that experience in Science should not be restricted to the activities which are concerned purely within the confines of the school laboratory has been frequently reiterated by researchers and Science educators (Gayford 1988: 71). For instance, many pupils today see Science as being remote from their everyday life. As a result of this, even the most intelligent and lively pupils feel alienated by Science (Adey et al 1989: 165). This assertion is supported by Entwistle (1987:
when he says: "Teachers may generally see their subject as intrinsically interesting and relevant to life and culture, but many pupils see it, at best, as only having intrinsic value and at worst having little or no relevance to the world they meet outside school." Along this line, Nelson (1988: 99) and Yager and Penick (1984: 146) argue further that although many pupils may believe that the study of Science will be useful, very little of what they learn in class has any relevance. This non-relevance of subject content has a very powerful impact on the amount of effort pupils will exert in their learning, which may also equally influence their attitude and performance in Science related-activities.

A study conducted by Sewter in schools in England (Pell 1982: 10), indicates that in a number of areas of Science education, the type of teaching received by pupils was in many ways a source of disappointment. Teaching in these schools was not in line with developing pupils' thinking skills. This factor is thought by Gayford as highly contributory to pupils' disenchantment with Science (Gayford 1988: 72).

Science requires students to make observations and inferences, make predictions based on relevant data, formulate hypotheses, design an experiment and draw conclusions from the results of this experiment. However, one wonders whether this scientific process prevails in Gazankulu Biology classes. It would seem that much of the classroom activities in our schools overlook the satisfaction that students may derive from them. It is believed that liking for and the way pupils feel about Biology and how it is taught, are important for enhancing the development of positive attitudes in pupils.

Nonetheless, it is assumed that every teacher attaches significant importance to scientific principles and practices with the aim of inducing in his pupils the necessary positive scientific attitudes as well as positive attitudes in general
towards Science. This is important because a positive attitude towards a given course leads to greater effort, and the willingness to pursue such a course in subsequent studies (Bell et al 1983: 239).

1.2 ANALYSIS OF THE PROBLEM

1.2.1 Awareness of the problem

Many developing countries are faced with rapid scientific and technological advances which impose demands on teachers which cannot be met. The Republic of South Africa in general, and Gazankulu in particular, are faced with just this sort of situation with regard to the teaching of Mathematics, Physics, Chemistry and Biology. Shortage of teachers in these disciplines has a serious influence on the quality of Science education received by our secondary school pupils.

According to the report released by the Department of National Education entitled "Education Realities in South Africa 1991", this shortage of adequately trained teachers in these subjects at high schools has been identified as the most important reason for the negative attitudes towards Science subjects among pupils and for their poor performance in them. For instance, of all teachers teaching General Science, approximately 66 percent had no post-matric training in the subject while 17 percent had more than two years training. In the case of Biology, 49 percent of teachers had no post-secondary training and up to 43 percent had more than two years training.

Slabbert (1990: 66) points out that environmental problems in South Africa, (and probably in the whole world), such as population explosion, pollution in urban areas, erosion, deforestation, declining crop yields and water shortages in rural areas are of a Biological nature and hence scientific. However, very little is being
done effectively in schools to stop it, probably due to the abovementioned insufficient teacher training.

The Gazankulu National State, and probably the vast majority of the other self-governing states, are experiencing deteriorating standard 10 end of the year results in Mathematics and the sciences. However, pass rates in Physical Science and Mathematics have been lower than that of Biology in the years up to 1989 (Figures A, B & C). Consequently, Biology has been one of the most popular school subjects. This is apart from the fact that Biology is compulsory for all pupils, except in certain schools where some pupils opt to pursue commercial courses. Pupils seemed to experience less tension in Biology classes and during Biology examinations than today. This is indicated by the pass rate in Biology which fluctuated between 45 percent and 50 percent (Figure D) in 1980 through to 1984 despite annual increases in enrolment (Pell 1987: 15). This pass rate was higher than in the other Science subjects.

However, since the inception of a more scientific Biology examination approach in 1989, performance started to decline. Interestingly enough, as performance in Biology declines, that of Physical Science and Mathematics improves (see figure A). It is not known for certain whether this improved pass rate in Physical Science and Mathematics can be ascribed to improved teachers' and pupils' attitudes, curriculum content, instructional strategies or to low enrolment. On the other hand, it can be asked whether the deteriorating performance in Biology can be ascribed to the absence of any of the attributes mentioned above.

In 1990, the Biology pass rate was 2.2 percent in the whole region, while that of Physical Science and Mathematics was 14.4 percent and 5.6 percent respectively (see figure A). This is really a considerable decline over a period of six years! Although moderate, the same decline was reported by Pell (1987: 15) to have
Figure A: Gazankulu Education Department
Standard 10 Examination results

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<td>88 89 90 91 92</td>
<td>H.G.</td>
<td>31.8 10.9 14.4</td>
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Figure B: Maths Passes (HG and SG) at Grade E and above

From a report on Science education in secondary schools in Gazankulu (1987) and recommendations for action Dr. A.W. Pell.
Figure C: Physical Science Passes (HG and SG) at Grade E and above

From a report on Science education in secondary schools in Gazankulu (1987) and recommendations for action Dr. A.W. Pell.
Figure D: Biology passes (H.G. and S.G.) at Grade E and above

From a report on Science education in secondary schools in Gazankulu (1987) and recommendations for action Dr. A.W. Pell.
started earlier in 1985. It would seem that Biology was not so easy to pass as was previously thought.

As a compulsory subject, and an “at least” Science subject a child must have studied in secondary school, Biology is taken by all pupils on a higher grade level without considering each child’s aptitude, prior knowledge or interest. It is also worth pointing out that more than 80 percent of the standard 10 pupils in Gazankulu are non-Science pupils, with the result that most of them lack a great deal of scientific capability and problem-solving skills.

Preliminary research into the scientific status of Biology in Gazankulu secondary schools indicates that although a Science subject, Biology has a structure and approach which differ considerably from that of Physical Science (Pell 1987: 15), with the result that teaching it becomes a matter of having the correct textbook for the examinations. In this way, the aim of teaching takes as its point of departure, the assistance of pupils towards passing examinations.

The entrance qualifications of our colleges of education and universities compel both teachers and pupils in high schools to teach and learn in a way that will enable pupils to obtain grades that will satisfy the requirements of these institutions (Slabbert 1990: 67; Charoux 1993:10). This statement is supported by Opie and Watson when they say that our Biology education is focussed on preparing learners for the university, and in this way receiving and retaining content is strongly emphasised (Slabbert 1990: 66). This situation is conducive to the development of tensions which may conflict with meaningful learning. This in turn, may culminate in poor performance and negative attitude formation by the pupils.
Sund and Trowbridge (Degenaar 1986: 44), stress the importance of having clearly defined aims and objectives in the teaching of a school subject, because goals provide guidance and direction. It is true that no effective Science teaching will necessarily take place if goals are not clarified and properly transformed into objectives to be achieved. On the basis of this, it can be asked whether the Department of Education and Training has ever endeavoured to apply conventional curriculum approaches to the construction of Biology methods and instructional strategies that could benefit every child at school (Pell 1987: 15; Watson 1990: 49). The development of Biology curricula and the prescription of Biology syllabi seem to overlook the child as a whole and his educational environment. This situation results in mis-matched learning experiences with what pupils could generally understand and appreciate. For example, certain aspects of the Biology syllabus need not be emphasised for examination purposes. As a result, teachers are forced to attach significance only to the examinable content of the syllabus thereby ignoring those objectives (such as attitudes) that are not evaluated in the examination (Charoux 1993: 10).

According to Watson (1990: 49), education in South Africa is bound by highly academic syllabi which are fundamentally irrelevant. The Biology that is taught in schools seems not to assist pupils towards the acquisition of skills that would lead to the reversal of the processes leading to environmental destruction. The relevant content which reflects new developments and appropriate life-skills is not addressed in Biology education (Slabbert 1990: 68). Therefore, this inordinately detailed Biology content tends to keep teachers and pupils away from relevant Biology for the sake of passing examinations.

Again, as Nelson points out, our curricula and the school environment are highly prescriptive (Nelson 1988: 7). For example, the matric teacher is under pressure to complete the more detailed syllabus before the final examinations. Apart from
this, the Biology aims seem to be based more on the accumulation of facts than on their application to the wider social issues — where problem-solving is merely uttered and not practised because of lack of time, resources and class size (Woods 1990: 176). The rigidity of the school environment, which is controlled by a hardly-flexible timetable, makes it even more complicated for the teachers to implement a wider range of teaching methods.

According to Hoyle (Eggleston 1977: 132-3), the school is a key variable in the process of curriculum change. However, much of curriculum development in South Africa seems to be centred more on the initiatives of the selected experts who are working at some distance from the classroom. Teachers have no say because the experiences are simply imposed on them and must be implemented verbatim if pupils are to succeed in the examinations. This assertion is supported by Fraser (1992: 52) when he says: “One of the main criticisms against the present curriculum-development procedures in South Africa is that very few teachers have had the opportunity to take part in the development of the draft curricula.” This kind of logic is deductive and characterised by power-coercion.

Furthermore, Nelson (1988: 7) maintains that many curriculum innovations in South Africa are adopted piecemeal. On this basis, Watson (1990: 49) wrote: “...the processes of syllabus revision seem always to be of snip and paste variety, it is assumed that what has gone before is fundamentally suitable and that it is just modification and up-dating which is required.” This may be because the current fundamental principles of curriculum development (such as the psychology of learning and pupil interest in the area of study) are not employed during the process.

For example, it would seem that each newly appointed examiner in this department tries to renovate the Biology curriculum from the examination point
of view. Assessment in these examinations seems to be linked mainly to the recall of facts. As a result of this, the higher order cognitive functions are usually left to the discretion of the teacher and teacher-training institutions (Fraser 1992: 57).

Pell (1987: 6) determined the statistical performance of Gazankulu standard 10 examination results using the computer print-out of the Department of Education and Training. This researcher reported that the examination support of this department appears to be of a variable quality. It is unreliable and rudimentary.

According to this Department, it seems as if learning has taken place only if the child manages to get a pass in such examinations. Connel, as cited by Nelson (1988: 6), sees a curriculum based on such examinations as highly "competitive academic". Therefore, the activities of the pupils in school are reduced, converged and channelled towards passing examinations. According to Opie (Slabbert 1990: 67), this academic nature of our Biology syllabi does not allow the learning opportunity which will prepare learners for life. This situation has very serious educational consequences. Because it is not flexible, it is likely to conflict with meaningful learning. This again, may culminate in less positive attitudes towards Biology and Science generally in pupils.

Apart from the above, the schools in Gazankulu are poorly equipped with Science facilities. At the same time, the examinations require pupils to have had a thorough experimental background of the Biology content. This also has an adverse effect on pupils' attitudes towards Biology.

A pilot study to investigate standard 10 pupils' attitudes towards Biology in Gazankulu was conducted by the researcher as follows: The sample consisted of 79 girls and boys of between 17 and 20 years in three senior secondary schools. A 20-item attitude questionnaire was issued. Subjects were assigned an attitude
score indicating agreement or disagreement with items relating to commitment towards Biology, enjoyment of Biology and the learning of Biology through experiments and problem-solving activities (Pell 1985: 124)

The results of this investigation revealed that the majority of the participants enjoyed Biology (75.8 percent) and were committed to it (77.2 percent). For the learning-by-experiment and problem-solving category, fewer subjects (63.7 percent) responded positively. Therefore, according to these results, it seems that pupils' attitudes towards Biology are quite positive.

However, these results seem suspect. Since subjects were forced to choose between the two constructs of agree and disagree and testing took place on a day they were about to sit for the Biology examination, it is possible that most of them were inclined to report positive attitudes. These results contradict the researcher's observations through questioning and listening. Most of the pupils talk about the subject as too difficult.

It is therefore these pupils' attitudes towards Biology which prompted the researcher's concern. He consequently decided to study the factors which influence adolescents' attitudes towards Biology in Gazankulu secondary schools.

1.2.2 Examination of the problem - an historical background

Numerous research studies on attitude have been carried out in other countries (Talton and Simpson 1987: 508) as well as in South Africa. The aim of these studies was to investigate systematically pupils' attitudes towards Science as taught in schools. It was also investigated how attitudes affect learning, in order to obtain a sound research base for future curriculum development (Pell 1985: 123). However, no such research has been carried out in Gazankulu!
Studies ranged from characterisation of the classroom and classroom interactions with the aim of examining the relationships of the classroom environment variables with cognitive and affective learning outcomes. For instance, in his study of the relationship between enjoyment and achievement in school Physics, Pell (1985: 123) pointed out that no effective learning is likely in situations where a cognitive mis-match is accompanied by lack of affective feedback from pupils on Physics. Apart from this, Talton and Simpson (1987: 508) stated: “the cognitive aspects of the learning environment are better predictors of cognitive outcomes and the affective aspects are better predictors of affective outcomes.”

Very strong correlations were reported to exist between some classroom environment variables with attitude towards Science (Talton and Simpson 1987: 513). None of the classroom environment variables investigated by Talton such as climate, curriculum, physical environment, teacher, student and friends, had a strong positive correlation with achievement. However, a moderate correlation was reported to exist between “climate” (people’s general attitude to an aspect of life) and achievement.

Several other research studies on the relationship of students’ attitudes and classroom characteristics revealed that students’ attitudes may be associated with some classroom learning, instructional and teacher variables (Hasan 1985: 4). Students’ perceptions of some aspects of classroom learning environment were also found to be significantly related to their attitudes towards Science. It is surprising to note that Disinger and Mayer (Hasan 1985: 5) found no significant relationship between teacher characteristics and instructional variables with attitude. However, to them, instructional variables seemed more related to attitude than teacher-characteristics.
Other researchers like Gabel, Korth, Shallis and Hills (Gogolin and Swartz 1992: 489) revealed that Science students have more positive attitudes to Science than non-Science students. At the same time, the number of Science courses taken by pupils may have a cumulative effect in positively influencing attitudes. This may therefore be a case of unknown, unresolved.

The influence of gender, age and standard on attitude toward Science has also received more emphasis over the past years. For example, Gardner (1975) described gender as the major variable in the measurement of attitudes towards Science. Again, in their international survey of the relationship between gender and attitude towards Science, Comber and Keeves reported that gender differences play an important role in influencing attitudes towards Science (Pell 1982:33). These differences favour boys. Furthermore, the achievement gap in Science between boys and girls widens with age.

With regard to age, the relationship of attitude towards Science is as follows: Yager and Penick (Gogolin and Swartz 1992: 489) found that although pupils in elementary school perceive Science to be enjoyable, interesting and useful, a decline in attitude occurs throughout junior high and high school. This results in young adults who do not feel positively about their school Science experience. Bohardt's examination of changes in pupils' attitudes towards process based instruction in Science of the fourth through eighth grades concluded as follows: Fourth and fifth graders had positive attitudes but as the grade level increased, attitudes deteriorated markedly for both males and females (Cannon and Simpson 1985: 121). Another study conducted by Randall of the eighth, tenth and twelfth grade pupils' attitudes and perceptions towards Science lectures indicated a similar deterioration in attitudes with each increasing grade by both males and females (Cannon and Simpson 1985: 122).
However, uncertainty still remains whether attitudes in any way influence achievement and vice versa. Little research evidence exists to support the seemingly fairly reasonable belief that favourable attitudes towards a subject lead to higher achievement in it. Very few of these studies supported the existence of such a relationship. For example, Jackson and Knaup found no significant correlation between attitudes and achievement. On the other hand, Aitken, Tishmer and Greenblatt found a significant correlation between attitude and achievement although stronger in the case of boys (Bell et al 1983: 251-2).

Several other researchers like Haugh and Towse (Nelson 1988: 19), also reported a significant correlation between attitudes and performance. However, Towse questioned which one (of attitudes or interest) was the cause or effect. According to Hough and Piper (1982: 33), these disappointing findings can be explained by the interference of individual differences among pupils. Again Shrigley (Eichinger 1992: 601), in his investigation of the relationship between attitude and behaviour, concluded by saying that the relationship between the two should be viewed as correlational rather than literal. This is because, although attitudes may be a valuable predictor of achievement, they are not a causal factor. However, changes in behaviour could be expected to accompany some modifications of attitudes!

Thus from this preliminary literature study, it seems as if students' attitudes may relate to teacher characteristics (such as personality, enthusiasm, attitude, effectiveness, teaching method or teaching strategy and support); pupil characteristics (such as learning style, gender, age and motivation); curriculum as well as the school environment.

In chapter two all these and other important factors which influence adolescents' attitudes towards Biology, will be discussed in depth.
1.3 STATEMENT OF THE PROBLEM

The importance of the influence of attitudes has been recognised as can be seen from the increasing number of articles and research studies dealing with their description, measurement and influence (Hasan 1985: 3). Consequently, it is reasonable to suggest that the development of attitudes be accorded status no less than cognitive development.

Therefore, it is the purpose of this study to investigate empirically the factors which influence the attitudes of the standard 10 Gazankulu adolescents towards Biology. Thus, the following question is asked:

"Which are the most important factors influencing Gazankulu adolescents' attitudes towards Biology?"

1.4 AIMS OF THE STUDY

1.4.1 Specific aim

The specific aim of this study is to determine which factors are most important in influencing Gazankulu adolescents' attitude towards Biology.

1.4.2 General aims

For many years, Gazankulu has been experiencing problems with low enrolments in Physical Science and Mathematics, poor results in the Sciences and Mathematics, as well as poor quality teaching in its schools. Causes are varied. Some people would say that poor end of the year results in Gazankulu are the
consequence of the pupils' laziness or lack of intelligence, while others blame the quality of teaching offered to pupils. The parents' expectations of their children and those of the university and vocational fields are also viewed as other dimensions which may lead to this situation.

Pell (1982: 23) maintained that if Science teaching should benefit, the affective domain variables such as pupils' expectations of their subject content and of teacher behaviour should be seriously considered. Therefore, the correlation between certain variables (which will be identified in the literature study) and attitude towards Biology, should be re-examined and thoroughly evaluated in order to improve Biology education in our schools.

For instance, the Nuffield O-level Science programmes in the UK have been severely criticised. One of the reasons for such a criticism was their lack of a satisfactory curriculum model. Their curriculum was mis-matched with what might reasonably be expected from secondary school pupils (Pell 1982: 123).

Therefore, it is hoped that the results of this study will add to the existing store of knowledge about the development of pupils' attitudes towards Biology. In this way, curriculum designers, directors of education, inspectors of education and schools, principals and Science educators' attention will be drawn to factors which influence pupils' attitudes towards Biology. This may result in the development of positive attitudes towards Biology by pupils so that they may possibly achieve better results.

1.5 DEMARCATION OF THE FIELD OF STUDY

Many factors exist, both in school and in society, which influence pupils' attitudes towards Science and Biology. However, for the present study, only the
most important of these factors will be investigated to establish their relationship with attitudes towards Biology. These factors are:

- Teacher characteristics (such as personality, enthusiasm, attitude, qualifications, teaching method or teaching strategy);

- Pupil characteristics (such as learning style, gender, age and motivation);

- School environment (such as the availability of Science equipment and a laboratory, teacher-pupil ratio, subject content, evaluation techniques and management).

1.6 DEFINITION OF CONCEPTS

For the purpose of clarity, and to avoid ambiguity in communication, concepts such as adolescence and attitudes are defined and described as follows:

1.6.1 Adolescence and adolescent

Adolescence comes from the Latin verb “adolescere” which means to grow into maturity (Rogers 1981: 6, Darley et al 1981: 367). It is the period between childhood and adulthood and as such, a bridge linking these two stages of development (Rogers 1981: 10). Vrey defines adolescence as a stage of growth and development towards something, as well as the period of maturation as such (Vrey 1979: 165). The adolescent is a youth who is growing into the adult world.

Therefore, an adolescent is a person in the process of growing to adulthood. During this period the adolescent strives towards achieving the attitudes and
beliefs, as well as developing skills, needed for survival and for effective participation in society (Darley et al 1981: 367).

1.6.2 The period of adolescence

No complete agreement exists on the exact period which marks the beginning or end of adolescence. This is because children and cultures differ widely and therefore many approaches and criteria for such a division exist (Vrey 1979: 165). These approaches and criteria range from cultural, psychological, biological, sociological, and chronological age perspectives. For instance, some people see adolescence as that span between the onset of puberty and the completion of bone growth, while others regard it as a stage between the confines of specific age limits.

Biologically, the child is an adolescent from the onset of puberty, that is, the period during which sexual maturity is attained. However, sociologists argue that adolescence should be seen as a socially rather than biologically determined phase of development (Darley et al 1981: 368).

Different views on the chronological age of the adolescent exist. Some people see adolescence as starting from 12 or 13 to 17 or 18 years of age. Aristotle regards it as the period between puberty and 21 years of age (Siann et al 1988: 211). Brown and Weiner (1979: 322) maintain that in the Western culture, adolescence is seen as that period starting from eleven years of age up to the early twenties. According to Vrey, when cultural influences are considered, adolescence should be seen as starting from 12 and going up to 22 years of age (Vrey 1979: 165).

Secondary school pupils are often regarded as adolescents. Yet, this may not necessarily be correct in developing and under-privileged communities. Many
pupils in these communities, and especially in Gazankulu, are already adolescents while in primary schools. At the same time, many secondary school pupils could rather be seen as youths than adolescents. Therefore, it would be fair to say that adolescence begins with puberty but its ending is culturally determined. This assertion is supported by Brown and Weiner (1979: 322) when they say that it would be a temptation to assume that words such as childhood and adolescence have a psychological meaning because their definition is strictly based on culture.

In some societies there is no such thing as adolescence because as soon as young people reach sexual maturity, they enter adulthood. This may be accompanied by some kind of initiation or puberty rite to mark the occasion. Until recently, many children in Western societies carried adult responsibilities such as working in factories at the approximate age of seven or eight (Brown and Weiner 1979: 323). This situation still prevails in Gazankulu as most children are already parents and labourers at an age when other children in Western societies are still attending school. Reasons for this state of affairs may be sought from poverty for the majority of them, parental negligence due to illiteracy as well as confused roles these children had ascribed to themselves when they were still scholars.

### 1.6.3 Developmental aspects of adolescence

#### 1.6.3.1 Cognitive development

Each phase in the development of the child displays its own cognitive manifestations. Piaget identified three of these levels of cognitive development from childhood to adolescence as pre-operational (2-7 years), concrete operational (7-11 years) and formal operational (from 11 years) (Vrey 1979:153 155). Parallel to these are Bruner and Vygotsky's enactive/ vague syncretic, iconic/complexes and symbolic/potential stages (Fontana 1988: 52-53). Children
in the first two operational levels of cognitive development rely on their senses and on the concrete. As Kolodiy stated, these children can manipulate physical objects, but have difficulty dealing with hypothetical problems or with those which involve predictions of the future (Yount and Horton 1992: 1060). This means that the truth of any piece of reality is based on its concrete relevance.

However, from the age of 11 or 12, the child enters Piaget's final stage of formal operations (Darley et al 1981: 369). It is during this stage that the child acquires several important cognitive capacities he did not have in childhood. The most basic change in the formal operational period is his ability to think about the possible and the abstract rather than the concrete. For instance, at this stage, the adolescent can consider that which has not occurred and can, at the same time imagine all the diverse possible relationships and outcomes in a given situation. Hence adolescents can reason about contrary-to-fact situations (Darley et al 1981: 370; Yount and Horton 1992: 1060).

Adolescents have the ability to test systematically a set of possibilities for correctness as well as to manipulate thoughts and their systems of thought mentally. Therefore, adolescents can be seen as propositional and hypothetico-deductive thinkers respectively (Darley et al 1981: 370, Vrey 1979: 155). It is this ability to think abstractly which enables adolescents to explore the impossible and improbable as well as reality. However, the frequent use of abstract and deductive reasoning, when coupled with his frustration at the adult world, often leads to a great deal of questioning which results in estrangement (Fontana 1977: 34). This may result in the development of negative attitudes towards any referent as well.

In order for the adolescent's formal operational level to be enhanced, the ability to think more abstractly should be reflected in the educational system's
curriculum with special reference to the Biology curriculum. This will increase the child's freedom of thought and self-expression which may positively influence his Biology self-concept and attitude.

However, it must be noted that not every child reaches the formal operational stage. For instance, Neimark reported that only 30 to 40 percent of adolescents and adults display formal operational thinking, while Berry and Dansen reported absence of this aspect in non-literate cultures (Darley et al 1981: 370). Again, a small scale research into the cognitive development of the standard sixes in Gazankulu using the Science Reasoning Tasks, revealed that only about 2 percent of the pupils in this region can handle formal operations. Too much abstraction in curricula and teaching may hence lead to conflicts which may well result in pupils' swing away from learning a specific course or subject, thereby developing negative attitudes towards such a course or subject.

1.6.3.2 Affective development

Like any other transition, adolescence is marked by profound pressure exerted upon the child. This is because he cannot yet reconcile the two poles of childhood and adulthood. On this basis, Fontana commented thus: "The adolescent has learned to cope with the business of being a child; now he finds himself called upon to cope with the business of being an adult; and to cope with it in a complex industrial society which, because of the lateness of school leaving age, is reluctant to accord him adult status" (Fontana 1977: 33).

Adolescence is seen by psychologists as a period during which a person is in a psychological moratorium, more especially when choices have to be made (Burns 1979: 174). This is because these choices are often made on the basis of inadequate knowledge and experience. For instance, the choices of career, values,
life-style, personal relationships and fields of study are more of a psychological problem. This is because such choices are often undertaken in the face of conflicting evidence and values within a restless and uncertain society.

Social scientists, on the other hand, labelled adolescence as a period of storm and stress. According to Hall, adolescents typically waver between contradictory and extreme states such as cruelty and sensitivity, diligence and laziness (Darley et al 1981: 370). It is the period of dramatic ups and downs through which every teenager must pass in order to develop into a mature adult (Brown and Weiner 1979: 372). As a period of mood swings, and of rapid shifts from enthusiasm to deep depression, adolescence is also characterised by the child's low self-confidence, anxiety and escalating aggressive and sexual impulses.

In contrast to the above, the notion that adolescence is a crisis period, flowing from physiological change and psychological maturation is not supported by many researchers (Brown and Weiner 1979: 372, Burns 1979: 176). On this basis, Offer was quoted by Brown and Weiner (1979: 372) as saying that adolescent turmoil, should be seen as only one route for passing through adolescence. Adelson (Gage and Berliner 1988: 44) also confirmed this last view. According to him, adolescents are not in a state of turmoil, nor are they deeply disturbed, resistant to parental values and politically active and rebellious. In his view, adolescent turmoil should rather be regarded as culturally determined. The validity of these conflicting views should be given serious consideration in educational settings, including the Biology classroom. This is because emphasising any one of them may be an over-simplification.

1.6.3.3 Social development

Adolescence is characterised by the child's craving for self actualisation and a total emancipation from his parents. As Darley pointed out, the adolescent longs
impatiently for liberation and the acquisition of an autonomous adult status. He does this by breaking his childhood bonds of emotional dependency on his parents. This is often accompanied by the rejection of his parents' opinions resulting in a certain amount of parent-child conflict (Darley et al. 1981: 371).

The adolescent's increased ability for abstract thought makes it possible for him to conceptualise his own thoughts. He can question his or her own moral opinions and religious beliefs and treat them as objects to discuss and reason about (Brown and Weiner 1979: 369). At the same time, the adolescent is also critical of what others think of him. It is this personal evaluation of oneself against the real and the imaginary others that helps the child's development of a genuine concept of himself. A more positive self-concept is desirable because it serves as a strategy the child can use to cope with anxiety or tension (Vrey 1979: 168), thereby developing positive attitudes towards people, objects and ideas. Thus a positive self-concept may promote the development of a positive attitude towards Biology.

Adolescence is also characterised by an inclination to conform. This is the tendency whereby adolescents identify themselves more with their peer group than with their parents. According to theorists, the major task during adolescence is to establish intimate relationships (Darley et al. 1981: 376). It is in his relationships with friends where the adolescent's views are shared. The more acceptable his views are to the group, the more positive will be his self concept and attitudes and the more will he be ready to participate in tasks regarded by others as complicated, for example Science.

However, this conformity to the peer group has some serious problems. The new ideas acquired by the adolescent from his relationships with friends often conflict with those of his parents and teachers. The kind of persons exemplified by parents and friends has a very decisive influence on the behaviour of the
adolescent. Apart from this, the manner in which the Science teacher handles his subject, and the value of this subject to pupils can influence their attitudes positively or negatively.

1.6.3.4 The adolescent and identity formation

This is the fifth of Erikson's developmental stages, namely "identity versus role confusion". This stage is characteristic of adolescence because it is more concerned with the child's discovery of himself. During adolescence, the adolescent is preoccupied with identity formation. Self-identity is defined by Fontana to refer to the sum total of the concepts individuals have about themselves (Fontana 1988: 248-249).

Although there is some sense of self-identity in early infancy, the search for it is particularly characteristic of late adolescence (Brown and Weiner 1979: 374). This is partly because of the emergence of more mature life goals, such as career choice and of the adolescent's high level of intellectual functioning (Brown and Weiner 1979: 374; Fontana 1988: 249).

This search for self-identity is often accompanied by a great deal of experimentation and the adoption of role models in order to establish who the adolescent actually is. By finding out more about his life-world, listening to what others say about him, identifying with adults, children and the subjects he learns, the adolescent gradually constructs a picture of the kind of person he is (Fontana 1977: 33).

Thus, the adolescent can view himself as a scientist or a non-scientist, capable or incapable, and so forth.
However, the socio-psychological atmosphere in which the adolescent finds himself, and his physical maturity may have profound immediate and enduring effects on his personality as well as on his overt behaviour. Failure for him to identify himself positively with his life-world, the significant others, as well as the school subjects, always lead to what Erikson called “role confusion”. According to Fontana (1988: 251), role confusion implies that an individual has no clear idea of the kind of a person he is or the role that he should resume in life.

Low self-esteem, insecurity, self-doubt and self-questioning are the consequence of the child’s distorted image of himself. The adolescent with no clear idea of the person he is, is prone to fall prey to the many diverse and conflicting pressures of adult life, adhering for security to a rigid and artificial picture of himself that leaves no room for change (Fontana 1977: 33).

Therefore, schools should understand the child’s search for identity and provide education which will be seen by all as relevant to their present and future needs. This encourages the development of positive attitudes (Fontana 1977: 121). Shayer and Adey (1989: 145) pointed out that pupils will be well motivated as long as the aims and content of the Science curriculum to which they are exposed are related to the model of how they proceed through adolescence to adulthood.

Teachers should understand adolescence as a human stage of development and, by their tolerance of the adolescent, yet maintaining consistent standards, help him to answer the questions which he is confronted with on his way to adulthood.

Although most adolescents have reached a stage of formal operations, only the minority will have reached the ego identity achievement stage at which to make crucial decisions about their subject choices at school (Kelly 1987: 22 and Vrey 1979: 177).
Therefore, all educators should approach their adolescent students with much more circumspection and care in order to prevent the development of ill-defined tensions and conflicts characteristic of this period. These tensions have severe educational effects on pupils' attitudes and performance.

1.6.4 Attitudes

An attitude is defined as a state of mind, behaviour, or conduct regarding some matter as indicating opinion or purpose; a state of readiness, a tendency to act or react in a certain manner when confronted with stimuli; and a mental set held by an individual which affects the way he acts (Oppenheim 1979: 105 and Hayes and Orell 1989: 338).

Attitudes are those convictions held by a person about something, which influence such a person's behaviour. They represent states of mind, favourable or unfavourable, towards anything and everything and therefore, are especially important for mental development. Attitudes influence the individual's readiness and receptiveness to learning (Rogers 1981: 141; Hasan and Billeh 1975: 247). As internal states of mind that influence the individual's choices of personal action, attitudes contain some elements of value and belief (Fontana 1977: 104). Fontana (1988: 204) maintains that attitudes may be partly conscious and partly unconscious, with the two even in conflict with each other.

According to Gagne' (1977: 21), attitudes are response tendencies or states characterised by readiness to respond. They are enduring orientations which people develop towards the objects and issues they encounter in life (Fontana 1977: 104). Allport, as cited by Gagne'(1977: 219), defines attitudes as a mental and neural state of readiness, organised through experience, and exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related.
Newcomb, as cited by Wright et al (1970: 480), defined attitude as indicating an individual's organisation of psychological processes as inferred from his behaviour, with respect to some aspect of the world which distinguishes itself from other aspects. Attitudes represent the residue of the individual's experience with which he approaches any subsequent situation. This, together with contemporary influences of such a situation, determine his behaviour in it.

Attitudes can be positive, neutral or negative (Child 1986: 257). According to Hart and McClaren (Yount and Horton 1992: 1059), an attitude can be considered as an enduring positive or negative feeling towards an aspect of an environment conflict, and generally as an interaction of cognitive, affective and conative domains. Therefore, attitudes, whether positive or negative, are reinforced by beliefs (cognitive) and often attract strong feelings (affective) that will lead to a particular form of behaviour (behavioral) (Oppenheim 1979: 106).

A close connection exists between attitudes and interest. However, the two are not synonymous and they differ considerably. For example, attitudes are more general while interests are specific to a given stimulus. Interests are directly related to what a person can do and what he has already learned. Interests are reflected in a person's tendencies to seek or avoid certain kinds of activities (Evertson et al 1980: 211). Interests have a personal subjective character and as such, are related to value. However, Rogers (1981: 142) maintains that interests suggest favourable attitudes towards an activity and a desire to participate. Vrey sees interest as implying a deliberate direction, and therefore is a completely voluntary attitude (Vrey 1977: 232).

The development of attitudes is dependent upon the extent to which various activities or objects appeal to the individual's convictions and feelings about them. For instance, pupils need to perceive the relevance of the subject in order
to assimilate it in a meaningful way. If they cannot, the content of this subject is simply memorised and later forgotten, with no modification of their internal cognitive structures, or their attitudes (Yount and Horton 1992: 1060-1061). This situation may propagate a serious and irreparable damage on the pupil's feelings about and attitudes towards Biology.

However, it is the possession of positive attitudes towards an event which will enhance the struggle towards its achievement. Therefore, educators and the school should strive to promote the development of positive attitudes in their pupils towards Science in general and Biology in particular.

1.7 PROGRAMME OF STUDY

This study comprises the following chapters:

*Chapter 1*

This was an introductory chapter describing the research problem and defining important concepts.

*Chapter 2*

In this chapter the researcher will present a review of the literature concerning factors which may influence adolescents' attitudes towards Biology. An analysis of the literature will lead to the formulation of hypotheses.

*Chapter 3*

The methods undertaken by the researcher in carrying out the research to test the hypotheses will be explained in detail.
Chapter 4

In this chapter, the results of the empirical investigation will be described.

Chapter 5

Conclusions and recommendations derived from the literature review and the empirical research will be presented.
CHAPTER 2

Factors related to attitudes towards science, including Biology:

a review of the literature
2.1 INTRODUCTION

Based on the specific aim of this study, that is, to determine which factors are most important in influencing Gazankulu adolescents' attitudes towards Biology, the literature survey that follows commences with a general overview of the studies on the development of attitude and the problems experienced in this regard. Each one of the probable factors influencing attitude will be reviewed as they had been discussed by many researchers. These factors are associated with the teacher as well as with the pupils themselves, the curriculum and the classroom.

Finally, some hypotheses for factors relating to attitudes towards Biology will be stated.

2.2 VIEWS ON ATTITUDE DEVELOPMENT

The affective domain, as the co-determinant of pupils' opting for or against the study of Science, enjoyment of Science and commitment to Science, has been severely neglected over the years. This view is supported by Collier (Miller 1991: 217) who said: "One limitation of education, especially higher education, is its over emphasis on analytical, intellectual training at the expense of affective and conative development." For example, the curriculum evaluation programmes have been criticised by researchers for their neglect of studying the effects of pupils' perceptions of their learning, as well as the environment in which learning takes place (Randhawa and Fu 1973: 304).

Although sometimes studied and defined, attitude towards Science was not distinctly differentiated from scientific thinking and problem-solving skills (Hasan 1985: 3; Koballa and Crawley 1985: 223). The development of goals for
understanding concepts and conceptual schemes of inquiry has been more emphasised than the development of attitudes (Hasan 1985: 3).

For about three decades, poor Science examination results, for instance, have been linked more with the cognitive than with the affective domain. A series of research studies conducted by Lewis (Ormerod and Duckworth 1975: 1-2) into pupils' poor performance in Science, revealed that the high proportion of variance of examination results gained by 14 and 16 year old pupils was loaded on the general factor of attainment. The same findings were reported by Willmot and Nuttall in 1972.

However, after the release of Dainton's report in 1968 on pupils' "swing away from Science" (Ormerod and Duckworth 1975: 2) and of the assessment results of the NAEP in 1978 of pupils' sentiments about Science teaching and Science teachers (Yager and Penick 1984: 143), several explanations were made. Of the many explanations, lessening interest in Science and the dissatisfaction with Science and Technology among pupils have been suggested. Consequently, a number of scales have been developed to measure attitude (Duckworth and Entwistle 1974: 76). Hence a follow-up analysis of examination results of the 16 year old pupils conducted by Hall in 1975 (Ormerod and Duckworth 1975: 2), showed that the attainment factor was itself also heavily loaded with non-cognitive factors. Therefore, research on other factors apart from pupils' cognitive abilities became necessary.

This was seen as important in better explaining both pupils' performance and attitudes towards Science. In this way, pupils' attitudes towards Science, their school and the teaching they received were emphasised and researchers recognised them as important to try and determine reasons why pupils did not enroll in Science courses (Ormerod and Duckworth 1975: 1).
Nonetheless, it would seem that worldwide, let alone in South Africa, very little was done in this domain. Consequently, Taylor, Ramsey and Howe (Hasan 1985: 4), wrote: “Despite the recognition that attitudes towards Science are a significant outcome of Science teaching and relevant variable in students’ cognitive learning of Science, little has been made towards specifying and determining the conditions that affect their dynamics and influence their development”.


Nevertheless, although spotty (Hasan 1985: 4), sufficient evidence exists to support the significance of positive attitudes in education. Research on factors associated with the development of positive and/or negative attitudes towards Science and Biology will now be reviewed.
2.3 PROBABLE FACTORS RELATED TO PUPILS' ATTITUDES TOWARDS GENERAL SCIENCE INCLUDING BIOLOGY

2.3.1 Factors associated with the teacher

2.3.1.1 Introduction

While many factors exist to account for the variance in the learning outcomes and attitudes of pupils, such as curriculum materials in schools (Jegede 1989: 235; Vitale and Romance 1992: 915), those inherent within the teacher himself cannot be ignored. Although no research findings exist to prove the actual determinants of pupils' attitudes towards Science, the possibility that the teacher is the most powerful factor in developing such attitudes cannot be underscored (Haladyna et al 1982: 672-673, Fontana 1988: 345).

Kach and Borich (Simpson and Troots 1982: 766) indicated that teacher behaviour influences students' self-esteem and attitudes towards school learning in general. Rothman et al (1969: 59) have also suggested that the pupils' learning is greatly influenced by the teacher, and that his characteristics are likely to be reflected in the patterns of change that occur in them. However, Ormerod and Duckworth (1975: 71) warned that, even so, the degree and nature of influence of teachers on pupils' attitudes towards Science should be treated with care as it may vary for different groups of pupils.

According to Abell and Pizzini (1992: 649), a great potential for improving pupil learning in Science lies with the classroom teacher. Kyle (Holdzkom and Lutz 1989: 124) also pointed out that the teacher, as well as the principal are vital factors in education improvement, and that without their help, change cannot occur. Talton and Simpson (1987: 508) regarded the teacher as the mediator of
the effects of the learning environment and a main agent for change in attitude (Myers and Fouts 1992: 931). Thus the teacher should be seen as the pivot of any Science education programme (Jegede 1989: 235) and probably the largest single influence upon classroom interaction (Simpson and Troots 1982: 768).

The teacher's personality and value system, attitude, sexual orientation, cognitive and affective teaching style, interest, commitment to Science and a capacity for flexibility have been reported to be strongly related not only to pupil achievement, but also to attitudes towards and interest in Science (Hasan 1985: 4; Lawrenz 1975: 435; Rothman et al 1969: 63; McMillan and May 1979: 217; Simpson and Troots 1982: 768). Furthermore, teacher support, task orientation, order and organisation, teacher control, enthusiasm, knowledge, praise, commitment, fairness to pupils and innovation were reported to influence pupils' learning outcomes (and probably attitudes) either positively or negatively (Jegede and Okebukola 1992: 638; Haladyna et al 1982: 685; Larkins and McKinney 1982: 27).

The use of some instructional procedures and models in the teaching of Science has been indicated as important in positively and significantly influencing pupils' attitudes towards Science (Hasan 1985: 5). It was also shown that lack of adequate instructional expertise for Science teaching in secondary schools should be seen as limiting in improving the quality of Science instruction and the development of positive attitudes towards Science among pupils (Vitale and Romance 1992: 545). Consequently, a decline in scientific literacy and interest in Science was related to the quantity and quality of instruction young people receive during elementary and middle school years (Simpson and Troots 1982: 763). Poor Science understanding may be due to lack of Science teaching skills and strategies that focus on inquiry, hands-on-activities, processes of scientific method and applications of Science and technology in society (Vitale and Romance 1992: 915).
Several aspects regarding the teacher may influence pupils' attitudes towards Biology. Some of these will now be discussed. In the discussion, it will be kept in mind that Biology is one of the Natural Sciences, (as is Physics and Chemistry). Hence the word "Science" also refers to "Biology".

2.3.1.2 Teaching methods and attitudes towards Science (Biology)

The teacher of Science today is confronted by an immense variety of possible teaching methods and techniques which he may employ in his work as a result of changes in curricula, technology (Stutton and Haysom 1974: 67), as well as working environments that are more complex today (Holdzkom and Lutz 1989: viii). The teacher is also faced with a twofold task of instructing pupils to become scientists and creating in the average citizen an interest in the scope and methods of modern Science (Meyer and Penfold 1961: 3; Simpson and Troots 1982: 766-767; Pestel 1988: 26; Janners 1988: 32; Watson 1990: 49).

However, the relative effectiveness of various teaching methods on the development of positive attitudes towards Science in pupils has been and still is a controversial issue (Oliver 1965: 289). For instance, Yager and Penick (1984: 143) pointed out that no method has been singled out as the method for successful teaching. With regard to Biology, Dallad (Davies 1985: 258) stated that there is no one way or method of teaching the subject. Whitefield (Stutton and Haysom 1974: 12), also pointed out that any method, as long as it is grounded on the teacher's intended objectives, is likely to positively influence pupils' learning of a given content. Hyman (Rehage and Van Til 1976: 242) classified teaching methods into three categories of presenting, exemplifying and enabling. He further pointed out that each one of them has either a positive or a negative tone for a specific goal. This may also be true for attitude development. Eichinger (1992), in an attempt to collect and analyse the perceptions of university students regarding their
formal experience in junior and high schools, discovered that these students favoured classes that offered laboratory work, teacher demonstration, projects and the use of audiovisual materials.

Contradictory views exist on which one of either teaching methods or the nature of the subject is more important for facilitating or inhibiting learning. In their study to investigate pupils' attitudes towards Physics, Ahlgren and Walberg (1973: 187) suggested that the popularity of Physics and pupils' achievements in it were, in part, more highly influenced by its teaching than its nature. Anderson (Randhawa and Fu 1973: 304) also stated that the quality of an educational experience is less closely related to the content of the subject matter learned than to the method or process of learning. In his review on styles of teaching and their influence upon the interest of pupils in Science, Hornsby-Smith (1973: 812) also suggested teaching styles as a more important variable than the subject matter in determining pupil outcomes.

However, several researchers have reported a positive relationship between pupils' aversion for Science courses and their perceptions of the nature of Science and scientists (Ahlgren and Walberg 1973: 187). In a study to investigate the causes of pupils' choice of Science, Kelly (Meyer 1963: 21) concluded that within the school, it was the nature of the subject rather than the teacher and fellow pupils which had the greater influence. For instance, researchers have reported no significant differences among a variety of teaching methods in relation to their influence on pupils' attitudes and achievement (Oliver 1965: 289). Instead, some methods were seen as more superior than others in eliciting and facilitating the development of a variety of behaviour among pupils.

Nevertheless, the superiority or inferiority of different methods was regarded by Head (Stutton and Haysom 1974: 67) as important in providing information which
could help the teacher develop and modify his own teaching style. The selection and adaptation of teaching methods were seen by Hofwolt (Holdzkom and Lutz 1989: 51) as also highly dependent upon an instructional system such as team-teaching. This is because each instructional system was capable of providing the teacher with a framework that could accommodate a variety of instructional strategies.

Numerous research studies have been conducted to investigate the influence of selected teaching strategies at a time, on pupils' attitudes and achievement. Kilpatrick (Rehage and Van Til 1976: 183) has emphasised the importance of pupils' involvement and pupil-centred learning through purposeful activity and intrinsic motivation. Teaching Science as a problem-solving process was reported by Pestel (1988: 30) to have a positive influence on pupils' feelings and attitudes towards the learning of Science.

In their investigation of the impact of activity-centred Science lessons on attitudes of the upper elementary school pupils towards Science, Story and Brown (1979) reported that pupils following the activity-centred lessons as enrichment exhibited more favourable attitudes towards Science than those following a textbook approach. Furthermore, it was indicated that carefully planned, yet supervised early exposure programmes for inexperienced teachers can produce a measurable benefit in terms of children's attitudes towards the study of Science and achievement in Science.

Brunkhorst (1992) also investigated whether the development of pupils' Science knowledge and attitudes towards Science, as well as its applications are related to an activity-based Science classroom. It was found from this study that pupils in classes where teachers involved them in a variety of activities, spent less time on testing and encouraged them to ask questions and to share ideas revealed to have
gained more knowledge and their attitudes towards Science were significant in relation to their learning environments. Pupils in these classes indicated that their learning environments developed their positive attitudes towards Science.

Ehud (Adey 1989: 285) conducted research to investigate the extent to which teachers insist on inculcating skills in the domain of critical/logical/analytical thinking with specific emphasis on judgment, process, cause and effect relationships, the evaluation of evidence and the validity of conclusions in their teaching. It was found from this study that the level of student (teachers') achievement on this test left much to be desired. Many teachers were shown to have no reasoning patterns which activity-centred science curricula seek to develop. As a result it was suspected that teachers force pupils to memorise blindly by imposing such material requiring abstract reasoning capacities they have not yet obtained and of which many of their teachers are themselves incapable. This led to negative attitudes towards Science in pupils.

Ebenezer and Zoller (1993) conducted research to assess standard ten pupils' perceptions of their classroom practices and activities, as well as their attitudes towards Science teaching and school Science. It was found from this study that pupils did not appreciate the contemporary classroom activities and practices. The classrooms were perceived as places for mainly copying notes, whereas pupils preferred teaching and learning in which they could take an active part. It was also found that the teaching style was the main determinant of attitudes towards Science teaching and school Science.

McMillan and May (1979) also assessed the perceptions of middle school pupils towards school influences on Science attitudes. The study was structured to probe the most important school-related determinants of liking or not liking Science, from the point of view of each student. Results of this study indicated that
pupils preferred class formats which stressed their active involvement and experience, such as hands-on-activities. The teacher was mentioned as a crucial variable in enhancing or inhibiting positive attitude formation. It was also found that females stressed the importance of "doing" more and indicated that this could enhance their liking of Science.

Lederman (1986) identified teacher behaviour and classroom climate which are related to changes in high school pupils' conceptions of the nature of Science. It was revealed by this research that those teachers who were rated as "high" by pupils outperformed their low-rated counter partners. Their dynamic behaviour and teaching influenced the development of problem-solving skills, low anxiety, interest and willingness of their pupils to be actively engaged. This was in contrast with colleagues who emphasised seat-work and an emphasis on rote memory in which case communication of the teacher's knowledge on the nature of scientific knowledge became the priority.

Teacher modelling in the teaching of Science was regarded as important in enhancing pupils' achievement process skills. Rubin and Norman (1992), investigated the effectiveness of a systematic modelling approach on achievement of integrated Science skills and formal reasoning ability of middle school Science students. Results of this study revealed that pupils exposed to this approach demonstrated greater integrated process skills than those exposed to a cyclic or traditional methodology. However, those pupils who experienced cyclic or traditional methodology in integrated process skills achieved better and had more positive attitudes towards Science when taught by teachers who received Science process instruction. Both groups of pupils whose teachers participated in classes which emphasised Science process skills demonstrated greater achievement and more positive attitudes than those whose teachers did not.
Saunders and Dickinson (1979) compared the effects of lecture-only and lecture-laboratory methods of instruction upon cognitive and affective pupil outcomes in a general Biology course. From this study, it was shown that pupils exposed to lecture-laboratory and lecture recitation methods learned more Biology and acquired more positive attitudes towards Science than those exposed to the lecture-only method. Increased instructional time, active student participation and involvement in learning activity, student freedom of expression and small class size were found to account for increased mean achievement and attitude scores.

Kahn (1962) investigated the effects of a selected procedure applied to the teaching of current events in Science upon the development of scientific attitudes of the standard five and six boys in New York City. The null-hypothesis tested was that there would be no significant difference between groups within the experiment. Findings from this study showed that standard six boys who experienced training in scientific attitudes scored higher on tests of scientific attitudes than the others. The significant gain in positive scientific attitudes achieved by the experimental group over the control group was retained for a period of over four months without further training. The low-reading ability standard sixes in the experimental group showed significant reading gains as did the high-reading ability students. Pupils of low intelligence also showed a considerable development of scientific attitudes approximating that of the high mental ability experimental subgroup. A large majority in the experimental group for both the standard five and six pupils said they were in favour of the procedure and were of the opinion that it caused a favourable change in their thinking.

The use of computers and videodisk materials has been reported to influence students' attitudes and learning of Science. Hounshell and Hill (1989) examined the impact of computer-loaded Biology courses on pupils' achievement and
attitudes towards Science. Subjects of this study were randomly assigned both to the experimental and control groups. From this research, it was found that the experimental group outperformed the control group in both the first and second questions investigated. They concluded that a computer-loaded Biology curriculum offered promise for secondary education with regard to achievement and the development of positive attitudes towards Science.

Another study involved the use of computers. Faryniarz and Lockwood (1992) investigated the effectiveness of microcomputer simulations in stimulating environmental problem-solving by tertiary students. The statistical analysis of the results indicated a highly significant improvement in attitude for the experimental group. Environmental problem-solving was shown to improve with students' opportunity to use computer simulations.

Marverech and Rich (1985) also determined whether computer assisted instruction, as a supplement to traditional Mathematics instruction fostered gains for the disadvantaged primary school pupils in the affective and cognitive domains. Pupil gender was included as a moderator variable. In addition to Mathematics achievement, the effects of computer assisted instruction on pupils' self-concept and perceptions of school life were investigated. Results of this study revealed significant differences between computer-assisted instruction and traditional instruction groups. At all standards, pupils in the experimental group scored higher on Arithmetic tests than did pupils receiving traditional instruction only. The experimental group pupils rated themselves higher on self-concept than their counter partners. More important, they also expressed more positive attitudes towards their schooling than the control group pupils. However, no significant difference was found between the two genders.
Vitale and Romance (1992) investigated whether the use of videodisk technology to remediate core concept knowledge deficiencies of pre-service teachers in the areas of physical and earth sciences also fostered the development of positive attitudes towards Science teaching. Subjects in this study were assigned both to the experimental and control groups. From this study, it was found that subjects in both groups exhibited knowledge deficiencies on core concepts pre- and post-tests. However, after completion of the course, the experimental group exhibited a higher degree of mastery than the control group. They also had more positive attitudes towards Science than the control group subjects.

Holdzkom and Lutz (1989) investigated the teachers' instructional methods in the classroom to determine whether other methods existed that would be more effective than what teachers were using. Results of this study indicated that the predominant methods of teaching observed were recitation and lecturing, with the textbook providing any source of information. The textbook dictated the course content, mode of instruction and evaluation. Demonstrations, pupils' reports, and projects were infrequently used. Pupils were rarely engaged in activities for which the answers were not prescribed by the textbook. In this way, their inquiry skills were not developed. The main aim of teaching in such classes was the preparation of students for the next grade, with evaluation emphasising definitions and knowledge dimensions. This inhibited the development of positive attitudes towards Science.

Similar findings were reported by Wise and Okey (Holdzkom and Lutz 1989: 74). These researchers analysed research reports to give a description of a typical or traditional classroom. It was found that pupils were not made aware of the instructional objectives. Most of the questions asked in such classrooms were posed by the teacher, were primarily fact orientated and did not reflect any preplanning on the part of the teacher. Pupils had no opportunity to manipulate
materials or plan activities that interested them. The teacher followed the
textbook in general and was in control of it. Lecture and discussion were
teaching methods frequently used, with evaluation being summative for the
purpose of reporting pupils' progress only.

Gottfried and Kyle (1992) observed and documented the teachers' classroom
practices in the context of textbook orientation. The aim of this research was to
ascertain if the teacher's textbook use reveals relationships between factors
indicative of the Biology education desired state or actual state criteria. The same
study also sought to identify factors other than textbook orientation such as
philosophy, personality traits, or instructional style that might enable them to
align themselves better with the Biology education desired state criterion.
Findings from this study revealed that the classroom environment in each one of
the categories of textbook-centred, multiple-reference, and the neutral group of
teachers were less than desirable. The majority of teachers was found to function
as passive and uncritical technicians who were ready and willing to disseminate
knowledge in an authoritarian fashion. It was also found that these teachers
lacked the philosophical underpinning, psychological basis or civic rigour
requisite for engaging in activities that would transform classroom activities to
bear relevance upon public spheres in which pupils live.

Avertson et al (1980) conducted research to investigate how effective middle
school English and Mathematics teachers taught and what their classes were like.
Findings from this study revealed that seatwork, lecture demonstration, and class
discussions were popular in these classes. More contacts among pupils, as a result
of class discussions made pupils more active. However, this was more common
particularly in Mathematics classes than in English classes. Pupils, particularly in
English classes, showed preference for teachers who used self-paced work.
Positive relationships were also found between achievement and the kind of
higher order process questions asked, with a significant relationship between these questions and pupils' attitudes. Pupils who were called to volunteer had more positive attitudes than those forced to. Feedback in the form of praise was positively associated with pupils' achievements. Whole class involvement correlated positively with pupils' attitudes. Acceptance of pupils' ideas and contributions during lessons improved their self-confidence. These findings may also be true for Biology classes.

Lederman and Drager (1985) conducted research to test the hypotheses that:

(1) the teachers' understanding of the nature of Science in, and of itself is positively related to the conceptions of the nature of Science by their pupils,

(2) certain classroom variables are significantly related to pupils' conceptions of the nature of Science.

Results of this study did not support the first hypothesis as such. Therefore, these researchers concluded that teachers do not necessarily pass on their conception of Science to pupils by any mystical process nor do their conceptions of Science necessarily determine behaviour in their classrooms. However, for the second hypothesis, it was found that teachers/classes in the higher-ability group were warmer than those in the low-ability group. They were found to be open and used a variety of instructional media. The pupils frequently asked questions and were more able to relate content to their own personal lives. Successful classes were often typified by, among others, methods of inquiry and problem-solving. This resulted in positive attitudes towards Science.

Kelly (1959) investigated factors which influenced pupils to prefer scientific subjects in order to gain information about the attitudes of school pupils when
they take a scientifically based curriculum. The study also compared the attitudes of these pupils with those who chose to specialise in other subjects using questionnaires and interviews. From this study, a significant difference was found between the Science and non-Science majors. Pupils who chose to specialise in Science had long-standing, stable attitudes towards Science. Their choice of Science and attitudes towards Science were found to be strongly influenced by the nature of the subjects, teaching and the school environment.

The purpose of the research conducted by Gardner (1976) was to measure the attitudes of pupils towards various aspects of a high school Physics course, and to relate these attitudes to various pupil personality characteristics and teacher characteristics. Results of this study have indicated that the pupils' initial attitudes are the best single predictor of their final attitudes. Pupils high on achievement and understanding were shown to have more favourable attitudes towards non-authoritarian modes of learning and expressed greater enjoyment of Physics. Pupils who experienced their teachers as well-organised, intellectual and stimulating enjoyed Physics more. It was also revealed that teachers who stress success and examination performance are less likely to maintain the highly open attitudes that students had on entry to the course.

Hacker and Carter (1987) quantified teaching processes found in Social Studies classrooms. This was done in order to ascertain whether sufficient variance in style might exist in natural, intact classrooms to justify the possibility of using the prescriptive instructional theory in them. From cluster analysis, the social scientist, social inquirer and the knowledge transmitter were identified. The social scientist and social inquirer styles were found to emphasise problem-solving and higher order activities, use of multi media materials, making observations and interpreting and inferring from such observations. They were found to be process-orientated and emphasised intellectual and personal
development of the child for decision-making. It emphasised questioning and making statements with many speculations. The knowledge-transmitter style on the other hand, was found to put more emphasis on the acquisition of facts. Teachers with more teaching experience were found to be more inclined to use the social scientist and social inquirer styles or approaches in their teaching than the less experienced.

Pell (1982) conducted research to investigate the factors influencing pupils' choice of Physics at the GCE A-level in Britain. After cluster analysis, four groups of teachers were identified. These were: process-orientated Science teachers, planned experimental laboratory group, preferred teaching group and routine teachers. Results of this study revealed that for the learning by experiment and enjoyment, enjoyment more strongly correlated with attitudes for girls than for boys. Enjoyment was also found to predict attainment in Physics. Classes in which teachers emphasised a pupil centred/textbook style were poorly rated by pupils in favour of a teacher-centred/note-making style method. The varied teaching for understanding method was strongly associated with high match scores and positive attitudes towards the subject.

2.3.1.3 Teacher personality, attitudes, enthusiasm and pupils' attitudes towards Science

Teacher personality has often been linked with teacher effectiveness. Starring, Kelly and Pheasant (Ormerod and Duckworth 1975: 74) have emphasised effective teaching as the most important and influential variable in Science interest and attitudes. That the teacher's behaviour, knowledge of his subject and pupils, his style of teaching and attitudes play an important role in the teaching-learning situation has been reiterated by researchers (Fontana 1988; Ebenezer and Zoller 1993: 184; Eggleston et al 1976: 24).
One of the earliest extensive studies of the relationship between teacher effectiveness and teacher personality was conducted by Ryans in the USA (Fontana 1988: 346). From the Teacher Characteristics Rating scale, Ryans found that successful teachers tended to be warm, understanding, friendly, responsible, systematic, imaginative and enthusiastic. Rosenshine and associates (Fontana 1988: 347; Randhawa and Fu 1973: 308) suggested a positive relationship between successful teaching and an uncritical approach to pupils. According to these researchers, pupils of low self esteem, who are frequently criticised by their teachers, lose confidence in their abilities and will consequently under achieve and develop negative attitudes. Whereas pupils who are allowed to find what could be described as their own level had less anxiety than those who were pressurised by teachers to come up to a certain standard. Successful teachers are also linked with proper lesson preparation, devoted time in out-of-school activities and interest in their pupils as individuals.

Important causal relationships have been reported to exist between most of the characteristics composing the personality of the teacher on the one hand, and pupils' achievement and attitudes, on the other hand. According to Walberg (1969b: 168), the personality patterns of the teacher, his needs, values and attitudes predict the climate of his classes. Rosenshine and Furst (Fraser 1986: 63) maintained that pupil learning is associated with clarity, variability of teaching methods and materials, enthusiasm, task-orientated behaviour, indirectness, pupil opportunity to learn, teacher use of structuring comments, multiple levels of questioning and discourse and teacher criticism. In their study to investigate how effective English and Mathematics teachers taught, Avertson et al (1980) discovered that task-orientated, competent, confident, academically effective, and student-orientated teachers were rated high by their pupils. In other words, if teachers have confidence in themselves, their behaviour is such that they, and possibly the subjects they teach, are experienced positively by pupils.
Hamaceck (Stutton and Haysom 1974: 56), in an attempt to relate teacher effectiveness with his personal characteristics concluded that effective teachers are those perceived by their pupils as human, humorous, fair, empathetic, more democratic than autocratic and apparently more able to relate easily and naturally with pupils. Jegede (1989) assessed the teacher's classroom characteristics, behaviour, personality and attitudes as perceived by their pupils for effective teaching. The study revealed that factors such as knowledge, organisation, planning, preparation, confidence and openness were seen by pupils as important in characterising an effective Science teacher.

Another study by Eichinger (1992) which was aimed at collecting and analysing the perceptions of university Science students regarding their formal Science experience in junior and high schools showed that students preferred teachers who were friendly, enthusiastic, knowledgeable, inspirational and fun. This, in turn promote the development of positive attitudes towards Science (and Biology).

Rothman et al (1969) investigated the relationships between teacher training, teacher experience, teacher attitudes towards teaching, teacher personality, teacher values, pupil achievement, interest in understanding Science and attitudes towards Physics. From this study, strong correlations were found between teacher personality and values with pupils' achievements in Physics as well as attitudes towards Physics and Science. However teacher preparation/training, knowledge of Physics and teaching experience were not significantly related to pupils' achievement and attitudes towards Physics.

Lawrenz (1975) investigated the influence of the teacher's knowledge of the subject matter, teaching methods, teaching experience, attitudes towards Science, professional self improvement and the type of learning environment on pupil
outcomes. It was found as a result that, among others, such teacher characteristics as formality and self-improvement correlated significantly with pupils' achievements and attitudes towards Science.

Research on teacher enthusiasm and pupils' learning is very scarce. The available literature on this variable concentrated more on Social Studies than on Science. Research on the effects of this factor was prompted by an assumption that enthusiastic teachers are more effective than unenthusiastic teachers and that students give enthusiastic teachers higher evaluations than unenthusiastic teachers (Larkins and McKinney 1982: 27). Contradictory research results on this aspect were reported in 1963 and 1979 by Mastin and Bettencourt respectively.

In 1982, Larkins and McKinney conducted two research studies:

(1) They wanted to determine whether teacher enthusiasm would produce corresponding differences in Social Studies achievement for the standard five pupils in intact classes. The same study also sought to determine whether pupils perceived differences in teacher enthusiasm and whether those differences affected their attitudes. It was hypothesised that an increase in teacher enthusiasm would produce increased pupil achievement and positive attitude development. (Subjects were exposed to high, normal and lethargic levels of enthusiasm treatments.)

(2) They also wanted to determine whether results of the first study would replicate using the same procedure and subjects as in the first study except that subjects were randomly assigned to the different treatment levels.

The results of the first study revealed no significant influence of the high (enthusiastic) treatment on pupils' achievement and attitudes. The normal and lethargic treatments seemed to account for much of the variance in pupils' achievement and attitudes towards Social Studies and Social Studies instruction.
The aforementioned results contrasted with those reported by Sneed and Malcolm in 1977 (Larkins and McKinney 1982: 29 30). Results of the second study revealed that Social Studies achievements did not replicate. In each comparison, the enthusiastic treatment group scored significantly greater than the normal and low treatment group. However, no significant difference in achievement was found between the high and normal treatment groups.

McKinney and Larkins (1983) also conducted another research to examine the effect of teacher enthusiasm on pupils' achievements in standard two Social Studies, and the ability of teachers to exhibit inter-teacher enthusiasm. Results of this study indicated that the teacher's level of enthusiasm did not affect achievement in Social Studies. Teachers in the high-enthusiasm group were found to exhibit increased classroom management problems because children exposed to high enthusiasm were overexcited. On the other hand, those in the low enthusiasm group exhibited boredom. From these results, the researchers concluded that children in primary school appeared to behave more appropriately when teachers conveyed a medium level of enthusiasm. However, enthusiasm positively influenced attitudes.

Jolly and Strawitz (1984) designed a study to investigate the effect of teacher-pupil cognitive style matching and mismatching on pupil achievement and attitude. It was hypothesised that a cognitive match between pupils and teachers leads to higher achievement and the development of positive attitudes. The results of analysis of covariance (ANCOVA) revealed significant main effect favouring field independent (FI) teachers and pupils. However FI pupils achieved significantly higher than field-dependent (FD) pupils with both FI and FD teachers. The FD pupils achieved higher with FI than with FD teachers. These results negated those of Witkins and his associates who found more positive effects on achievements and attitudes between matched than between mismatched cognitive styles of teachers and pupils.
Harvey et al (1968) conducted research to assess the relationship between pupils' performance and attitudes, as well as teacher resourcefulness, authoritarianism and punitiveness. The study also tested the replicability of the previous findings that concrete and abstract orientated teachers differed in the kinds of classroom behaviour they manifested. It was found from this study that pupils of more abstract teachers, as compared to pupils of the concrete orientated teachers, were significantly more involved in classroom activities, more active, higher in achievement and less concrete in their responses. They were less nurturant seeking, more cooperative and helpful than those of concrete teachers. The teachers' scores on the abstractness measure and on each of the three factors correlated with each of the seven factors from pupil rating scales. A significantly positive correlation was found to exist between teacher resourcefulness and all the seven pupil factors. On the other hand, a significantly negative correlation was found between the seven factors and teacher punitiveness and authoritarianism.

In summary: teachers who are enthusiastic about their teaching so that they are resourceful, tend to have pupils who have positive attitudes towards their courses

2.3.2 Factors associated with the pupils

2.3.2.1 Introduction

It is felt that for effective education in general, and Science curriculum design in particular, the child as a learner, should be of central concern. Yager and Penick (1984: 143) have emphasised the importance of placing the child in the forefront thereby giving due consideration both to his affective and cognitive domains.
Much research has been conducted to determine which factors pertaining to the child himself influence his attitudes towards Science. Many of these studies have revealed causal relationships between pupils' exposure to Science (Cannon and Simpson 1985), choice of Science and future specialisation (Tilford 1971; Novick and Duvdevani 1976; Gogolin and Swartz 1992; Perrodin 1966), perceptions of Science and scientists (Haladyna et al 1983; Yager and Penick 1984 and 1986; Lawrenz 1976), gender, grade, ability and age level (Jolly and Strawitz 1984; Cannon and Simpson 1985; Haladyna et al 1983), interest, enjoyment and motivation (Pell 1985; Cannon and Simpson 1985), socio-cultural background (Jegede and Okebukola 1992) and their achievements and attitudes towards Science. Some of these aspects will be discussed and their relationship with Science (Biology) heightened.

2.3.2.2 Gender and attitude towards Science (Biology)

Duckworth and Entwistle (1974) determined pupils' attitudes to school subjects. The dimensions of interest, difficulty, freedom and social benefits were isolated. Rank orders of mean scores of pupils on the four scales were produced together with their inter-correlations indicating the extent to which attitudes were specific to particular subjects. The majority of the relationships found were significantly more positive with interest and more negative with difficulty of the subject. For all the four dimensions, Biology was more positively rated by pupils than Chemistry and Physics, with slight gender influences in favour of girls.

The results of a survey of pupils' enjoyment of Physics were presented by Pell (1985). From analysis of the results of gender, achievement in Physics and a type A-level course, it was found that boys displayed superior enjoyment of Physics in both the fifth- and lower sixth-forms. However, this superiority disappeared by the end of the sixth-form year. The study also revealed that girls who reached
the sixth-form and who still enjoyed Physics, had recognised the nature of the subject and the part experimental work played in it. Pupil involvement was found to be closely related to enjoyment, with stronger relationships for girls. The materials of the London General Certificate Education (GCE) examination seemed to enhance the affective outcomes of the sixth-form course.

Ormerod (1971) investigated the social implications factor in attitudes towards Science. This was done in order to establish the relationship between this factor and the option for or against Science by boys and girls of 13 to 14 years of age. Results of this study revealed that more than four times as much of the variance in pupils' attitudes was accounted for by the nature of the subject itself rather than its social implications. However, although not statistically significant, higher correlations of social and preference scores were found in favour of girls. Enrolling in more Science subjects was seen as a truer underlying motivation for or against the choice of Science than a preference score. No relationship was established between social scores and Science options for boys and girls. The relationship between attitude and Science options was found to be influenced by gender differences, with girls being more restrained in making Science options than boys.

In a study to uncover gender differences in factors contributing to Science interest, Martinez (1992) concluded that gender-related interactions with interest value of school Science can, if modified, influence pupils' attitudes towards Science and subsequent choices concerning Science involvement. This study also revealed that boys and girls differed significantly in their self-reported intrinsic interest of the experimental procedures regardless of interest enhancement. It indicated that girls were generally more responsive than boys in experiments which were of more social appeal. However, this finding contradicted that of Ormerod (1971) who found no significant difference between the two genders for
the relationship between social scores and Science options. Thus the researcher concluded that the more interesting Science experiments are, the more likely are they to enhance attitudes of students of both genders towards Science.

Meyer (1963) conducted research to investigate the influence of some home-independent factors (pupil gender, age and grade, preferences and knowledge of academic sciences and school type), and home-dependent factors on pupils' attitudes towards Science. Findings from this study revealed that, although of a borderline significance, boys displayed more positive attitudes towards Science than girls. Further analysis of Science interests revealed a highly significant difference between boys' and girls' preferences for Biology and Physical Science, indicating that boys preferred Physical Science more than Biology. Gender differences were also associated with pupils' scientific knowledge.

Jegede and Okebukola (1992) conducted research to examine how secondary school boys and girls in Nigeria perceived the socio-cultural environment in their science classes. The study focussed on the five scales of authoritarianism, goal structure, African world-view, societal expectation and sacredness of Science. Results of this investigation revealed that pupils, irrespective of their gender, perceived the socio-cultural environment of their classrooms in more or less the same way, suggesting that culture is homogeneous for individuals in a homogeneous group. Boys obtained higher mean scores on authoritarianism while the means for girls out-scored those for boys in the other subscales. A highly significant gender difference in societal expectation was found to favour girls. This further suggested that girls were not recognised as scientists with the result that their self-concept and attitude development towards Science were hampered.

Another study conducted by Novick and Duvdvani (1976) attempted to assess the relative level of general scientific attitudes held by the standard eight pupils in a
stratified random sample of Israeli high schools. It was designed to reveal the effects of variables such as school type, future specialisation, curriculum, gender, achievement level and cultural background on pupils' attitudes towards Science. It was hypothesised that both school and student variables are likely to influence students' attitudes towards Science. Data were gathered using the Science Attitude Inventory (to measure both the intellectual and emotional attitudes), and a questionnaire (to gather information on all dependent variables). The results of this study revealed that school type and pupils' cultural background correlated significantly with emotional attitudes towards Science. Gender did not correlate with the scientific attitudes of pupils towards Science. However, the interaction between gender and school type influenced pupils' intellectual attitudes; with boys holding more positive attitudes towards Science than girls. Achievement level and gender-achievement level interaction influenced pupils' intellectual attitudes towards Science more than the effect of future specialisation. Gender was found to be influential in the academic population where boys assumed more positive emotional attitudes than girls. Achievement levels influenced both intellectual and emotional attitudes. The curriculum was more influential with respect to intellectual attitudes, with girls showing more positive attitudes towards traditional curricula.

2.3.2.3 Age and attitude towards science (Biology)

Although some tendency of improved attitudes towards Biology with age were eminent, the link was not significant. Instead, a significant link existed between age and preference for Science. This contradicted findings with pupils in London and was seen as being influenced by the pupils' increased mental sophistication. However, no significant relationship was found between age or academic grade with preferences for either Biology or Physical Science, although there was a link between age and general scientific knowledge. There was no significant
relationship between pupils' attitudes towards Science and the type of school. Home-dependent factors were found to be related to pupils' attitudes towards Science (Meyer, 1963).

Yager and Penick (1986), conducted research to examine the perceptions of four age group pupils of their Science classes, teachers and the value of Science. Findings from this study revealed a trend of pupils' deteriorating attitudes with increased age for all variables. It was also found that in each case, the nine-year-old pupils were more positive about their Science classes, teachers and the value of Science. However, decrease in the perception of the three variables increased with age, with the young adults being the least appreciative.

Hadden and Johnstone (1983) conducted research as a follow-up study to their investigation of the attitudes of primary school pupils towards Science. The main aim of this study therefore, was to detect whether pupils' attitudes to Science, Geography and Mathematics changed during the first year of their secondary school. The study also sought to determine whether the change was more marked in Science than in the other two subjects. Findings from this study revealed that pupils' attitudes towards Science at secondary school changed although such a change did not lead to Science as being completely unfavourable. The overall erosion of pupils' attitudes towards Science, however, was seen to have been greater for girls than for boys. Pupils' attitudes towards the importance of Arithmetic and Mathematics were found to have been more improved than eroded by the time they were in secondary school.

2.3.2.4 Pupils' perceptions of their Biology classes and attitudes towards Biology

Yager and Penick (1984) reported the results of research carried over two decades on pupils' perceptions, opinions and interpretations regarding their classroom,
study of Science and their teachers. The results of this study revealed that in concurrence with the results of the study carried in 1978, teachers were viewed as prescriptive. Teachers chose topics for pupils and consequently, very few perceived they had any input in determining content and the way they were taught Science. They did not have much to say in determining the order of Science topics considered apart from the textbook. However, middle school pupils reported being able to study Science at their own pace much more than those in a high school. Concerning their views on teacher actions in their classes, under half of them felt that teachers encouraged them to state their opinions. Approximately half of the pupils reported that Science teachers rarely or never admitted that they did not know everything about Science. Very few teachers were reported as taking much personal interest in their pupils. Very few pupils also reported that what they learned in Science classes had any relevance to the real world. They also indicated that they had little satisfaction from their Science classes. The classes were characterised as dull, no fun and not as a place where they wanted to be found.

Gogolin and Swartz (1992) conducted research to investigate attitudes towards Science of the non-Science pupils. The study was carried out in order to determine:

1. how the attitudes towards Science of non-Science pupils compared with those of Science majors

2. whether attitudes towards Science changed with instruction and

3. what developmental experiences were associated with attitudes towards Science.
The results of this study revealed a significant difference between non-Science and Science majors in their pretest attitudes towards Science. The Science pupils also showed a significantly lower level of anxiety than the non-Science students when confronted with Science-related material. However, after taking a Science course, the attitudes of both groups changed significantly, although the statistical mean scores differed in favour of the science majors. Results of the interviews with the non-Science pupils indicated that the majority of them came from backgrounds of low science interest which had implications for the development of their attitudes towards Science. They had no background in Science experience. Although most of the non-Science pupils gained insight into the importance of Science and acquired a positive respect for it, the classroom did not foster an interest in Science. Their enjoyment of Science seemed to wane as they proceeded through the standards. Several students related their Science experiences to feelings of boredom. This stemmed from what they considered to be meaningless memorisations. Some pupils had negative experiences with teachers which both contributed to feelings of anxiety and confusion, and affected their ability to understand Science.

Walberg (1969a) conducted research to investigate some hypotheses concerning pupil backgrounds, personality and intelligence and the learning of Physics. Results of this study revealed that of many variables investigated, only classroom climate, biographical and miscellaneous variables were significant predictors of the learning of Physics and therefore attitudes towards Science. The biographical variables alone were also found to be better predictors of the non-cognitive learning outcomes than the learning environment variables.
2.3.2.5 Pupils previous Science (Biology) experience

Gayford (1988) investigated the expectations, experiences and attitudes of 16 year old pupils studying Biology or Human Biology in the United Kingdom. It was hypothesised that the type of learning experience pupils had at that stage would strongly influence their attitudes towards Science.

Results of this investigation indicated that of the two types of courses, pupils had more positive attitudes towards Human Biology. They thought it offered greater opportunities than Biology. It was also seen as a course which was more related to life outside school than Biology. However, in both courses, it was found that taking notes and remembering things with few opportunities for self-expression were emphasised. Subjects following Human Biology were found not to prefer scientific subjects. Activities going on in Science classes did not appeal to Human Biology pupils while the opposite was true for Biology pupils. Both groups desired a high level of relevance in their subjects.

*In summary:* if previous experience of Biology proved to pupils that what they learn in Biology is relevant to them, their attitudes towards Biology will improve.

2.3.2.6 Career goals and attitudes towards Science (Biology)

Crawley and Black (1992) investigated the utility of the theory of planned behaviour for understanding and predicting the Physics course enrolment intentions of secondary school Science pupils. It was found from this study that pupils' intentions to enrol in Physics were determined by their attitudes towards Physics. Grade level, and more importantly career goals, were found to be influential in shaping pupils' attitudes towards Science.
Butcher (1969) conducted research to determine who were potential pupils by assessing the psychological and sociological factors affecting successful degrees of subject specialisation using 1000 Scottish pupils in secondary schools. The kind of measures employed fell into pupil, school and home variables. Differing curricula, teacher qualifications, laboratory facilities, attitudes of head teachers and other teachers as variables, were assessed using interviews and questionnaires. The home variables assessed were parental encouragement and the extent of educational advantage and disadvantage from the home. The pupil variables included their ability level, school achievement, general interests, degree of interest and biographical factors. Findings from this study revealed that apart from pupils' ability and personality, career goals, were found to account for much of the variance in pupils' attitudes and their choice of Science.

2.3.2.7 Home background and attitudes towards Science (Biology)

Meyer and Penfold (1961) conducted research to determine the statistical relationships between interest in Science and the variables representing factors in school and the home. The study involved 150 pupils. Information about the parents was gathered through the social status of the father's occupation rating scale. It was found from this study that no relationship existed between the father’s occupation and his child’s degree of scientific interest. On the other hand, a Physical Science course was found to elicit more interest in pupils than Biology.

The purpose of research conducted by Fraser (1992) was aimed at describing criteria to guide the selection, modification, and validation of scales for curriculum evaluation. Results of this study revealed that the instructional treatment was significantly related to scores on the social implications of Science and enjoyment of Science lessons. Apart from that, pupils of higher Science Environment Scales were found to express more favourable attitudes than pupils
of lower Science Environment Scales. In other words, pupils from homes where there is stimulation for Science have more positive attitudes towards Science. As Biology is part of the field of the Natural Sciences, this may be true for Biology as well.

Tilford (1971) conducted research to identify some of the characteristics of Negro university students who were Science majors and what influenced their choice of Science, achievement in Science and attitudes towards Science. It was found from this study that the choice of Science was not affected by the high school Science activity. The choice of Science through the influence of the family was significantly different for pure Science majors, applied Science majors and non-Science majors.

Keeves (1975) investigated the ways in which characteristics of the educational learning environment of the teacher, school and peer group accounted for change in performance at school over a period of one year in which the sample of children progressed from primary school to high school. A hypothesis for the study was that there would be a distinct change in educational outcomes since pupils would be transferring from primary to a high school environment. From analysis of Science data, it was found that pupils' attitudes regarding school and learning were related to the parents' attitudes towards the child's education. Pupil gender was found to influence parents' attitudes, with stronger ambitions being expressed for the education of boys than girls. Hence, boys had more positive attitudes towards Mathematics and Science than girls. Home and initial pupils' attitudes towards Mathematics and Science made a significant statistical contribution towards pupils' final achievement in these subjects. Friends, as well as the teacher in the classroom setting, were also found to influence attitudes towards Mathematics and Science.
Simpson and Troots (1982) investigated adolescent pupils' commitment to Science and achievement in Science in the light of important individual, family and school influences. From this study, home commitment was found to correlate strongly with pupils' Science affective measures. However, a moderate correlation was revealed between self and school with achievement and attitudes towards Science.

2.3.2.8 Pupils' self-concept and motivation and attitude towards Science (Biology)

Hasan (1985) investigated the influence of instructional, pupil and home variables on attitudes towards Science of secondary school pupils in Jordan. Results from a multiple linear regression analysis revealed that seven variables contributed significantly to the variance in attitude towards Science scores. Of the seven variables studied, the inner motivational variable contributed 75 percent of the variance in attitude score. Pupils' perception of their Science ability correlated significantly with attitudes towards Science. In other words, pupils' self-concepts and intrinsic motivation may significantly influence attitude towards Biology.

2.3.2.9 Pupils' learning styles and attitudes towards Science (Biology)

Bou Jaoude (1992) conducted research to investigate the relationship between high school pupils' learning approaches, prior knowledge and attitudes towards Chemistry and their performance on a misconceptions test. The study also sought to describe and analyse the differences between the responses of pupils with different learning approaches on the same test. The results showed that the meaningful learners performed significantly better and had more positive attitudes towards Chemistry than the rote learners. This suggested, according to the researcher, that meaningful learners are better able to use information they acquired to correct their misconceptions. This accounted for much of their improved attitudes towards Chemistry.
Hug (1970) conducted research to investigate the influence of independent study on pupils' attitudes. Results of this study showed that pupils believed they learned more in independent study classes and had more improved study habits than in any other class, even if the work was not challenging. They believed that the work was interesting and had developed their thinking ability more than in any other classes. An independent study programme which included programmed instruction, library usage, discussion and quiet work areas could therefore improve pupils' attitudes towards their work and towards Biology.

2.3.2.10 Achievement in Science (Biology) and attitude towards Science (Biology)

Hough et al (1982) conducted research to investigate the relationship between attitudes towards Science and Science achievement using residualized gain scores. A significant relationship was found to exist between the pupils' residualized gain scores on the Hough Pupil Process Test and their residualized gain scores on the Hough Attitude Inventory. This suggests that pupils with significantly high Science achievements also had significantly high positive attitudes towards Science.

Apart from factors associated with pupils, curricular aspects may also influence attitudes towards Biology. These will now be explained.

2.3.3 Factors associated with the curriculum

Talton and Simpson (1987) conducted research to investigate the relationships between attitude towards and achievement in Science among standard eight Biology pupils. It was hypothesised that the characteristics of teachers, peers, and classroom environment affect pupils' affective and cognitive outcomes. It was found from this study that of all the classroom environment variables, curricula,
teachers, other pupils and friends were significantly correlated with attitudes towards Science throughout the school year. Of all these variables, the curriculum showed the strongest correlation with attitudes towards Science.

Cannon and Simpson (1985) conducted research to investigate if standard five pupils assigned to three different ability groups demonstrated different achievement levels and attitudes towards Science. The study also sought to examine where differences occurred, the strength of the various relationships and the extent to which one variable could be predicted by others. The results of this study revealed that attitudes towards Science for all pupils were more positive at the beginning of the year than at the end. Pupils in the advanced group revealed more positive attitudes throughout the year than the basic group. For all pupils, attitudes towards Science became less positive during the year. Changes in pupils' achievement motivation were similar to changes in their attitudes. In the beginning, pupils were more motivated to achieve than at the end, with the advanced group being the most motivated followed by the basic and the general groups respectively. Thus these researchers concluded that irrelevant curricula, (apart from ineffective teaching methods and inhibiting classroom environments), were responsible for decreased achievement and motivation towards Science, as well as the development of negative attitudes towards Science.

Ben-Peretz and Silberstein (1982) conducted research to sketch out a preliminary outline of a "Natural" model of curriculum development based on an examination of case studies in Science. This had to be done by examining the nature of curricular decision-making at two levels relating to external curriculum developers and teachers as curriculum users respectively. It was found from this study that the curriculum developers and users differed significantly in their interpretation of curricular restraints, intentions and implementation possibilities. These differences were seen as contributory to a mis-matched transformation of
the curriculum material to pupils, which would cause pupils develop estranged feelings towards the material. Hence pupils developed negative attitudes towards Science.

Kempa and Dube (1974) conducted research to measure the difference in attitudes brought about by two curricular approaches of the Nuffield and non-Nuffield study schemes. It was found from this investigation that non-Nuffield Chemistry courses encouraged the development of positive Science interest and attitude characteristics more strongly than the Nuffield Chemistry courses. These findings contradicted those disclosed by Meyer in favour of the Nuffield courses. A significant difference was found between Science interests and attitudes and academic achievement. Although weak, further analyses for achievement categories showed a strong relationship between the affective measures and academic achievement in Chemistry despite curricular differences. It was also found that the academically weak pupils, who were not capable of coping with the conceptual content of the course, derived some satisfaction from acquiring just its factual content. Inclusion of a reasonable amount of factual content in the curriculum was seen as important in enhancing positive attitudes, especially of low-ability pupils.

Milson (1972) conducted research to develop and evaluate Physical Science curriculum material which would produce positive attitudes towards Science instruction when used with the below-average secondary school pupils. No significant statistical difference was found between initial and final levels of attitudes for the control group. At the same time, a consistent pattern of negative change from pre-test to post-test of the means was found in this group. Positive attitude changes were found within the experimental group pupils after the presentation of the new curriculum material.
This indicates that the curriculum material may influence pupils' attitudes towards Biology.

2.3.4 School or classroom environment and pupils' attitudes towards Science (Biology)

2.3.4.1 Introduction

The concepts school and classroom environments have been defined in Chapter one. School environment was defined by Fraser (1989: 9) as the sum of the classroom environments within the school. The classroom environment on the other hand was defined by Myers and Fouts (1992: 930) as a unique interactive combination of teacher behaviour, curriculum expectations, and pupil-to-pupil interactions. The school environment is assessed in terms of the teacher's perceptions while that of the classroom is based on the perceptions of the pupil. In the present study, the classroom environment will be referred to more often than the school environment.

Research on classroom environments is based primarily on Murray's needs-press theory and Getzels and Thelen model of the classroom as a social system (Fraser 1989: 6; Myers and Fouts 1992: 930; Walberg 1968: 247; Randhawa and Fu 1973: 312-313). Murray's theory emphasised the personal needs and environmental press as important in enhancing pupil learning outcomes. Much research along this line has been conducted (Fraser 1989: 150-167). According to Lewin and Walberg (Randhawa and Fu 1973: 303), the student's behaviour is the result of the person and the environment and any variance in his performance is influenced both by him and the environment in which he finds himself. The Getzels and Thelen model on the other hand, holds that interactions between personalities, needs, role expectations and classroom environments are better predictors of pupil's behaviour and learning outcomes.
Consequently, numerous research that followed was based on Murray's needs-press theory and Getzels and Thelen model of viewing the classroom as a unit. For instance, a series of research and evaluation studies have used these theories as a basis for examining classroom environments (Randhawa 1973: 313; Talton and Simpson 1987: 508).

Literature accumulated over the past years has affirmed the notion that an appreciable amount of learning outcome variance can be attributed to the environment in which teaching and learning take place (Jegede and Okebukola 1992: 637), as well as student perceptions of such an environment (Fraser 1978: 491). The Science classroom environment in particular, has been reported to create a wealth of interactions among teachers and pupils, pupils and pupils and the curriculum affecting pupils' behaviour (Talton and Simpson 1987: 507). As such the classroom environment has been shown to be an important determinant of attitudes towards Science. The characteristics of teachers, peers, curriculum and classroom climate were reported to be significant correlates of attitudes towards Science (Talton and Simpson 1986: 366; Yager and Penick 1984: 143).

Changes in the outcomes of education have been seen as a function of the environment in which pupils learn (Keeves 1975: 442). According to Lawrenz (1976: 509), the social learning that exists in the classroom may be one factor related to Science attitudes. The final performance and attitudes towards learning were seen as heavily dependent upon the classroom environment (Talton and Simpson 1987: 508). In this way the classroom environment should be seen as a potent variable in accounting for the variance of attitudes towards Biology.
2.3.4.2 Atmosphere in the Science (Biology) class and attitude towards Science (Biology)

Rewards in the form of grades are not necessarily associated with attitudes towards Science. Teacher personality, relations and interactions with pupils, class activities, rewards, assignments and pupil work a classroom atmosphere which is significantly related to attitude formation towards the subject (McMillan and May, 1979).

Myers and Fouts (1992) conducted research to determine the types of Science classroom environments and how different environments related to pupils' attitudes towards Science. It was hypothesised that pupils' perceptions of their classroom environments affect their attitudes towards Science. The results of this study showed positive attitudes to be found in classrooms which exhibited high levels of pupil involvement and affiliation, high teacher support, high order and organisation, high teacher use of innovative teaching strategies and low levels of control. On the other hand, negative attitudes were found to be enhanced by strictly controlled classes. Pupils doing Chemistry and Physics had more positive attitudes towards Science than those doing Biology. However, the researchers failed to establish whether teacher qualifications had any influence on the classroom environment and pupils' attitudes towards Science or not. But it was pointed out that classroom environment variables which seem to be highly influential on pupils' attitudes were primarily those related to the teacher and the classroom atmosphere he creates.

Talton and Simpson (1986) conducted research to investigate the relationships of self, home and classroom environment with pupils' attitudes towards Science in standards four to eight. It was found that of the three sets of variables, the classroom environment variables predicted the greatest amount of variance in
attitudes towards Science. Variables related to the pupils themselves were found to influence attitudes towards Science more than family variables. However, all three variables were found to relate significantly with attitudes towards Science.

Haladyna and Shaughnessy (1983) conducted research to explore the relationships of students, teachers and the learning environment variables to Science attitudes. From this investigation it was found that numerous endogenous and exogenous pupil, teacher, school and class variables were strongly related to attitudes towards Science across all three standards. Exogenous factors of gender and parental involvement were only found to be related to attitudes towards Science in standards two and seven. Professional membership, in-service Science training, professional involvement, fatalism, importance of Science, teacher attitudes towards Science, competency teaching, teacher interest, teacher perceptions of pupils' ability, teacher certification and enthusiasm were found to be strongly related to Science attitudes. Cohesiveness, school environment, enjoyable and well-organized classes and instruction, friendship, management organisation, classroom enjoyment of classmates correlated positively with favourable attitudes towards Science.

Haladyna et al (1982) conducted research to investigate the possible determinants of attitudes towards the subject-matter of Science using a theoretical model which examine three essential features thought to influence attitudes, namely: pupils, the teacher and the learning environment. No correlation was found between pupils' exogenous factors and attitudes towards Science, apart from parental involvement for boys and girls in standard seven. Two of the factors related to the pupils, namely self-confidence and the perceived importance of Science correlated strongly with pupils' attitudes towards Science for all standards. Significantly higher correlations between teachers variables and attitudes towards Science were found to be more for girls than for boys.
Furthermore, the strength of the correlations increased with increased standard in each case. Homework and concern for promotion did not correlate with attitudes towards Science. Among the learning environment variables, satisfaction; enjoyment of classmates; class environment; disorganisation and attentiveness emerged frequently showing moderate correlations with Science attitudes.

Lawrenz (1976) conducted research to examine pupil perception of the social learning environment in Biology, Chemistry and Physics classes. From this study, significant perceptual differences were found on 9 of the 10 LEI scales. Among the three courses, Biology classes were perceived as diverse and usually controlled by strict rules determined by teachers without consultation with pupils. Extensive subgroup cultures existed within classes with corresponding friction and differential teacher response. Biology was viewed by pupils as the least difficult. Chemistry classes were perceived as the most difficult and the least disorganised. The classes were seen as diverse with fairly strict rules and little consultation on decision-making. There was some subgroup culture and apparent differential teacher response but little friction. The Physics classes were perceived as being fairly cohesive with little friction or teacher favouritism. Physics classes did not have strict rules and pupils had a voice in decision-making. The course was viewed to be almost as difficult as Chemistry with less diversity. Overall, the course was viewed as the most satisfying among the three courses, which indicates the influence of classroom atmosphere on the development of attitudes.

Lawrenz (1976) conducted research to investigate how well Biology, Chemistry and Physics pupils' attitudes could be predicted from their perceptions of the classroom environments. Findings from this study showed that about 30 percent of variance in pupils' attitudes towards Science was the consequence of pupils' perceptions of their learning environment. The perceived learning environment was found to be highly correlated with attitudes, especially in Biology and Chemistry. Positive attitudes towards Science were found in classes perceived by
pupils as having little internal conflict. It was also found that a challenging Chemistry or Physics class created more positive attitudes towards Science, whereas the reverse was true for Biology classes.

The purpose of the study conducted by Fraser (1978), was to investigate the relationship between a set of Science-related attitudinal outcomes and pupils’ perceptions of their classes. The attitudinal outcomes investigated were pupils’ attitudes to four sources of information namely: experiments; experts; books; and teachers. It was found that the learning environment perceptions had predictive validity for learning outcomes. A significant correlation was also found between individual learning environment variables and attitudes towards different sources of scientific information. Favourable environments (for example challenging environments) produced positive attitudes towards Science.

Walberg (1969b) conducted research to investigate the influence of the teacher's personality and attitudes on classroom atmosphere. Although the results were not easily interpretable, several suggested predictable relationships between teacher personality and classroom atmosphere were found to exist. For instance, in goal-directed classes, pupils tended to feel less intimate to the other members in the class. Some kinds of tensions in the teacher's personality were found to be significantly associated with certain patterns of classroom atmosphere as perceived by pupils. The teacher's self-centredness was found to be associated with class disorganisation, constraint, loose supervision and lower group status. In summary, the personality patterns of the teacher, his needs, values and attitudes predicted the atmosphere of his classes. The teacher's achievement and interest in Science, as well as his conceptions of himself and the universe were seen to be better predictors of classroom atmosphere.
2.4 SUMMARY AND HYPOTHESES

From this review, it can be noted that factors associated with the teacher, the pupils, the curriculum and the classroom environment are related to pupils' attitudes towards Science. Keeping in mind that Biology is one of the study fields of the Natural Sciences, an analysis of the literature leads to the formulation of the following hypotheses:

(1) Certain factors associated with the teacher are significantly related to pupils' attitudes towards Biology.

These factors are:

- teaching methods
- teacher personality, attitude and enthusiasm

(2) Certain factors associated with pupils themselves are significantly related to pupils' attitudes towards Biology.

These factors are:

- pupils' gender
- pupils' age
- pupils' perceptions of their Science classes
- pupils' previous Science experiences
• pupils' career goals

• pupils' home backgrounds

• pupils' self-concepts and motivation

• pupils' learning styles

• pupils' previous achievements in Science

(3) Certain factors associated with the curriculum, are significantly related to attitudes towards Biology.

One of these factors is:

• the way in which pupils perceive the curricula

(4) Certain factors associated with the school or classroom environment, are significantly related to attitudes towards Biology.

One of these factors is:

• atmosphere (climate) in the Biology class.

(5) There is a significant difference between the attitudes of boys and girls towards Biology.
(6) There is a significant difference between the attitudes of standard eight and nine (or ten) pupils towards Biology.

(7) There are significant differences in attitude towards Biology of pupils with illiterate and literate parents.

(8) There are significant differences in attitude towards Biology of pupils in the Major School Biology classes and those in the Community and State School Biology classes.

These hypotheses will again be formulated in the next chapter. The basis of each hypothesis will be explained. Thereafter the research design to test these hypotheses will be described.
CHAPTER 3

Research design to test for the relationships between certain factors and adolescents' attitudes towards Biology in secondary schools
3.1 INTRODUCTION

The main purpose of this chapter is to outline the research design to test the hypotheses, for the relationships between certain variables and the adolescents' attitudes towards Biology in Gazankulu. The data are derived from a questionnaire which is based on the preceding literature review. An attempt will be made to quantify information obtained in the areas of teacher characteristics, pupil characteristics, the Biology curriculum, the classroom environment characteristics and attitudes towards Biology.

Measurement has been defined as the assignment of numerals to attributes of objects, events or people according to certain rules (Hills 1981: 4; Kerlinger 1986: 391; Siegal and Castella 1988: 23). According to Thorndike and Hagen (1977: 435), attitude measurement tries to get a precise appraisal of the intensity of some specific sentiments in each individual.

Measurement in this study is therefore quantitative, and it will be used to obtain an indication as to what extent pupils' attitudes towards Biology are related to either one or all of the factors mentioned above. Tuckman (1988: 177-179) outlined six scales according to which measurement can be executed. For the purpose of this study, an "interval scale" will be adopted because it involves judgement (Tuckman 1988: 179). The averages of two or more variables can be calculated and compared to test for significant differences (Siegel and Castella 1988: 28).

3.2 GENERAL PROBLEM STATEMENT

The literature has suggested in detail that the development of positive attitudes in pupils is a significant outcome of education. As Koballa (1992: 64) has stated, inculcating attitudes and assisting their growth is an important part of Science
(Biology) education. For example, major statements of the goals of Science education in the USA have stressed the importance of developing scientific attitudes in pupils, and curriculum projects tended to include this among their aims (Gauld 1982: 109).

However, the development of the cognitive and psychomotor skills are equally important and may in a number of ways interact with the affective component, to mutually influence pupils' performance.

Therefore, it is the major concern of this research to establish whether certain teacher characteristics, certain pupil characteristics, the Biology curriculum and the classroom environment are related to pupils' attitudes towards Biology, with due regard to the Gazankulu adolescent. Furthermore, an attempt will be made to establish the relative influence of these factors on attitudes towards Biology. This research problem stems from the researcher's observation in terms of standard ten pupils' declining end of-the year performance in Biology since 1989. This lower achievement may be caused by poor attitudes towards Biology.

3.3 HYPOTHESES

In order to investigate the previously stated problem in a logical way, the following hypotheses, (derived from the literature study), are stated:

3.3.1 There is a significant correlation between pupils' attitudes towards Biology and certain factors related to the teacher

It has already been reiterated in the previous literature review that the teacher is an integral part in the teaching-learning situation (see paragraph 2.3.1). From the literature, it has also become evident that the teacher's teaching methods,
personality, attitude and enthusiasm are important in influencing the pupils' learning outcomes, as well as attitudes towards Biology.

A good teacher, as described by Gunter (1983: 121), is one who does not concentrate on knowledge and skills only, but also on the cultivation of positive attitudes in his pupils. However, it would seem as if the teacher in the classroom today is heavily pressurised and concerned about the academic achievement of his pupils. Thus in his teaching, and in his general behaviour, he may emphasise the intellectual development and achievement of his pupils at the expense of their physical, volitional and affective development.

The type of Biology examination format since 1989 leaves many teachers undecided as to which teaching strategy could best interest the pupil in Biology and enhance his achievement. The experimental approach, which is emphasised by these examinations in the teaching of Biology, is not always easy to follow by the teacher because few facilities to actualise this are available in schools in Gazankulu. In some schools where such equipment do exist, many teachers never use it. This may be due to lack of expertise and self confidence.

Furthermore, many teachers today are highly preoccupied with academic self-improvement studies for salary purposes. This, coupled with lack of representative in-service training programmes for Biology teachers, may negatively influence their attitudes and enthusiasm for teaching the subject.

Therefore, it is proper to anticipate a significant relationship between teaching methods, teacher personality, teacher attitude and enthusiasm and pupils' attitudes towards Biology.
3.3.2 There is a significant correlation between pupils' attitudes towards Biology and certain factors related to the pupil.

According to the previous literature review, much of the variance in pupils' performance also lies with the pupils themselves (see paragraph 2.3.2). For example, the choice of Science in schools, particularly Physical Science (but also Biology) is highly influenced by gender.

The way pupils perceive their study of Science and Biology and the importance these subjects have for their future career opportunities are of crucial importance in shaping their attitudes towards Science. Research has also shown that the more Science courses the pupil enrolls in and the earlier he is exposed to the scientific world, the more positive his attitudes are likely to be towards Science (see paragraph 1.2.2). However, it should be noted that more than 80 percent of pupils in standard ten classes in Gazankulu are non-Science pupils, yet they all take Biology as a Science subject.

According to the literature review, many pupils come to a Science class with a lot of misconceptions about Science (see paragraph 2.3.2.5). This, coupled with lack of parental and teacher support, may make the study of Science less interesting and hence pupils may develop negative attitudes towards Science. The way pupils learn and the manner in which they engage in independent study of Biology depend in part on their interest and motivation. The more interested and motivated pupils are in their study of Science and Biology and the more positive their Science (Biology) self-concepts are, the more positive will be their attitudes towards Biology.

Thus it is anticipated from the literature study in paragraph 2.3.2 that pupil characteristics of gender, home background, self-concept, career orientation,
achievement motivation, previous experience, and learning styles will mutually 
exercise an influence on pupils' attitudes towards Biology.

3.3.3 There is a significant correlation between pupils' attitudes towards Science 
and certain factors related to the curriculum

From the literature review in paragraph 2.3.3 it seems that a curriculum which 
emphasises textbook use and examinations based on the recall of facts, with no 
investigations done, could influence pupils' attitudes towards Biology.

Apart from this, the literature study also reveals that a Biology curriculum which 
is totally academic and lacks any relevance to pupils' immediate lives may also 
relate to negative attitudes towards Biology.

Another aspect which was revealed in the literature to influence attitudes towards 
Biology, is the length of the syllabi. Too long syllabi may also influence pupils' 
attitudes towards Biology negatively.

3.3.4 There is a significant correlation between pupils' attitudes towards Biology 
and certain factors related to the classroom environment

According to paragraph 2.3.4.2 it is true that formal teaching and learning cannot 
be dissociated from the milieu in which they take place. What goes on in the 
classroom directly influences pupils' behaviour and attitudes towards such an 
environment.

As explained in the previous chapter, the classroom environment consists of the 
teacher, the curriculum and the pupils themselves. Therefore, the interactions 
among these elements create a climate that can be perceived by pupils as
Conducive to learning or not. The way teachers interact with pupils, as well as how pupils themselves relate to one another in the classroom and to the curriculum, should be viewed as strong determinants of attitudes and learning outcomes.

Consequently, it is felt that a significant correlation may exist between pupils' attitudes towards Science (Biology) and the classroom environment in which pupils find themselves.

3.3.5 There is a significant difference between the attitudes of boys and girls towards Biology

No research has so far been conducted in Gazankulu to compare boys' and girls' attitudes towards Science (Biology). The fact that Biology is a compulsory Science subject makes it difficult for one to speculate with certainty whether boys have more positive attitudes towards Biology than girls or vice versa. However, evidence from the preceding literature review suggests that significant differences in attitudes towards Science may exist between the sexes, with boys holding more positive attitudes towards Physics and Chemistry than girls. On the other hand, girls were found to prefer subjects and activities that are more social in nature. Hence, girls had more positive attitudes towards Biology whereas boys regarded it as a feminine subject.

Therefore, it is anticipated that there may be a significant difference in boys' and girls' attitudes towards Biology in Gazankulu secondary schools.
3.3.6 There are significant differences in the attitudes of standard eight, nine and ten pupils towards Biology.

According to paragraph 2.3.2.3, pupils' attitudes towards Science often grow more negative as they progress in school. The same may be true for their appreciation of Biology which they may have loved and enjoyed while they were in lower classes. This may be the result of numerous factors, including the kind of teaching pupils receive, the curriculum and the climate in their classes.

3.3.7 There is a significant difference in attitude towards Biology of pupils with literate and those with illiterate parents.

According to paragraph 2.3.2.7 the parents' level of formal schooling has an influence on pupils' attitudes towards school. This may also be true of its effect on pupils' attitudes towards Biology.

Therefore, the level of literacy and illiteracy of parents will be determined by the questionnaire with the expectation that it contributes to pupils' attitudes towards school work, with special reference to Biology education.

3.3.8 There is a significant difference in attitude towards Biology of pupils in the State Major School Biology classes and those in the Community and State School classes.

Secondary schools in Gazankulu can be classified into three groups, namely the Community Schools, State Schools and State Major schools. The two types of state schools are funded by the Government with the community schools being the responsibility of the community concerned.
The State Major Schools, apart from being funded by the government, follow a specific Science innovative trend peculiar to themselves. However, these schools do not necessarily produce their own pupils, instead pupils throughout the region are systematically selected using the Gazankulu Standard Seven Scholarship Examination. Successful candidates are transferred from their original schools to the Major Schools.

The Science classes in these schools are well equipped and they follow a common predetermined plan throughout the year. For instance, pupils in these classes are subjected to testing twice a year. Consequently, pupils in these classes constitute an elite group based on their performances in the scholarship examinations. Many of the activities in these classes are also focussed on the development of pupils' critical thinking and problem-solving skills through experimentation. As the literature has revealed, methods used by the teacher influence attitudes towards Science (see paragraph 2.3.1.2).

Therefore, it is believed that the attitudes of pupils from Major Schools towards Biology will differ considerably from that of pupils in the other types of schools.

3.4 OBJECTIVES OF THE EMPIRICAL INVESTIGATION

From the preceding paragraphs and from the previous two chapters, it follows that the objectives of the empirical investigation will be:

3.4.1 to determine the relationship between pupils' attitudes towards Biology and certain factors related to the teacher, the pupil, the Biology curriculum and the Biology classroom environment
3.4.2 to determine the relative influence of the factors related to the teacher, the pupil, the curriculum and the classroom environment on pupils' attitudes towards Biology

3.4.3 to determine whether significant differences occur in pupils' attitudes towards Biology on the basis of gender, standard, the level of parents' formal education and school type factors

These objectives will be accomplished in the following manner:

- The variables teacher characteristics (TC), pupil characteristics (PC), Biology curriculum (BC) and the classroom environment characteristics (CE) will be quantified and measured by items in a questionnaire. Items covering pupils' biographical factors of standard, gender, parents' formal educational background and school type will also be included in the questionnaire.

- An inter-correlation matrix will be calculated to determine possible relationships among variables and, at the end, to identify which one of the factors related most to pupils' attitudes towards Biology. This will be followed by a regression analysis which will be done to determine the relative influence of each factor on pupils' attitudes towards Biology.

- With regard to differences in attitudes towards Biology between pupils who differ with regard to biographical variables of standard, gender, parents' formal educational background and school type, the formulated hypotheses will be subjected to testing through the analysis of variance as well as t-tests.
3.5 PLANNING THE EMPIRICAL RESEARCH

3.5.1 The research group

The research group will comprise pupils doing Biology in standards eight, nine and ten classes. The sample will involve pupils of ages between twelve and twenty-three years.

It has been indicated by Borg and Gall (1989: 179-80) that sampling bias is a factor that greatly weakens educational research more than any other factor. Therefore, in order to avoid this, and to increase the sample's representativeness of the whole population, many subjects will be involved. Furthermore, a random sampling technique will be used so that the sample is representative of the population from which it was chosen.

Because respondents from three different standards are needed, the technique of stratified random sampling will be used. Consequently, subjects will be selected randomly from each of standards eight, nine and ten. Furthermore, this selection will be from varied types of secondary schools, namely from the community, government and Major Science schools.

There are approximately 177 secondary schools in Gazankulu. Since the present study focuses on pupils' attitudes towards Biology from standard eight to ten, all schools with classes running up to standard seven or nine will be excluded. Of the remaining secondary schools, a total of three secondary schools will be involved.
For practical reasons, the subject sample will be constituted as follows:

- a stratified random sample of 150 pupils (50 from each standard) in Major School Biology classes in one of these schools in Gazankulu with classes running from standard eight to ten;

- a stratified random sample of 150 standard eight to ten pupils from one Community School (50 from each standard);

- a stratified random sample of 150 standard eight to ten pupils from one State School (50 from each standard).

Therefore, a total of 450 pupils will participate in this study.

Random selection will be done by numbering each pupil (on a list). Thereafter the numbers will be put in a container, shuffled, and randomly selected. This will be done nine times, in other words, once for each standard and for each school type.

3.5.2 Permission and execution of the empirical investigation

In order to avoid problems of questionnaire administration in schools as discussed by Best and Kahn (1993: 240), and to increase the effort of respondents to give their views honestly, permission will be requested from the Gazankulu Education Department's Director-General to do the investigation. Conditions for granting such permission will include the following:
The questionnaire will be administered by the researcher with the aid of Science teachers. Permission from, and cooperation of the school principals and inspectors will be requested.

The administration of the questionnaire will not interfere with schools' daily programmes since it should not take more than half an hour to complete.

All information will be treated confidentially and names of subjects and schools will not be disclosed in the dissertation.

The information obtained from the questionnaire responses will be presented in such a way that no injustice will be done to the schools, the pupils or the teachers.

Above all, the results of this study will highlight some important educational information which may in turn lead to the improvement of educational practice in Gazankulu, with special reference to Biology.

3.5.3 The questionnaire

The type of research envisaged by this study requires participation by many subjects with the aim of generalising the findings. Hence, it is nomothetic in nature. For the purpose of this nomothetic research, a questionnaire will be used. This is because a questionnaire is the most practical means of collecting data from a large sample of subjects (Pell 1982: 95). A huge amount of data can be gathered within the shortest period of time possible.

Since the empirical investigation will involve many respondents, their perceptions will be operationalised and the quantified data will be analysed statistically and interpreted. From this, logical deductions will be made.
The scope of the questionnaire entails the following:

- 23 questions concerning pupils' attitudes towards Biology;
- 18 questions concerning teacher characteristics (TC);
- 17 questions concerning pupil characteristics (PC);
- 14 questions concerning the Biology curriculum (BC);
- 23 questions concerning the classroom environment (CE);
- 5 questions concerning age, gender, standard and parents' level of formal education.

Thus 100 questions are asked in total.

3.5.3.1 Characteristics of a good questionnaire

The questionnaire to be used in this empirical investigation will be of a structured nature. Subjects will be expected to respond to predetermined statements on the basis of a five point Likert response mode. This scale gives allowance for the following responses:

- strongly agree
- agree
- undecided
In order for the questionnaire to produce reliable and valid responses, it must comply with all the characteristics of a good questionnaire. The following characteristics of a good questionnaire, as outlined by researchers, will be strictly adhered to:

- The questionnaire will be concise and neat.

- Instructions will be clear and easy to follow.

- All questionnaire items will be clear and unambiguous.

- Each questionnaire item will deal with only one idea.

- All questionnaire items will be objective.

- Responses of the questionnaire will be easy to analyse and interpret.

- The questionnaire will have short and simple items.

- Questionnaire items will not channel respondents towards specific direction through the use of qualifiers.

- Questionnaire items will not imply a moral or ethical view.
Some of the above are also mentioned by Tuckman (1988: 197).

Cognisance will also be taken of the content validity of items so that the range of items covers the intended area of study. This will be done by presenting the questionnaire to two experienced Biology teachers for their opinions on the questions asked, before the questionnaire is finalised.

3.5.3.2 The questionnaire format

The questionnaire will seek to obtain information on the following categories of teacher characteristics (TC), pupil characteristics (PC), the Biology curriculum (BC) and the classroom environment (CE). Items pertaining to the respondents' biographical factors will be treated first. (The questionnaire is in Appendix A).

(a) Teacher characteristics (TC)

In this category, the questionnaire items will attempt to gather information from respondents on the basis of how they feel about their Biology teachers. Items in this category are designed in such a way as to gain information from respondents about their teachers especially in terms of the following:

- teaching methods;

- personality;

- attitudes; and

- enthusiasm.
In total, 18 items were formulated. (Card number one, computer numbers 34 to 51).

(b) Pupil characteristics (PC)

Items in this category are centred around pupils' perceptions relating to their study of Biology. The questionnaire items are designed in a way that will elicit information from pupils about how their attitudes towards Biology are influenced, especially by the following:

- interest and enjoyment;

- Biology academic self-concepts;

- learning styles;

- home background; and

- perceived worth of Biology, for example for career opportunities.

In total, 17 items were formulated. (Card number one, computer numbers 52 to 68.)

(c) The Biology curriculum (BC)

The aim of this category in the questionnaire is to get a picture of the respondents' attitudes towards the nature of Biology. Items in this category will require respondents to give their views with regard to the study of Biology on matters relating to the following:
the aims of the subject;

the content relevancy for pupils and for society;

the difficulty of the subject matter; and

the syllabus in terms of length, flexibility and examination orientatedness.

In total, 14 items were formulated. (Card number one, computer numbers 69 to 80; and card number two, computer numbers 2 to 3.)

(d) The classroom environment

The questionnaire items in this category seek to gain information on the respondents' perceptions of their Biology classes. Items will be designed in such a way that they reveal the pupils' attitudes towards their Biology classes based on the following:

satisfaction;

formality;

friendship;

favouritism; and

competition/cooperation
In total, 23 items were formulated. (Card number two, computer numbers 4 to 26.)

3.5.3.3 Item composition

Items in this questionnaire will be stated in the first person. This procedure is important since it gives the respondent a feeling of identifying with the item. Apart from this, it also makes the statements less clumsy. Items will be stated in the affirmative, and in certain cases, provision will be made for negative scoring.

In order to counteract any influence on the respondents' judgement, items will consist of simple statements without qualifiers. This is important because the use of qualifiers can affect the nature and quality of findings which may, in turn, affect the validity of the recommendations later made. All items of the questionnaire will be of a structured, predetermined nature. Respondents will be required to choose from a continuum of responses as explained in 3.5.3.1.

3.5.3.4 Pilot Study

In order to establish clarity on the questionnaire items, a pilot study involving a few subjects of the target population will be conducted. A class of standard eight pupils will be used. From the responses obtained, all necessary changes will be brought about. Only then will the questionnaire be finalised for use with the respondents.

3.5.3.5 Statistical techniques

After the questionnaire has been administered to the selected sample of this study, and after the results have been computed, the procedure of correlational
analysis will be carried out. This will enable the researcher to determine the correlation between the dependent variable (attitude towards Biology) and a series of independent variables. These independent variables will be:

- teacher characteristics (TC);
- pupil characteristics (PC);
- the Biology curriculum (BC); and
- the classroom environment (CE)

After this, a multiple linear regression analysis will be performed. This will help the researcher to determine which independent variables (singly or in group) are significant predictors of pupils' attitudes towards Biology at all grade levels.

Apart from regression analysis, the following statistical techniques will be used:

As described in paragraph 3.4.3, analysis of variance (F tests) will indicate if significant differences exist between the average attitude towards Biology scores of:

- three different schools;
- three age groups; and
- different levels of literacy of parents.
Another technique, the t-test, will be used to determine if significant differences exist between the average attitude towards Biology scores of the two genders.

The results of the abovementioned statistical analysis will be described in chapter 4.
CHAPTER 4

Analysis and discussion of the results
4.1 INTRODUCTION

The results of the empirical investigation to determine which factors are important in influencing the adolescents’ attitudes towards Biology in Gazankulu secondary schools are presented, analysed and discussed in this chapter. The adolescents that took part in this research were as follows:

Total number of respondents: 426

- number of boys: 239
- number of girls: 187
- number of standard eight pupils: 132
- number of standard nine pupils: 149
- number of standard ten pupils: 145
- number of pupils from a Major School: 140
- number of pupils from a State School: 144
- number of pupils from a Community School: 142

The analysis is based on the hypotheses already stated in the preceding chapters. In order to facilitate coherence in presentation, the hypotheses will be restated. Subsequent analysis and discussion of the results will be done with the help of tables containing the quantitative data. Although the null hypotheses are
hypotheses of no significant difference, for the purpose of this analysis, both the experimental and null hypotheses will be restated simultaneously. Eventually, it will be determined if the null hypothesis was rejected or not and therefore if the experimental hypothesis was accepted.

There are 23 tables containing the quantitative results for each pair of hypotheses. Therefore, analysis and discussion of the findings for each pair will be based on these tables. The tables illustrate the relationships between the dependent variable (Attitude towards Biology) and various independent variables as outlined in chapter 2.

The results were obtained through the use of four statistical techniques as described in chapter 3. The Pearson Product Moment Correlation statistical technique was used to establish relationships between the variable (attitude towards Biology) and the four variables related to the teacher, pupil, curriculum and classroom. This was followed by a Regression analysis which was computed to determine which of the four variables most contributed towards the variance in pupils' attitudes towards Biology. Whether differences in pupils' attitudes towards Biology on the basis of gender, school type and parental level of formal education were significant, was established through the calculations of t-tests and F-tests respectively.

For the following results, the SAS system was used by the computer department of the University of South Africa (UNISA).
4.2 RESULTS AND DISCUSSION OF HYPOTHESES 1-4

4.2.1 Hypotheses

_Hypothesis 1:_ There is a significant correlation between pupil attitude towards Biology and certain factors related to the teacher.

_Null hypothesis 1:_ There is no significant correlation between pupil attitude towards Biology and certain factors related to the teacher.

_Hypothesis 2:_ There is a significant correlation between pupil attitude towards Biology and certain factors related to the pupil.

_Null hypothesis 2:_ There is no significant correlation between pupil attitude towards Biology and certain factors related to the pupil.

_Hypothesis 3:_ There is a significant correlation between pupil attitude towards Biology and certain factors related to the curriculum.

_Null hypothesis 3:_ There is no significant correlation between pupil attitude towards Biology and certain factors related to the curriculum.

_Hypothesis 4:_ There is a significant correlation between pupil attitude towards Biology and certain factors related to the classroom environment.

_Null hypothesis 4:_ There is no significant correlation between pupil attitude towards Biology and certain factors related to the classroom environment.
With regards to the aforementioned hypotheses, the statistical techniques of correlation and regression analysis were used.

4.2.2 Correlational analysis

4.2.2.1 Correlation between attitude towards Biology and four other variables

The Pearson correlation coefficient was calculated to determine the relationships between the variable (attitude towards Biology) on the one hand and teacher, pupil, curriculum and classroom on the other hand. The probability level of each of these correlations are also given. The interpretation of these correlations are based on Mulder (1988). The results of this correlational analysis are presented in Table 1.

TABLE 1

Pearson Correlation Coefficients between attitude towards Biology and other variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Correlation with attitude</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher characteristics</td>
<td>426</td>
<td>0.3182</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil characteristics</td>
<td>426</td>
<td>0.66042</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curricular aspects</td>
<td>426</td>
<td>0.65812</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Classroom aspects</td>
<td>426</td>
<td>0.44981</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>
When Table 1 is studied, it seems that in all four instances significant relationships existed between attitude towards Biology (on the one hand), and the following variables: teacher characteristics, pupil characteristics, curricular aspects and aspects related to the classroom environment.

In quantitative terms, the correlations may be interpreted as follows:

- The correlation between attitude towards Biology and pupil characteristics is 0.66. This is a high correlation.

- The correlation between pupil attitude towards Biology and factors related to the curriculum is also 0.66. This is a high correlation.

- The correlation between attitude towards Biology and factors related to the classroom environment is 0.45. This is a moderate correlation.

- The correlation between pupil attitude towards Biology and certain factors related to the teacher is 0.32. This is a low correlation (Mulder 1988: 73).

Further correlations of attitude towards Biology with diverse sub-factors of the main factors (teacher characteristics, pupil characteristics, the curriculum and classroom aspects), were calculated. This was done in order to determine which one of the sub-factors for each main variable correlated the highest with attitude towards Biology. The analysis was done for the group of pupils as a whole. The results are presented in the following paragraphs.
4.2.2.2 Teacher characteristics

The correlations of attitude towards Biology with various teacher characteristics were determined. These characteristics were:

- the *methods* of teaching used by the teacher;

- *effectiveness* of the teacher;

- his *enthusiasm*; and

- his *supportiveness*.

Significant correlations are indicated in Table 2.

**TABLE 2**

*Correlations of attitude towards Biology with teacher characteristics*

<table>
<thead>
<tr>
<th>Teacher characteristics</th>
<th>N</th>
<th>Correlations with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>426</td>
<td>0,20</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>426</td>
<td>0,14</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Enthusiasm</td>
<td>426</td>
<td>0,28</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Support</td>
<td>426</td>
<td>0,38</td>
<td>p &lt; 0,01</td>
</tr>
</tbody>
</table>

According to Table 2, attitude towards Biology has low correlations with teacher characteristics. In order of merit, attitude towards Biology has low, positive correlations with:
• supportiveness of the teacher;

• enthusiasm of the teacher;

• methods used by the teacher; and

• his effectiveness.

Although low, these correlations were all significant at the 1 percent level.

4.2.2.3 Pupil characteristics

Thereafter, pupil characteristics were correlated with attitude towards Biology. The following pupil characteristics were used:

• standard;

• parental involvement;

• learning style;

• self-confidence;

• self-concept; and

• enjoyment

Significant results are indicated by Table 3.
TABLE 3

Correlations of attitude towards Biology with pupil characteristics

<table>
<thead>
<tr>
<th>Pupil characteristics</th>
<th>N</th>
<th>Correlation with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>426</td>
<td>0.33</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>426</td>
<td>0.12</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Learning style</td>
<td>426</td>
<td>0.38</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Self-confidence</td>
<td>426</td>
<td>0.52</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Self-concept</td>
<td>426</td>
<td>0.49</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>426</td>
<td>0.54</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

According to Table 3, attitude towards Biology correlated moderately with (in order of merit) enjoyment of Biology, self-confidence and a positive self-concept. These correlations are significant at the 1 percent level.

There are also low (but significant) correlations between attitude towards Biology and learning style, standard and parental involvement. However, parental involvement seems to have the lowest correlation with attitude towards Biology. The level of significance was smaller than 0.05.

4.2.2.4 Curricular aspects

The correlations of attitude towards Biology with various curricular aspects were determined. These aspects were:
the content of the curriculum;

- the perceived importance of the curriculum;

- the perceived relevance of the curriculum; and

- the difficulty of the curriculum

Significant correlations are indicated in Table 4.

TABLE 4

Correlations of attitude towards Biology with aspects of the curriculum

<table>
<thead>
<tr>
<th>Curricular aspects</th>
<th>N</th>
<th>Correlations with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>426</td>
<td>0,15</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Importance</td>
<td>426</td>
<td>0,59</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Relevance</td>
<td>426</td>
<td>0,52</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Difficulty</td>
<td>426</td>
<td>0,58</td>
<td>p &lt; 0,01</td>
</tr>
</tbody>
</table>

According to Table 4, attitude towards Biology has a low (yet significant) correlation with content of the curriculum. However, in order of merit, attitude towards Biology has moderate, positive correlations with perceived:

- importance;

- difficulty; and

relevance of the curriculum.
These correlations were all significant at the 1 percent level.

4.2.2.5 Aspects related to classroom atmosphere

The correlations of attitude towards Biology with various aspects related to the atmosphere in the classroom were determined. These aspects were:

- satisfaction;

- competition;

- formality;

- friendship;

- favouritism;

Significant results are indicated by Table 5.

When Table 5 is studied, it is clear that satisfaction has a moderate, positive and significant relationship with attitude towards Biology.

Low and yet significant relationships between attitude towards Biology and formality, friendship in classroom as well as favouritism by the teacher are also indicated.
TABLE 5

**Correlations of attitude towards Biology with various aspects related to the classroom atmosphere**

<table>
<thead>
<tr>
<th>Classroom variables</th>
<th>N</th>
<th>Correlation with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>426</td>
<td>0.53</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Competition</td>
<td>426</td>
<td>-0.18</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Formality</td>
<td>426</td>
<td>0.25</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Friendship</td>
<td>426</td>
<td>0.19</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Favouritism</td>
<td>426</td>
<td>0.22</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

It is, however, important to note that *competition* correlates negatively with attitude towards Biology. In other words, the more pupils compete with one another in the Biology class, the more negative their attitudes towards Biology become.

In order to throw some more light on the probable influence of other variables on the aforementioned correlations, it was decided to use *gender, standard* and *parents' literacy level* as moderator variables. The results are described in the following paragraphs.

**4.2.2.6 Gender as moderator variable**

When the correlations between the four factors (teacher characteristics, pupil characteristics, curricular aspects, and classroom aspects) on the one hand, and attitude towards Biology on the other hand were determined *for the two genders separately*, the results were as shown in Tables 6 and 7:
TABLE 6

**Correlations of diverse factors with attitude towards Biology for boys**

<table>
<thead>
<tr>
<th>Factor</th>
<th>N</th>
<th>Correlation with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher characteristics</td>
<td>239</td>
<td>0.26</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil characteristics</td>
<td>239</td>
<td>0.69</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curricular aspects</td>
<td>239</td>
<td>0.71</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Classroom aspects</td>
<td>239</td>
<td>0.43</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

TABLE 7

**Correlation of diverse factors with attitude towards Biology for girls**

<table>
<thead>
<tr>
<th>Factor</th>
<th>N</th>
<th>Correlation with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher characteristics</td>
<td>187</td>
<td>0.42</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil characteristics</td>
<td>187</td>
<td>0.62</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curricular aspects</td>
<td>187</td>
<td>0.58</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Classroom aspects</td>
<td>187</td>
<td>0.48</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>
According to Tables 6 and 7 there are significant relationships between all four aspects and attitude towards Biology for both genders.

However, when the correlations between each of the aspects and attitude towards Biology for the two genders are compared, the following becomes apparent:

The attitudes for boys as compared to those for girls were more influenced by pupil and curricular aspects than by teacher and classroom aspects. For both the genders, attitude towards Biology was moderately correlated with the classroom aspects. The correlation between the teacher characteristics on the one hand, and pupil attitudes towards Biology on the other hand, was lower for boys than for girls.

4.2.2.7 Standard as a moderator variable

When the correlations between the four factors (teacher characteristics, pupil characteristics, curricular aspects and classroom aspects) on the one hand, and attitude towards Biology on the other hand were determined for the three standards separately, the results were as shown in Tables 8 to 10:

According to Tables 8 to 10, there are significant relationships between all four aspects and attitude towards Biology for all three standards.

When the correlations between each of the aspects and attitude towards Biology are compared, the following becomes apparent:
TABLE 8

*Correlation of diverse factors with attitude towards Biology for standard 8*

<table>
<thead>
<tr>
<th>Factor</th>
<th>N</th>
<th>Correlation with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher characteristics</td>
<td>132</td>
<td>0.27</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil characteristics</td>
<td>132</td>
<td>0.69</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curricular aspects</td>
<td>132</td>
<td>0.69</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Classroom aspects</td>
<td>132</td>
<td>0.44</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

TABLE 9

*Correlation of diverse factors with attitude towards Biology for standard 9*

<table>
<thead>
<tr>
<th>Factor</th>
<th>N</th>
<th>Correlation with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher characteristics</td>
<td>149</td>
<td>0.44</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil characteristics</td>
<td>149</td>
<td>0.61</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curricular aspects</td>
<td>149</td>
<td>0.69</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Classroom aspects</td>
<td>149</td>
<td>0.52</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>
TABLE 10

*Correlation of some diverse factors with attitude towards Biology for standard 10*

<table>
<thead>
<tr>
<th>Factor</th>
<th>N</th>
<th>Correlation with attitude towards Biology</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher characteristics</td>
<td>145</td>
<td>0.24</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil characteristics</td>
<td>145</td>
<td>0.70</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curricular aspects</td>
<td>145</td>
<td>0.60</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Classroom aspects</td>
<td>145</td>
<td>0.39</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

For all three standards, attitude towards Biology was highly correlated with the pupil and curricular aspects. Both the standard eight and nine pupils' attitudes towards Biology correlated similarly with curricular aspects. Pupil characteristics had the highest correlation with the attitudes of standard ten pupils towards Biology. Classroom aspects had the highest correlation with the standard nine pupils' attitudes towards Biology in comparison with the standard eight and ten. However, very low correlations were found between the attitudes of the standard eight and ten pupils towards Biology and teacher characteristics.

4.2.2.8 Literacy level of parents as moderator variable

When literacy level of the father was used as a moderator variable, it did not add any additional information. However, according to the results, pupil characteristics and curricular aspects yielded significant and high positive correlations with attitudes towards Biology.
Furthermore, when the literacy level of the *mother* was used as a moderator variable, similar results were obtained — *pupil characteristics* and *curricular aspects* were important variables with regard to correlation with attitude towards Biology.

4.2.3 Regression analysis

The aforementioned statistical analysis was followed by regression analysis. Regression analysis is a statistical technique that enables the researcher to examine the correlation between the dependent variable and a series of independent variables. The determination of this correlation also enables the researcher to, amongst other things, calculate how much variance was caused in the dependent variable (attitude towards Biology) by one or a combination of independent variables (pupil, teacher, curriculum and classroom environment characteristics). Furthermore, regression analysis helps the researcher to determine which independent variables (singly or in a group) are significant predictors of pupils' attitudes towards Biology in all standards. Consequently, a forward selection procedure for the dependent variable was followed. In this way, it could be ascertained, how much each independent variable contributed and predicted variance in pupils' attitude towards Biology.

4.2.3.1 Regression analysis of the whole group

A summary of the results of regression analysis for the whole group is shown in Table 11. In this table, the *independent variables* which significantly contributed and predicted variance in attitude towards Biology, are indicated.
TABLE 11

Summary of stepwise procedure for dependent variable attitude towards Biology

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable</th>
<th>Variance (r2)</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Curriculum</td>
<td>0.44</td>
<td>329.2</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Curriculum + pupil characteristics</td>
<td>0.55</td>
<td>102.7</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

According to Table 11, two independent variables contributed significantly to variance in attitude towards Biology, as follows:

1. **44 percent** of the variance in attitude can be explained by the curriculum.

2. **55 percent** of the variance in attitude can be explained by the *curriculum plus pupil characteristics*. This means that **11 percent** of the variance in attitude can be explained by pupil characteristics.

Teacher characteristics and the classroom environment variables did not contribute significantly towards variance in attitude towards Biology. This means that there are still one or more variables that have not been researched in this empirical investigation that accounts for nearly **45 percent** of variance in attitude towards Biology.

However, as with the correlational analysis, regression analysis was further done with *gender, standard and literacy level of parents* as moderator variables. (In all of the following, only those variables that significantly added to the variance in attitude towards Biology, are indicated.)
4.2.3.2 Gender as moderator variable

When regression analysis was done for the attitudes of boys and girls separately, the results were as indicated by Tables 12 and 13.

TABLE 12

Summary of stepwise procedure for dependent variable attitude towards Biology for boys

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Variance (r²)</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum</td>
<td>0.51</td>
<td>241.3713</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curriculum plus pupil</td>
<td>0.62</td>
<td>71.8680</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>

TABLE 13

Summary of stepwise procedure for dependent variable attitude towards Biology for girls

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Variance (r²)</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum</td>
<td>0.38</td>
<td>114.8263</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Curriculum plus pupil</td>
<td>0.46</td>
<td>24.3165</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>teacher</td>
<td>0.48</td>
<td>8.6148</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>
According to Tables 12 and 13 the attitudes of boys towards Biology were more influenced by the curriculum and pupil characteristics than those of girls. The curriculum accounted for 13 percent more (51% minus 38%) of the variance in attitude towards Biology for boys in comparison with the girls. Again, pupil characteristics accounted for 3 percent more (11% minus 8%) of the variance in attitudes towards Biology for boys than for girls. For girls, teacher characteristics added another 2 percent to the variance in attitude towards Biology but this aspect was not significant for the boys.

4.2.3.3 Standard as moderator variable

When standard was used as a moderator variable, the results for the regression analysis were as shown in Tables 14 to 16.

TABLE 14

Summary of stepwise procedure for dependent variable attitude towards Biology for standard 8

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Variance (r2)</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupil</td>
<td>0.48</td>
<td>120,1521</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil plus curriculum</td>
<td>0.60</td>
<td>37,3825</td>
<td>p &lt; 0.01</td>
</tr>
</tbody>
</table>
TABLE 15

Summary of stepwise procedure for dependent variable attitude towards Biology for standard 9

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Variance ( (r^2) )</th>
<th>( F )</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum</td>
<td>0.48</td>
<td>136.4854</td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>Curriculum plus pupil</td>
<td>0.55</td>
<td>20.3596</td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>Curriculum plus pupil plus classroom</td>
<td>0.57</td>
<td>9.2163</td>
<td>( p &lt; 0.01 )</td>
</tr>
</tbody>
</table>

TABLE 16

Summary of stepwise procedure for dependent variable attitude towards Biology for standard 10

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Variance ( (r^2) )</th>
<th>( F )</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupil</td>
<td>0.48</td>
<td>131.1276</td>
<td>( p &lt; 0.01 )</td>
</tr>
<tr>
<td>pupil plus curriculum</td>
<td>0.53</td>
<td>16.3424</td>
<td>( p &lt; 0.01 )</td>
</tr>
</tbody>
</table>

When Tables 14 to 16 are studied carefully, the following aspects become apparent:

Two independent variables contributed significantly towards variance in attitude towards Biology as follows:
(1) For the standard eight and ten pupils alike, 48 percent of variance in attitude towards Biology can be explained by pupil characteristics.

(2) This is in contrast to the figures of standard nine pupils. Curricular aspects accounted for most, (48%) of the variance in attitude towards Biology for the standard nine pupils.

(3) For the standard nine pupils, classroom variables added another 2 percent to the variance in attitude towards Biology whereas for the other standards, classroom variables did not contribute significantly.

(4) For standards eight and ten, apart from pupil characteristics, curricular aspects added another 12 percent and 5 percent respectively to variance in attitude towards Biology.

4.2.3.4 Literacy level of parents as moderator variable

When the regression analysis was done with literacy level of the father as moderator variable, results indicated that the variance in attitude was mainly affected by pupil characteristics as well as by the curriculum. However, for pupils whose fathers had a literacy level of between seven and twelve years, the results were as follows:
TABLE 17

Summary of stepwise procedure for dependent variable attitude towards Biology for pupils whose fathers had between seven and twelve years of formal education

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Variance (r²)</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupil</td>
<td>0.47</td>
<td>95.3519</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil plus curriculum</td>
<td>0.57</td>
<td>23.8054</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Pupil plus curriculum plus classroom</td>
<td>0.58</td>
<td>3.8632</td>
<td>p &gt; 0.05</td>
</tr>
</tbody>
</table>

According to Table 17, pupil and curriculum variables caused 57 percent of the variance in attitude towards Biology. Classroom variables also added 1 percent to the variance in attitude although this was not significant.

The regression analysis was also done with literacy level of the mother as moderator variable. The results of this analysis indicate that the variance in attitude was also mainly affected by pupil characteristics and by the curriculum. However, when the literacy level of the mother was between 1 and 6 years, the result was as indicated by Table 18.

According to Table 18, teacher variables added 1 percent to the variance in attitude towards Biology. However, the probability is greater than 0.05. This means that the influence of these variables on attitude towards Biology was not significant.
TABLE 18

Summary of stepwise procedure for dependent variable attitude towards Biology for pupils whose mothers had between one and six years of formal education

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Variance (r²)</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupil</td>
<td>0,45</td>
<td>91,9725</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Pupil plus curriculum</td>
<td>0,57</td>
<td>30,9864</td>
<td>p &lt; 0,01</td>
</tr>
<tr>
<td>Pupil plus curriculum plus teacher</td>
<td>0,58</td>
<td>2,5850</td>
<td>p &gt; 0,05</td>
</tr>
</tbody>
</table>

4.3 RESULTS AND DISCUSSION OF HYPOTHESIS 5

The following hypotheses were stated:

*Hypothesis 5:* There is a significant difference in attitude towards Biology between boys and girls.

*Null hypothesis 5:* There is no significant difference in attitude towards Biology between boys and girls.

In order to test this hypothesis, a t-test was done.

The results are presented in Table 19.
When Table 19 is studied, it seems that boys have slightly more negative attitudes towards Biology than girls. This is indicated by a higher mean value for the boys than for the girls. However, this difference between the two is not significant. Consequently the null hypothesis, which predicts no significant difference in attitude towards Biology between boys and girls, cannot be rejected. This means that gender had no significant influence on pupils' attitude towards Biology.

**4.4 RESULTS AND DISCUSSION OF HYPOTHESIS 6**

The following hypotheses were stated:

*Hypothesis 6*: There is a significant difference in attitude towards Biology of pupils in standards 8, 9 and 10.

*Null hypothesis 6*: There is no significant difference in attitude towards Biology of pupils in standards eight, nine and ten.

In order to test these hypotheses, an analysis of variance procedure (ANOVA) was performed. This was done by comparing the average achievements in attitude towards Biology of the three groups of pupils in order to see if there were any significant differences.
The results are presented in Table 20.

**TABLE 20**

*F-values for the comparison of average achievement in attitude towards Biology of standards eight, nine and ten pupils*

<table>
<thead>
<tr>
<th>Standard</th>
<th>N</th>
<th>Mean</th>
<th>df</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eight</td>
<td>130</td>
<td>2.329</td>
<td>2</td>
<td>0.6</td>
<td>p &gt; 0.05</td>
</tr>
<tr>
<td>Nine</td>
<td>148</td>
<td>2.321</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ten</td>
<td>142</td>
<td>2.300</td>
<td>2</td>
<td>0.6</td>
<td>p &gt; 0.05</td>
</tr>
</tbody>
</table>

When Table 20 is studied, it seems that the attitudes towards Biology of pupils in Gazankulu becomes more *positive* with *age* and *standard*. For instance, from the table above, it would seem that standard *eight* pupils' attitudes towards Biology are more *negative* than those of standard *nine* pupils. Also, the attitudes towards Biology of standard *nine* pupils are more *negative* than those of standard *ten* pupils. However, there appears to be no significant differences in attitude towards Biology of pupils in the three standards, as the probability is greater than 0.05. Consequently the null hypothesis that there is no significant difference in attitude towards Biology of pupils in standards eight, nine and ten cannot be rejected. Therefore, the fact that pupils' attitudes towards Biology become more positive with age and standard may not be generalised as it may be attributed to chance.
4.5 RESULTS AND DISCUSSION OF HYPOTHESIS 7

The following hypotheses were stated:

*Hypothesis 7*: There is a significant difference in attitude towards Biology of pupils with fathers of different literacy levels.

*Null hypothesis 7*: There is no significant difference in attitude towards Biology of pupils with fathers of different literacy levels.

In order to test these hypotheses, the mean values for attitude towards Biology of pupils with fathers of the four different levels of literacy, were compared. This was done in order to test for possible significant differences.

The four levels of literacy are:

1. more than 12 years of formal education
2. 7 to 12 years of formal education
3. 1 to 6 years of formal education
4. no formal education

The results are presented in Table 21.
TABLE 21

F-values for the comparison of average achievement in attitude towards Biology of pupils with fathers of different levels of formal education

<table>
<thead>
<tr>
<th>Level of formal education</th>
<th>N</th>
<th>Mean</th>
<th>df</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 12 years</td>
<td>58</td>
<td>2,335</td>
<td>2,335</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-12 years</td>
<td>109</td>
<td>2,323</td>
<td>2,323</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-6 years</td>
<td>116</td>
<td>2,314</td>
<td>2,314</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>137</td>
<td>2,305</td>
<td>2,305</td>
<td>0,07</td>
<td>p &gt; 0,05</td>
</tr>
</tbody>
</table>

A study of Table 21 reveals that attitudes towards Biology grow progressively more negative as level of formal education of the father increases. This is indicated by the mean value becoming progressively greater with an increase in formal education of the father. However, the differences in the mean values are not significant (p > 0,05). Consequently the null hypothesis cannot be rejected. That is, there is no significant difference in attitude towards Biology of pupils with fathers of different levels of formal education. This means that the father's level of formal education may not have an influence on pupils' attitudes towards Biology.

4.6 RESULTS AND DISCUSSION OF HYPOTHESIS 8

The following hypotheses were stated:

Hypothesis 8: There is a significant difference in attitude towards Biology of pupils with mothers of different formal education.
Null hypothesis 8: There is no significant difference in attitude towards Biology of pupils with mothers of different formal education.

In order to test these hypotheses, the mean values for attitude towards Biology of pupils with mothers of different levels of literacy were compared. This was also done in order to test for significant differences.

The four levels of literacy were:

(1) more than 12 years of formal education

(2) 7 to 12 years of formal education

(3) 1 to 6 years of formal education

(4) no formal education

The results are presented in Table 22.

TABLE 22

F-values for comparison of average achievement in attitude towards Biology of pupils with mothers of different levels of formal education

<table>
<thead>
<tr>
<th>Level of formal education</th>
<th>N</th>
<th>Mean</th>
<th>df</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 12 years</td>
<td>66</td>
<td>2,334</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-12 years</td>
<td>66</td>
<td>2,341</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-6 years</td>
<td>115</td>
<td>2,283</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>173</td>
<td>2,322</td>
<td>3</td>
<td>0.31</td>
<td>p &gt; 0.05</td>
</tr>
</tbody>
</table>

130
According to the results in Table 22, there is no significant difference in attitude towards Biology of pupils with mothers of different levels of formal education. Since the null hypothesis cannot be rejected at this level, it follows that the mother's level of formal education may not be important in explaining pupils' attitudes towards Biology.

4.7 RESULTS AND DISCUSSION OF HYPOTHESIS 9

The following hypotheses were stated:

*Hypothesis 9:* There is a significant difference in attitude towards Biology of pupils from three different school types.

*Null hypothesis 9:* There is no significant difference in attitude of pupils from three different school types.

An analysis of variance (ANOVA) was done to test these hypotheses. The procedure was employed in order to ascertain whether significant mean differences in attitude towards Biology existed for pupils in the three different school types.

The results of this investigation are presented in Table 23.

According to the means in Table 23, pupils from *Community Schools* have the most *positive* attitudes towards Biology. On the other hand, pupils from *Major Schools* have the most *negative* attitudes towards Biology. However, as the probability is greater than 0.05, these differences are not significant. Consequently the null hypothesis may not be rejected.
TABLE 23

*F*-values for comparison of average achievement in attitude towards Biology of pupils from three different schools

<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>Mean</th>
<th>df</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>140</td>
<td>2,359</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>144</td>
<td>2,301</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td>136</td>
<td>2,288</td>
<td>2</td>
<td>0.96</td>
<td>p &gt; 0.05</td>
</tr>
</tbody>
</table>

From the aforementioned results, important conclusions may be made. These are described in the next chapter.
CHAPTER 5

Discussion of the conclusions
5.1 INTRODUCTION

The purpose of the research reported in this study was to investigate the relationship of certain factors with pupils' attitudes towards Biology in Gazankulu secondary schools. These factors are teacher, pupil, curriculum and the classroom environment.

It was hypothesised that

- pupils' attitudes towards Biology would be positively and significantly correlated with each of the independent variables named above;

- each sub-factor for every independent variable would be positively and significantly correlated with pupils' attitudes towards Biology;

- pupils' attitudes towards Biology would be positively and significantly correlated with the independent variables when gender, standard and parental level of formal education were used as moderator variables;

- significant differences in attitude towards Biology would be found between pupils of different genders, standards, parental levels of formal education and the type of school attended.

Thus in this chapter, conclusions from the literature review and from the results of the empirical study will be given. This will be followed by an analytical integration of these conclusions to highlight some common findings and discrepancies. The implications of the present study for the Biology teacher, limitations and recommendations for future Biology education and research will conclude this chapter.
5.2 CONCLUSIONS FROM THE LITERATURE REVIEW

An extensive review of the literature on the relationships between attitude towards Science and factors related to the teacher, pupil, curriculum and the classroom environment was done in chapter 2. Studies reviewed ranged from those that focused on the characteristics of these factors, as independent variables, to investigate their influence on pupils' affective outcomes.

5.2.1 Teacher characteristics and pupils' attitudes towards Science (Biology)

The role of the teacher in mediating and influencing pupils' learning outcomes, including attitudes, is outlined and discussed in paragraph 2.3.1.

5.2.1.1 teaching methods

From the review of the literature, the role of teaching methods to promote the development of pupils' positive attitudes towards Science generally has been a controversial issue. Fraser (1986), expressed lack of clarity on how teachers could improve pupils' learning outcomes (including attitudes) by changing the classroom to be in line with pupils' preferences. On the other hand, the influence of teaching methods, compared to the nature of the subject, posed another problem. This hampered conclusive generalisations on how effective teaching methods were influencing pupils' attitudes towards Science.

However, when various teaching methods were individually analysed, important significant relationships with attitude towards Science were established. These relationships were found to favour the following methods: activity-centred; problem-solving; laboratory work; teacher demonstration; project work; use of
audiovisual materials; teacher modelling; investigative reports; discussion and critical thinking approaches.

On the other hand, pupils' attitudes towards Science were found to decrease with increased and frequent use of the textbook, lecturing, testing, memorisation and copying of notes. Teacher-centredness, teaching for passing examinations and for factual acquisition were viewed as a strong source of disappointment to pupils.

5.2.1.2 teacher personality, attitude and enthusiasm

When the personality of the teacher was considered, it was found that pupils' attitudes towards Science were significantly influenced by this factor. As Walberg (1969b) has indicated, the personality patterns of the teacher, his behaviour, values and attitudes predicted the climate of the classroom and hence pupils' attitudes. Thus teachers who were viewed as punitive, authoritative, unfair and critical had pupils with negative attitudes towards their courses.

However, significant positive relationships were reported between positive pupil attitude towards Science and the following personality traits of the teacher: the teacher's task-orientatedness; competence and self-confidence. Also, teachers who were more inspiring, friendly, supportive, knowledgeable and enthusiastic were more preferred by their pupils than those who were not. Of these, teacher enthusiasm was seen as most influential on the attitudes of pupils, especially in lower classes.

5.2.2 Pupil characteristics and pupils' attitudes towards Science (Biology)

A review of the literature on factors related to the pupil which may influence pupils' attitudes towards Science is given in paragraph 2.3.2. Significant
correlations between some of these factors and attitudes towards Science were revealed.

The following are the main conclusions:

5.2.2.1 Gender and academic self-concept

The nature of the subject in terms of difficulty was reported to be an important factor in accounting for much of the variance in pupils' attitudes towards Science. When gender was used as an independent variable, it was found that boys and girls differed significantly in their attitudes towards Science. With Physical Science, the differences favoured boys. In other words, the attitudes of boys towards Physical Science were more positive than that of girls. On the other hand, girls had more positive attitudes towards Biology than boys. Again girls, more than boys, considered Physical Science to be more difficult than Biology.

It was also reported that the pupils' inner motivational variable accounted for 75 percent of variance in their attitudes towards Science. Therefore, pupils with significantly higher Science achievement motivation had significantly higher positive attitudes towards Science. However, when the differences in attitude towards Science between boys and girls were established in the area of pupils' preference for Science, it was found that girls' intrinsic interest in experimental procedures increased with experiments which had more social appeal to them than boys.

The pupils' academic self-concept and confidence were reported to be important variables influencing their attitudes towards Science. Consequently, pupils with positive academic self-concept and confidence in Science had more positive attitudes towards Science.
5.2.2.2 Age and type of school

Some studies reported no significant relationships between attitude towards Science and standard or age. However, other studies reported growing negative attitudes towards Science as children grew older, especially girls. Enjoyment of Science waned as children progressed through different standards. No significant relationships were found between pupils' attitudes towards Science and the type of school attended.

5.2.2.3 Perceived worth, for example for career opportunities

It was also revealed that importance and relevance of the subject in terms of career opportunities accounted for much of the variance in pupils' attitudes towards and their choices of Science in tertiary institutions. For example, when pupils' attitudes towards Science were related to their preferences for Biology and Human Biology, it was found that the latter was rated higher by pupils than the former. This is because pupils believed that Human Biology offered more career opportunities than Biology. The same was also reported for Physics.

5.2.2.4 Home background

The influence of the home on attitude towards Science was as follows:

No significant relationships were reported between the father's occupation and his child's degree of scientific interest. However, pupils from higher Science environments were found to express more positive attitudes towards Science than those from lower Science environments. Parents' attitudes towards their child's education, together with their involvement
in it, were more related to their children's learning. Yet, this attitude was more positively expressed by boys than by girls. This was seen to be the result of parents who held stronger ambitions for the education of their male than their female children.

5.2.2.5 Learning style

The manner in which pupils learn was found to be related to their attitudes towards Science. Pupils who learned for understanding had more positive attitudes towards Science than rote learners. This is because the former group could use learned information to correct their misconceptions in new and different situations. Independent and meaningful learners exhibited more improved study habits and they believed that this type of learning styles was interesting. Thus environments providing for independent and meaningful learning were positively correlated with improved attitudes towards courses.

5.2.3 Curriculum aspects and pupils' attitudes towards Science (Biology)

A review of the literature on the relationship between pupils' attitudes towards Science and the characteristics related to the curriculum is presented in paragraph 2.3.3. There is little research that deals with this aspect. However, the following were highlighted:

5.2.3.1 Relevancy

Research on the influence of diverse variables on pupils' attitudes towards Science revealed that of all the classroom environment variables, the curriculum as such was the most influential factor. For example, curricula which were perceived as irrelevant have been reported to decrease pupils' achievement, motivation and attitudes towards Science.
The differences between curriculum designers and users in the interpretation of curricular restraints, aims and implementation possibilities were also seen as contributory to a mis-matched transformation of material with pupils. This was regarded as important in explaining pupils' development of estranged feelings about the material. Hence negative attitudes towards the subjects concerned developed.

5.2.3.2 Syllabus length, flexibility and examination orientatedness

It was highlighted in previous research that too much factual or imaginative curriculum content neglected the child's ability. In other words, it was suggested that the curriculum should be flexible and should also include a reasonable amount of factual content. This was seen as important in enhancing the development of positive attitudes towards Science, especially of low-ability pupils. However, researchers warned that too much factual content on the other hand, would deprive pupils of using their reasoning abilities because it encourages rote learning, especially for examinations (Lederman 1986).

That the Biology curriculum is greatly influenced by examination requirements, has been a topic of great concern for South African Biologists (Charoux 1993; Degenaar 1986; Watson 1990; Slabbert 1990). For example, most of the aims of the syllabi which are not examined, are not emphasised when teaching the subject. Thus teachers and pupils tend to focus on examinable content of the syllabus. Some of the objectives, especially those that deal with human life, conservation and the environment are lacking in the Biology curriculum. Yet, emphasis of these objectives should be viewed as important in enhancing positive attitudes towards Biology.
5.2.4 The classroom environment and pupils' attitudes towards Science (Biology)

A review of the literature on the relationship between attitude towards Science and factors related to the classroom is given in paragraph 2.3.4. An appreciable amount of the variance in learning outcomes, for example attitude development, was found to be the result of the environment in which teaching and learning take place, as well as pupils' perception of such an environment. Consequently, the environment was seen to be most influential in attitude development towards Science.

The personality of the teacher, his relationships and interactions with pupils, class activities, rewards, assignment and pupil work related significantly with attitude formation and development. However, rewards in the form of marks was not associated with liking of Science.

Pupils in classes that offered high levels of pupil involvement and friendship, teacher use of innovative teaching strategies and low levels of control, high teacher support, high order and organisation revealed more favourable attitudes towards Science.

At the same time, pupils in classes that were goal-directed (classes that encouraged competitions), felt less intimate to the other members of their classes. Some teacher personality factors such as self-centredness, resulted in pupil constraint and a lowered group status. These were seen as important in increasing tensions and development of negative attitudes towards Science in pupils.
5.3 CONCLUSIONS FROM THE EMPIRICAL RESEARCH

The results of the correlation and regression analyses, as well as of the analysis of variance (ANOVA) and t-tests are presented in chapter 4. From these results, the following conclusions may be made:

5.3.1 Teacher characteristics and pupils' attitudes towards Biology

The empirical research with the Gazankulu adolescents indicated that teacher characteristics had a low correlation of 0.32 with attitude towards Biology. This correlation was significant (see table 1).

Table 2 indicates that of all the teacher characteristics which were researched, supportiveness by the teacher had the highest correlation with attitude development, although the methods he used and his enthusiasm also significantly correlated with attitude.

From tables 6 and 7, it is clear that girls' attitudes towards Biology are more influenced by the teacher than that of boys. This was confirmed by the results appearing in tables 12 and 13 for a regression analysis: it was found that 2 percent of the variance in attitude for girls was caused by the characteristics of the teacher. In contrast, these characteristics did not play an important role in influencing the variance in attitude towards Biology for boys.

The attitudes of standard nine pupils are also more influenced by the teacher than that of standard eight and ten pupils (see tables 8, 9 and 10).
5.3.2 Pupil characteristics and pupils' attitudes towards Biology

The results in table 1 show that pupil characteristics have a significant, high correlation of 0.66 with attitudes towards Biology. Of all the pupil characteristics which the questionnaire focused on, enjoyment of Biology, self confidence and having a positive academic self-concept had the highest correlations with attitude towards Biology.

All of these factors moderately and significantly correlated with pupils' attitudes towards Biology (see table 3).

Tables 6 and 7 show that of the two genders, boys' attitude development towards Biology is especially influenced by pupil characteristics. This was confirmed by the results of the regression analysis. Tables 11 and 12 indicate that 11 percent of the variance in attitude towards Biology for boys is caused by pupil characteristics while 8 percent of the variance in attitude towards Biology for the girls was caused by pupil characteristics.

According to tables 8, 9 and 10, the correlations between pupil characteristics and attitude towards Biology were high for all the three standards, but especially for standards eight and ten. (These were 0.69 and 0.70 for standards eight and ten respectively, and 0.61 for standard nine).

When a regression analysis was done for the whole sample, it was found that pupil characteristics caused 11 percent of the variance in attitude towards Biology. (Only the curriculum accounted for more). However, when the regression was repeated for the three standards separately, results in tables 14, 15 and 16 show that, for standards eight and ten, pupil characteristics were the main cause of the variance in attitude towards Biology - 48 percent for each.
(Variance in attitude towards Biology for the standard nine pupils was mainly caused by the curriculum).

Pupil characteristics were also most important in causing variance in attitudes towards Biology of pupils with mothers of a literacy level of between one and six years (see tables 17 and 18).

5.3.3 Curricular aspects and pupils' attitudes towards Biology

The results in table 1 show that curricular aspects have a significant, high correlation of 0.66 with attitude towards Biology. Of all the curricular aspects, the difficulty of the curriculum as well as its perceived importance and relevance had the highest significant correlations with attitude towards Biology. Apparently, the curriculum content was not an important factor influencing attitude development of Gazankulu adolescents (see table 4).

According to table 6 and 7, curricular aspects have a significant, high correlation of 0.71 for boys and 0.58 for girls. This higher correlation for boys was further confirmed by the regression analysis. Tables 12 and 13 indicate that for boys, 51 percent of the variance in attitude towards Biology was caused by curricular aspects compared to 38 percent for girls (see table 11). According to the table, this was the most important factor influencing pupils' attitudes towards Biology.

Tables 8, 9 and 10 show that the correlation between curricular aspects and attitude towards Biology is high (0.69) for both standards eight and nine pupils. However, when a regression analysis was done for the three standards separately, the curriculum was the most important aspect accounting for much of the variance in attitude towards Biology for the standard nine pupils. For this standard, the curriculum accounted for 48 percent of the variance in pupils' attitudes towards Biology (see tables 14, 15 and 16).
5.3.4 The classroom environment and pupils' attitudes towards Biology

Table 1 shows that the classroom environment variables have a moderate correlation of 0.45 with attitude towards Biology. Of the diverse aspects studied in this research, satisfaction with Biology had the highest correlation with attitude. On the other hand, competition among pupils negatively influenced their attitudes towards Biology (see table 5).

Tables 6 and 7 indicate that the two genders are equally influenced by the classroom environment. The correlation between this factor and attitude towards Biology is 0.43 for boys and 0.48 for girls.

When the influences of the classroom environment are compared for the three standards separately, tables 8, 9 and 10 show that standard nine pupils are more influenced by this factor than pupils in standards eight and ten. This is confirmed by the results shown in tables 14, 15 and 16. However, when these tables are carefully studied, it becomes clear that only 2 percent of the variance in standard nine pupils' attitudes towards Biology is accounted by the classroom environment variables.

5.3.5 Summary of differences between genders, standards and school types

With regards to Gazankulu adolescents involved in this study, boys had more negative attitudes towards Biology than girls. However, as indicated by table 19, this difference was not significant. For both genders, pupil and curricular aspects were most important variables influencing attitude towards Biology. The correlations between these variables and attitudes were especially higher for boys. The attitudes that girls have towards Biology are also influenced by the teacher.
Table 20 indicates that pupils' attitudes towards Biology grow more positive as they progress from standard eight to standard nine and thereafter standard ten. However, these differences are not significant.

According to table 21, pupils' attitudes towards Biology grow more negative as their fathers' levels of formal education increase. Once again, these differences are not significant.

Although the differences in pupils' attitudes from the three school types are not significant, table 23 shows that the attitudes of pupils from the Major Schools are most negative compared to the most positive attitudes held by pupils from the Community Schools.

5.4 FINAL CONCLUSIONS FROM THE LITERATURE STUDY AND THE EMPIRICAL RESEARCH

5.4.1 Final conclusions with regard to teacher characteristics and attitude towards Biology

In general, girls are more influenced by the teacher than boys. The following teacher characteristics seem to be important in promoting the development of positive attitudes towards Biology:

- the methods he uses — the use of methods that promote active participation in class by the pupils, instead of methods where pupils are required to sit passively and listen to lectures, promote the development of positive attitudes towards Biology;

- his enthusiasm for Biology;
• his *supportiveness* — for example the extent to which he encourages pupil participation in classroom activities;

• his *fairness* and

• his efforts to *understand* his pupils.

5.4.2 Final conclusions with regard to pupil characteristics and attitude towards Biology

Pupil characteristics are most important in influencing attitudes towards Biology. This is especially true for boys, as well as for the standard eight and ten pupils. Consequently, the following seem to be important in the development of positive attitudes towards Biology:

• *enjoyment* of the subject, Biology;

• *self-confidence*; and

• having a positive academic *self-concept*.

5.4.3 Final conclusions with regard to curricular aspects and attitude towards Biology

Curricular aspects are very important in influencing attitudes towards Biology. This is especially true for boys and for the standard nine pupils.
In general, the following seem to be important in influencing the development of attitudes towards Biology:

- a moderate degree of difficulty; and

- perceived importance and relevance of the curriculum to pupils' everyday lives.

5.4.4 Final conclusions with regard to classroom environment and attitude towards Biology

The classroom environment may influence pupils' attitudes towards Biology. This is especially true for the standard nine pupils.

In general, the following seem to be important in the development of positive attitudes towards Biology:

- satisfaction with the Biology class, for example, in being free to ask questions, being proud of the classroom, doing experiments, having variety in class and having some freedom of choice from the syllabus; and

- avoidance of competition among pupils.

5.4.5 Final conclusions with regard to the influence of standard and the type of school on attitudes towards Biology

Standard may influence attitudes towards Biology. Pupils' attitudes tend to grow more positive as they progress to higher standards.
The type of school attended may also influence pupils' attitude towards Biology.

5.5 DISCUSSION OF THE CONCLUSIONS

A review of the literature and of the results of the present study on the relationships between pupils' attitudes towards Science and some factors concerning the teacher, pupil, curriculum and classroom environment has identified important facets in a secondary school situation which can influence attitude towards Science.

The major conclusions from both the reviews indicate that all the four variables: (teacher characteristics, pupil characteristics, curricular characteristics and the classroom environment) as investigated in this study, are positively and significantly correlated with pupils' attitudes towards Biology. From the literature review, pupils' attitudes towards Science (Biology) have constantly been linked with the classroom environment. However, from the results of this study, the curriculum, more than the classroom environment, was the most important factor. As can be seen from table 11, this factor accounted for 44 percent of the variance in pupils' attitudes towards Biology. This was followed by pupil characteristics which accounted for 11 percent of variance in pupils' attitudes towards Biology. This suggests that a greater proportion of variance in pupils' attitudes towards Biology in Gazankulu secondary schools may be explained by the curriculum than by the classroom environment variables. This is especially true for boys and for the standard nine pupils. Thus from the results of this study, it may be proper to conclude that a moderately difficult, important and relevant Biology curriculum will improve pupils' attitudes towards the subject.
Nevertheless, as with the findings of many previous research studies, pupils' satisfaction with their Biology classes and a reduced level of competition in them were revealed in this study as most important in influencing pupils' attitudes towards Biology.

Low correlations reported in this study between pupils' attitudes towards Biology and teacher characteristics are consistent with previous research. According to Brown (Hadden and Johnstone 1983: 318), such correlations indicate that teachers rarely teach intentionally towards the stated objectives, or they merely pay lip-service to them (Charoux 1993: 15). However, the teacher's supportiveness, his enthusiasm, fairness, understanding of his pupils and a frequent use of methods that encourage pupil participation will enhance the development of positive attitudes towards Biology.

Pupils' enjoyment, compared to their confidence and self concept (see table 3), had the highest correlation with attitude towards Biology. Consequently, since many respondents of the present study perceived Biology as unimportant, difficult and somewhat irrelevant, it may be possible to conclude that their attitudes towards its curriculum were influenced by (in order of merit) their enjoyment, confidence and the Biology self-concept. Thus by increasing pupils' enjoyment of Biology, confidence in Biology and a positive Biology self-concept, their feelings about the subject may improve.

Absence of a significant difference in attitude towards Biology between the two genders, as opposed to findings from previous research, should be seen to illustrate that boys and girls alike, are affected by the curriculum. This may be due to the fact that both boys and girls, and more especially those in standard 10, exert equal efforts in studying Biology in order to pass the examinations. The fact that boys' attitudes, more than that of girls' towards Biology are influenced
by the curriculum, confirms previous research findings that the Biology curriculum is not more appealing to boys than to girls. However, it is not easy to conclude whether the present Biology syllabus is socially relevant as it may seem from girls' responses in this study. This may be a topic for further investigation.

In contrast to previous research, results of this study have showed slight improvements in pupils' attitudes towards Biology as they progress through standards. Both the results of the present and previous research revealed no significant differences between pupils' attitudes towards Biology and the type of school attended. However, pupils in the Major Schools, appear to have more negative attitudes towards Biology than pupils in the Community Schools (see table 23). This may suggest a shift, by Major School pupils, from a traditional outlook of a power-coersive system reported elsewhere. In other words, it would appear that pupils in Major Schools have developed sufficient skills to think critically. These pupils might have long realised that Biology, unlike Physical Science for example, was not so important for their lives after schooling compared to pupils in Community Schools.

Lack of sufficient evidence to support the influence of the home on pupils' attitudes towards Biology in Gazankulu, as can be seen from the results of the present study, may be an indication that parents are less concerned with the education of their children. This might be true when the amount of illiteracy in this region is considered. Furthermore, the more negative attitudes towards Biology held by pupils of literate fathers may be an indication of ignorance and lack of scientific literacy among the majority of parents in Gazankulu.
5.6 IMPLICATIONS OF THE RESULTS FOR BIOLOGY TEACHERS

The major finding of the present study is that pupils' attitudes towards Biology are consistently and strongly related to both the pupil and curricular aspects. Previous research has already indicated that the Biology curriculum in South Africa is academic, irrelevant and that for the most part, it is guided by the examinations (Charoux 1993; Slabbert 1990; Watson 1990). Furthermore, according to Sanders (1993), the Biology curriculum emphasises the acquisition of factual knowledge and skill- and attitude related aims are ignored.

Therefore, by increasing teacher awareness of the important role that the curriculum and pupil characteristics can play in Science education, a substantial improvement in pupils' attitudes towards Science, especially Biology may be obtained. For example, research has expressed the need for the Science class to be stimulating, supportive of pupils to express their opinions, ask questions and develop their interest in Science. Consequently, every teacher of Biology should be flexible, fair, empathetic and sympathetic with all his pupils.

Furthermore, the importance of cooperation rather than competition in education has been reiterated by researchers (Johnson and Johnson 1974). The results of the present study have also confirmed that the more competition there is in a Biology class, the more negative are pupils' attitudes towards the subject. Therefore, teachers should by all means avoid competition in their Biology classes.

Pell (1982) has warned that treating a class as a homogeneous group without acknowledging each learner's needs and abilities may be dangerous. It would be futile, according to this researcher, for the teacher to concentrate mostly on those pupils who could still do well regardless of ambiguities in class at the expense of the whole class as a unit. For example, teachers should be aware that girls, more
than boys, are influenced by the characteristics of the teacher. Furthermore, there is a tendency for boys not to prefer Biology compared to girls. Therefore, teachers should note that every success in their classes depend on equal support they are prepared to give to every pupil in their classes regardless of gender.

Everything that goes on in the Biology classroom should be appealing to pupils. The subject matter taught should be presented in a way that will stimulate pupils' curiosity and fascination. The teaching methods and personality of the teacher influence the development of pupils' attitudes towards Biology as reported in this study. Therefore, teachers should use methods in which pupils are active and they should be enthusiastic about the subjects they teach.

Frequent use of experiments and audio-visual media under the intelligent guidance and support of the teacher was reported to be the most important approach capable of satisfying the needs of most of the pupils. In this way, pupils may enjoy, have confidence and develop a positive Biology self-concept.

The identification in this study of the curriculum and pupil characteristics as the most important variables by which pupils' attitudes towards Biology may be explained, suggests the importance of teacher in-service training. Studies on curriculum evaluation (Fraser, 19986) have highlighted three dimensions regarding teacher in-service training. These modes are Action Research (AR), Educational Programme Evaluation (EPE) and Classroom Interaction Analysis (CIA). In the Action Research mode, teachers can deliberately and systematically reflect upon, discuss and question their own teaching practice. The Educational Programme Evaluation provides useful guidance about ways in which teachers can play a role in curriculum evaluation and self-evaluation of their work. The Classroom Interaction Analysis and Microteaching make teachers aware of and subsequently improve their own teaching.
Therefore, according to Pell (1982: 584), information on these modes by the teacher may permit the nature of Science to be examined while evaluating the learning theories that can be used to teach it. Consequently, improved classroom environments in terms of good teaching, good quality subject materials and cognisance of the nature of learners may improve pupils' achievements and attitudes towards Biology.

It is important for teachers to realise that while the teacher, pupil, curriculum and the classroom environment characteristics may have such an important influence on pupils' attitudes towards Biology, other factors also need to be considered. The fact that there is no significant evidence from the results of this study to support the notion that parents' involvement in the education of their children is important in explaining their attitudes towards Biology in Gazankulu should not support the total exclusion of parents in education. On this basis, Talton and Simpson (1986) have said: "If we are truly to develop positive attitudes towards Science the home environment needs to be considered." Therefore, it would be essential that teachers from now onwards, establish a very close partnership with parents, regardless of their level of formal education. In fact, it would be appreciated if parent-teacher associations could be established in Gazankulu.

5.7 LIMITATIONS OF THE PRESENT STUDY

It has always been contended that research on attitudes is chaotic. However, the present study attempted to fill the gap in Science research in South Africa, which has long been neglected. For example, the inclusion of the curriculum in the model used for this study as an independent variable to be related to pupils' attitudes towards Biology should be seen as a step towards the identification of more variables apart from those already researched.
Nevertheless, it is important to note that the research data presented in this study contain possible limitations, for example the following:

5.7.1 Sampling

The sample of this study was drawn from three out of one hundred and seventy seven secondary schools in Gazankulu. Since only 426 subjects were drawn from these schools, it may be possible that the sample was not representative of the total population of pupils.

5.7.2 Instrumentation

The use of the word “Science” in the questionnaire might have influenced the results negatively since most pupils in Gazankulu secondary schools are nonscience majors. The indication of negative attitudes towards Biology of the standard eight pupils might have been caused by lack of ability to understand the English used in the questionnaire. Hence, unreliable responses could have been given.

5.7.3 Data collection

The collection of data took place by the time pupils, and more especially those in standard ten, were preparing for the end-of-the-year examinations. Consequently, some pupils were absent from school on that day. However, it was the intention of the researcher to collect these data towards the end of the year on the grounds that all pupils would have gone through their respective syllabuses. It was therefore hoped that only then could they be in a position to give sincere responses based on their experience.
5.7.4 Population

The population consisted of pupils in Gazankulu secondary schools. Therefore, absence of significant differences in attitude towards Biology of pupils in the three school types might have been the result of the population being so homogeneous of only Gazankulu pupils.

5.8 RECOMMENDATIONS FOR FUTURE RESEARCH

The major finding of the present study was the consistently high relationships between pupils' attitudes towards Biology and pupil and curricular characteristics. The curriculum accounted for most of the variance (44%) in pupils' attitudes towards Biology, compared to all the other independent variables researched with it. However, it would seem that little research exists that deals primarily with the investigation of the relationship between this factor and pupils' attitudes towards Biology. Therefore the researcher suggests further research in this regard.

On the basis of the limitations of this study as discussed in paragraph 5.7, it may be unwarranted to conclude that the teacher and classroom environment variables are not important in accounting for the variance in pupils' attitudes towards Biology as is evident from the results. As the sample of the study came from the same geographic area, replication of this research with other cultural groups is advisable. This should also extend beyond Gazankulu from which this data was collected. A full-scale item analysis of the research instrument used in this study could also be conducted to obtain its validity and reliability. This was not done in this research as the researcher did not intend standardising the questionnaire.

Finally, more research studies should be conducted in Gazankulu and South Africa that would seek to generate research evidence regarding pupils' affective and conative domains.
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1. Age: (in years)

2. Gender: Boy = 1  
   Girl = 2

3. Standard: 8 = 1  
   9 = 2  
   10 = 3

4. What is the level of your father's formal education?

   None = 1  
   1-6 years = 2  
   7-12 years = 3  
   More than 12 years = 4

5. What is the level of your mother's formal education?

   None = 1  
   1-6 years = 2  
   7-12 years = 3  
   More than 12 years = 4

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<th>Agree</th>
<th>Undecided</th>
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Indicate YOUR feelings by writing down the appropriate number in the square on the RIGHT.

6. I enjoy Biology.
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<th>Strongly Agree</th>
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7. I enjoy Biology more than other subjects.  
8. I enjoy discussing Biology problems raised in class.  
9. Biology is just a load of technical terms.  
10. I would rather specialise in Biology than in other subjects.  
11. Studying Biology is a waste of time.  
12. I would enjoy school more if there were no Biology lessons.  
13. Biology is a very valuable subject.  
14. The school should have less Biology periods each week.  
15. Studying Biology gives me a feeling of satisfaction.  
16. There is very little one can learn from the present Biology syllabus.  
17. I think the study of Biology is relevant to human life.  
18. I believe that some subjects can offer better solutions to society’s problems than Biology.  
19. Biology knowledge is not very important.  
20. I hate preparing for Biology exams.  
21. A day without a Biology period is boring.
<table>
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<tr>
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22. Biology is too much work.  
23. I enjoy preparing for Biology tests.  
24. Biology is a simple subject.  
25. I want to do well in Biology.  
26. Biology is boring.  
27. I enjoy making diagrams in Biology.  
29. My Biology teacher is fond of letting us do things ourselves.  
30. The questions asked during Biology lessons are interesting.  
31. I hate writing regular tests in Biology.  
32. My teacher emphasises the memorization of Biology facts.  
33. My Biology teacher encourages us to take notes during Biology lessons.  
34. My teacher emphasises the importance of understanding Biology.  
35. I spend most of the time in Biology class listening to the teacher talking.  
36. New or difficult Biology processes and terms are practically demonstrated to us by the teacher.  
37. My Biology teacher encourages discussion or debate in class.
<table>
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<tr>
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38. My teacher uses computers or videos to make everyone in class understand Biological processes. [43]
39. My Biology teacher encourages us to do experiments on our own. [44]
40. My Biology teacher often refers to the textbook. [45]
41. My Biology teacher is interested in my questions and problems. [46]
42. My Biology teacher encourages everyone to participate in classroom discussions. [47]
43. My Biology teacher is lively in his presentation or discussion of Biology information. [48]
44. My Biology teacher is always fair. [49]
45. My Biology teacher has a lot of knowledge about Biology. [50]
46. My Biology teacher tries to understand each one of us in the class. [51]
47. I am concerned about my progress in Biology. [52]
48. My parents encourage me to study hard at school. [53]
49. I am interested in Biology. [54]
50. Biology is boring this year. [55]
51. I would enjoy doing more practical work in Biology. [56]
52. I liked Biology more when I was younger. [57]
53. I enjoy Biology activities. [58]
54. Biology is a simple subject. [59]
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<th>Strongly Agree</th>
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55. Biology is a difficult subject.  
56. I understand Biology when I study it on my own.  
57. The best way to study Biology is to memorize everything.  
58. I am able to help others with Biology problems.  
59. Biology has always been difficult for me.  
60. I think it will be wise for me to continue with Biology in future.  
61. My parents care whether I study or not.  
62. I think that our society should encourage Biology learning in order to improve the environment.  
63. I think there are many job opportunities for students specialising in Biology.  
64. Biology has a very positive aim for our society.  
65. With the knowledge obtained from the study of Biology, one can solve a lot of problems in society.  
66. The Biology that we study at school is relevant for our daily lives.  
67. The concepts and processes in the Biology textbooks are difficult to understand.  
68. Biology facts are interesting.  
69. I hate Biology experiments.  
70. Biology has no relevance for our daily lives.  
71. The Biology syllabus needs more content.
<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<tbody>
<tr>
<td>(5)</td>
<td>(4)</td>
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72. In Biology, one often repeats work done in previous years.  
73. I do not understand why I should learn Biology.  
74. There is too much content in the present Biology syllabus.  
75. The Biology that I learn in class enables me to understand my own environment.  
76. The content of the Biology syllabus can be understood completely.  
77. I learn't a lot in Biology this year.  
78. I enjoy being in my Biology class.  
79. Each one of us in my class wishes to be the best student.  
80. My Biology teacher allows us to participate actively in class.  
81. My Biology teacher always listens to what I have to say.  
82. My Biology teacher prefers that we learn in groups.  
83. I have a positive relationship with my classmates in the Biology class.  
84. The Biology class is well organized.  
85. We are told exactly how to behave in the Biology classroom.  
86. In Biology, our ideas are considered during classroom discussions.
<table>
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<th>Strongly Agree</th>
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</tr>
</tbody>
</table>

87. My Biology teacher often refers us to the textbook to find answers to questions. [ ] 13
88. My Biology teacher treats all students in the same way. [ ] 14
89. We are free to express our feelings about what we learn in Biology. [ ] 15
90. I am determined to make something out of Biology education. [ ] 16
91. What we do in Biology class seldom changes. [ ] 17
92. We can freely ask questions during Biology lessons. [ ] 18
93. I am satisfied with the work done in the Biology class. [ ] 19
94. We have some freedom of choice from the Biology syllabus. [ ] 20
95. I would be proud to show my Biology class to a visitor. [ ] 21
96. My Biology teacher is helpful to students who have trouble with the work. [ ] 22
97. My teacher conducts experiments to answer Biology questions coming from class discussions. [ ] 23
98. We are always quiet during Biology lessons. [ ] 24
99. My Biology teacher spends very little time in friendly talk with students. [ ] 25
100. Rules in the Biology class often change. [ ] 26

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