

ATTITUDE TO STUDIES OF FIRST-YEAR UNIVERSITY STUDENTS IN
BIOLOGICAL SCIENCES AT THE COMMENCEMENT OF UNIVERSITY LEVEL
TUITION

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of the degree Master of Education at the University of Cape
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DECLARATION

I declare that this dissertation is my own unaided work. It is being submitted for the degree of Master of Education in the University of Cape Town, Rondebosch. It has not been submitted before for any degree or examination in any other University.

Signed by candidate

Jean J de V Jordaan

13 day of December, 19 90.

ABSTRACT

First year students commencing studies in the biological sciences at two universities in the Cape Province, South Africa - the Universities of Cape Town and Stellenbosch - were sampled by means of a questionnaire. This investigation sought to establish in what way attitudes, formed at school during studies in biology would, on transferring to a university learning environment, play a part in determining successful outcomes of study in biological sciences during the first year of study at a university.

The total combined sample, $N_T = 893$, was finally reduced to $N_{TB} = 807$, this figure representing those who had studied biology at school and were therefore of direct concern in this study. The responses were analysed and discussed in the light of current theories of attitudes and recommendations put forward. These attempted to remedy the neglected or deficiently developed attitudes identified in the sample.

The sample was split a number of times, and the following splits were used: the university at which the students were studying; their course of study (science or medicine); those who had written the Cape Senior Certificate examination on leaving school; their sex. Similarities and differences in attitudes found in these samples were discussed separately and compared with those of the whole sample. Remedies, aimed at coping with the deficiently developed attitudes found in each sample were outlined, together with appropriate teaching strategies which might be put into practice at both school and university.

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PRELIMINARY NOTE

1 Splitting the sample

The sample of students on which this research is based was split in a number of ways. Splits were made, for example, by course of study (e.g. students studying medicine), by university (the Universities of Cape Town and Stellenbosch), and by examination written by the students on leaving school (e.g. Cape Senior Certificate examination).

Each of the samples in this research was assigned two N values:

- (a) The larger N value represents all the students in that sample. This value is designated "N" and is accompanied by the relevant identity e.g. medical sample or University of Stellenbosch sample.
- (b) The smaller N value of a sample refers only to those students in the sample who studied biology at school. This N value is designated " N_B ".

A list of the N values of the various samples is given below:

Whole sample (a sample combining students from the Universities of Cape Town and Stellenbosch): $N_T = 893$ and $N_{TB} = 807$.

University of Cape Town sample: $N = 368$ and $N_B = 329$.

University of Stellenbosch sample: $N = 525$ and $N_B = 478$.

Medical sample: $N = 288$ and $N_B = 260$.

Cape Senior Certificate sample (i.e. students who wrote the Cape Senior Certificate examination of the Cape Education Department, 1981-1985): N and $N_B = 382$.

Science students in the Cape Senior Certificate sample:
 N and $N_B = 248$.

Medical students in the Cape Senior Certificate sample:
 N and $N_B = 134$.

Females: $N = 436$ and $N_B = 405$

Males: $N = 457$ and $N_B = 402$

2 Reporting percentages obtained during sampling

Throughout this study the percentages reported, irrespective of whether they refer to the samples, to items in the questionnaire or to the frequencies of responses to items, are all rounded off to the nearest whole per cent. The result is that when a range of percentages is reported in full it might not total exactly 100 per cent. On a few occasions, however, percentages are given exactly.

3 Studies in the sciences at schools in South Africa in broad outline

By law, children enter school between the ages of 6 1/2 and 7 years of age. During the first three school years (two pre-primary years followed by Standard 1 and collectively known as the Junior Primary phase) virtually no formal subject teaching is done. During these years the emphasis is on reading, writing and numeracy. Here the foundations for the subject studies which follow - mathematics, history, geography, etc. - are laid.

During the next three years, i.e. in Standards 2, 3 and 4 (the Senior Primary phase), the children on average being respectively 10, 11 and 12 years old, subject teaching comes to the fore. At this stage "elementary science" is taught. This subject focuses heavily on Nature and natural processes.

In the following three years, Standards 5, 6 and 7 (the Junior Secondary phase), the children's ages now being 13, 14 and 15 years respectively, subject teaching entirely dominates the curriculum. Science in these standards is taught as "general science". During these three years nature and natural processes, both biological and physical, are studied in greater detail.

During the final three years at school - known as the Senior Secondary phase - the students progress through Standards 8, 9 and 10 and are aged 16 to 18 respectively. At this stage, science studies at school divide into physical science and biology as two completely separate subjects. Each of these science subjects could be regarded as complementing the other in the following way: If Nature and all natural processes are regarded as a coin, one subject will serve to show one side, whilst the other subject will show the reverse.

During these final years at school, physical science or biology (or both) may be studied on the Standard or the Higher Grade.

Standard Grade studies cover essentially the same material as Higher Grade, but place somewhat greater emphasis on factual content than those in the Higher Grade. Thus during tests and examinations it is chiefly recall of facts which is emphasised. Higher Grade studies, on the other hand, emphasise abstract thinking more than Standard Grade studies

do. Tests and examinations in Higher Grade studies necessarily reflect this approach.

Science teachers in South African and South West African/Namibian schools, whether teaching the lower or upper standards, are guided by detailed syllabuses provided by the education authorities. These syllabuses prescribe the content-material and practical work for each year of study, together with some guidance as to the required depth of study and the examination requirements.

Upon completion of the final three years of the Senior Secondary phase, students sit a school-leaving or "matriculation" examination. A good pass in this public examination will usually admit them to science courses at the university of their choice. If entry to a course is limited - and the medical course is a good example - students might have to meet further stringent requirements before they are admitted. Such requirements might include an excellent rather than an average pass, having studied both science subjects on the Higher Grade, etc. Competition amongst students for entry into over-subscribed university courses is often high.

Although studies in physical science and biology are not specifically designed only to admit students to science, medicine and other courses at university, they are nevertheless frequently studied with that in mind.

Selected courses at university might, as mentioned above, require school science studies to provide a background for the students' studies at university. For these students, therefore, school science studies make a vital contribution toward the success of their studies at university.

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1 INTRODUCTION

The origins of this study lie in the observed inability of first-year students at two South African universities to operate with the same degree of success they achieved at school in much the same type of studies.

Biology is a popular subject choice for large numbers of students while at school and for many students this subject serves as an introduction to Nature and natural processes. It is also considered by the majority of these students to be a fairly easy subject, yielding high marks in spite of having a high information content. Much of the subject matter is also intrinsically fascinating and possibly this is a further clue to the perennial popularity biology enjoys at school level.

For many students school biology serves as an introduction to further study in the biological sciences at university and for such students biological studies at school provide a background to, and experience of, the content of their intended courses of university study. Students who intend becoming doctors, microbiologists, oceanographers, entomologists, biology teachers, botanists, zoologists and the like have usually chosen biology as one of the subjects for their school-leaving examination.

While at school, the popularity of the teacher, the availability of the "nature films" shown at school, and the sociability of the subject have frequently been observed to create a pleasant atmosphere of study and involvement. The average (i.e. overall) mark of those students who take biology as a subject is usually improved by the marks obtained in this subject, thereby aiding entry to university, which is becoming steadily more competitive.

A few days or weeks after students begin their courses of study in the biological sciences at university, problems frequently begin to appear. These problems are not simply the normal problems of adjusting to a university environment. Somehow, school studies in biology frequently do not "match up" to the requirements of university courses. Enormous masses of information seem to flow at high speed from lecturers. Practical sessions occupy whole afternoons, reducing free time considerably. Much information is available, yet much of it seems bewildering. Class tests often do not yield the expected high marks. Almost every student is affected in some way and most are at a loss to understand why they are not coping as well as they did at school. Usually they cannot, in the stress and press of university studies, find the time to reflect on why they are not faring as well as expected, falling prey to their inability to learn successfully, particularly (and predictably!) before and during test and examination sessions. For many students, their university work has become somewhat soured and there is all too little enjoyment of their studies.

Learning problems, and especially those of successful learning during the first year at a university was the subject of a research project by Hart and Heyns (1970) at the University of Cape Town. They identify anxiety (1970:4, 6, 15) as a major problem during the learning process. Though nearly twenty years have elapsed since publication of their work, which appeared as a guide to successful studies rather than as a formal research report, the findings of that research are still highly relevant to the current student population.

To more fully understand, and hopefully identify, some of the sources of the problems associated with successful learning at university, a literature survey was undertaken. Science education, curricula and curriculum development, and

critical comment on science education received attention. The study and teaching of biology in South Africa and elsewhere received naturally particular attention.

As a result of this survey, student attitudes was selected as being a likely determinant to the outcomes of learning, and particularly in the case of successful outcomes of learning. The theories and research relevant to the mainstream of attitude theory, attitude formation and change, as well as the determining of attitudes, were established, and used as a basis for this research. Finally, it was decided that the most appropriate method of establishing students' attitudes to their studies would, in this case, be by developing and administering a questionnaire to students in the biological sciences. This questionnaire, administered at the beginning of the first-year university course, would attempt to establish to what extent attitudes formed by the teaching and learning of biology at school might influence subsequent studies in the biological sciences at university.

An analysis of the students' answers would then be undertaken to establish those attitudes and, based on the outcomes of the analyses, recommendations made for the remediation of those problems which are attributable to attitudes found among first-year biological science students at the commencement of university study.

2 REVIEW OF THE LITERATURE

Sentences or expressions which include "attitude" or "attitudes" denote, in a general or more specific way, the intentions of persons (or of one person in particular) to other persons, objects or events. Attitudes, understood in this sense, imply links between persons (or one person in particular) and the world at large. The definition originally proposed by Allport in 1935 was used throughout this investigation as a guide, and is included in chapter 3 (p. 17), below. Allport's definition stresses that attitudes are primarily intentions, and that their effect is observed - to a greater or lesser measure - in the action which follows, but on which they are nevertheless based.

Attitudes, of individuals or of groups, have been closely investigated by numerous researchers, who have firmly established attitudes as components of personality. Researchers in education are, for example, convinced that attitudes contribute powerfully to the outcomes of learning - positive attitudes to learning and studies improving the outcomes of learning, and vice-versa.

A guide to attitude research in science education was compiled by Shrigley et al in 1988. A number of problem areas which hamper researchers in this field are outlined by Germann (1988:689-693).

Of the many investigations and publications which have resulted from studies of attitude, three publications have been deemed particularly important during this investigation. They are by Thurstone, in 1928, Likert in 1932 and Allport in 1935. Their researches and publications established that attitudes were capable of measurement (Thurstone, 1928), and that scales could be developed to measure them (Likert, 1932). Allport began contributing to

this field of enquiry in 1935 and followed up this early publication with further researches and theories in this and other fields of psychology.

These early works of Allport, Likert and Thurstone were included in a 1967 volume, edited by Fishbein, which has been used as a key reference work during this investigation. When references are made to this particular publication, however, it should be kept in mind that the work of Allport, Likert and Thurstone is of much earlier date.

The theoretical framework applicable to attitudes on which this investigation is based, is based principally on research originally carried out by Allport (1967, 1970) and Likert, with additions by Evans (1965) and Triandis (1971), together with that of Thurstone (1967) who had proposed the construction of scales to measure attitudes.

Allport (1967:3-4) suggested that attitudes were profiles for activities which might take place, i.e. that attitudes were profiles for intended action. Thurstone (1967:79) suggested that attitudes could be measured in a manner similar to the methods used to scale scholastic achievement; i.e. that the results of the measuring of attitudes might be expressed on a linear scale. Allport (1970:359, 452) emphasized the uniqueness of the experiences of individuals during personality development. Thus researchers should, when assessing the outcomes of attitude measurement, and particularly those of groups, exercise caution, avoiding generalizations.

Evans (1965:10, 13, 16) indicated that the attitudes of, for example, students, should not be generalized to include the attitudes of the public; nor can the attitudes of students be compared with those of the public; that during attitude formation clever students of a group make decisions which

the duller students take over. Further, Evans mentioned that attitude formation of the learners should receive attention during teaching: one of the benefits which would result from paying particular attention to the formation of attitudes during teaching would be the reasonable conformity of attitudes amongst the learners at the end of teaching.

The measuring of attitudes of individuals, the need for the accumulation of knowledge about attitudes and, more generally, the predictability of the outcomes of the measurement of attitudes of individuals or selected groups was noted by Triandis (1971:5, 66, 117). He stressed how roles, habits and reinforcement can modify attitudes, how attitudes can persist in either individuals or groups, as well as the scope and stages of changes in attitudes.

The theories proposed, as well as the research of Allport and others, listed above, have been augmented by contributions in this field made by Fishbein as researcher (1967a), editor (1967b) and author, together with Ajzen, (1975). Fishbein's research in the sixties emphasized the multi-dimensional nature of attitudes which should receive attention during attitude testing. In collaboration with Ajzen (1975:508) Fishbein focussed attention on the nature of information: on the availability of information for learners to absorb, communicability of information and how, ultimately, behaviour was influenced by these variables.

The contributions of other researchers in the field of attitude studies are considered to be essentially supplementary to the mainstream of attitude research and theory established by the work of Allport, Evans, Fishbein and Triandis, which has been briefly outlined above.

The construction of attitude scales and the problems associated with them have received the attention of, amongst

others, Thurstone (1967), Likert (1967) and Thomas (1978). Youngman, as author (1978), and co-author with Eggleston (1979), has discussed questionnaire design and the construction of tests and scales for measuring attitudes, contributing to the operationalization of attitude testing and scaling for researchers.

In this research, in order to encompass as fully as possible the variety of attitudes which university staff encounter amongst their students, use has been made of research material originating during approximately the last decade in Australia, South Africa, the United Kingdom, Israel and the United States of America. Researches carried out in South Africa at university level dealing with the sciences, and especially the biological sciences, were particularly sought while sifting through the available literature. Not unexpectedly, many of the problems experienced by South African first-year university students are also found in the other countries listed above.

In Australia, Barnett et al (1983) found that among university third and fourth-year zoology students, a teaching programme being taught at that time did not necessarily result in the development of scientific thinking skills - to mention just one of the outcomes of the investigation.

Parker and Rennie (1986), studying ten year olds in Australia, found that science teaching could very easily discriminate between the sexes, disadvantaging girls and influencing their subsequent choice of occupation and career. This is supported by the most recent researches of Tamir and Amir (1987) in Israel, who studied twelve to fifteen year old science students at schools in Jerusalem. They mentioned the benefits to this age group of appropriately developed attitudes, providing an understanding of

how teaching strategies - teaching by enquiry as opposed to teaching by instruction - generate different attitudes.

Research in the United States of America by Leonard (1982) indicated that a problem-solving rather than an instructional and learning approach during laboratory sessions at university enabled students to formulate solutions to problems. Essentially, the students learn by enquiry rather than by take-over of information.

The activity-centred approach to the study of biology at both the junior and high school as well as university is endorsed by the researches of Tamir (1983a, 1983b), in Israel. It is noteworthy that the investigations of Leonard as well as those of Tamir focus on the implementation of modified Biological Sciences Curriculum Study (BSCS) approaches to the study of biology: the research clearly indicates the benefits which result by using the BSCS approach.

In South Africa, attitude research has received attention in a number of studies. These have often been of students at first-year university level, investigating relations between direction of study, e.g. dentistry or engineering, and attitudes. The research of Van Zyl (1982) at the Rand Afrikaans University, involving first-year science and engineering students, indicates that a cognitive gap undoubtedly exists between school leaving level and university first-year level. He points out the substantial costs incurred by the high first-year failure rate at university and concludes that a lack of developed reasoning skills is one of the causes of the poor results at university. He proposes that a remedy for this problem would consist of, amongst other things, deliberately developing science reasoning skills at university level in order to close the gap which exists between school and university.

However, these gaps are unfortunately not easily closed. Recent research by Sanders (1986), Sanders and Fridjohn (1986) and Jackson and Young (1987), have clearly shown that science education in South Africa is prone to a variety of problems when one science syllabus is taught to students of different races and cultures.

Problem areas, like the one regarding race and culture mentioned above, were identified and new approaches discussed by Keogh (1987). Essentially, these are centred on developing the whole student rather than merely transferring information to him or her.

Sanders and Fridjohn (1986) studied first-year zoology students at the University of the Witwatersrand, Johannesburg, discussing the high failure rate among these students, together with the efforts of academic support programmes (known as ASP) to remedy the situation. The complexity of the task of teaching heterogeneous groups of students was discussed with particular attention being paid to those who were educationally disadvantaged and were commencing study at university.

Sanders (1986) at the University of the Witwatersrand, emphasised the increasing proportion of educationally disadvantaged students in tertiary education in South Africa. She stressed the need for developing teacher training programmes enabling teachers to cope both with advances in science and a changing society.

The theme of teaching what is most suitable and of greatest worth came under scrutiny by Farrell (1987). The reader is left to reflect on the degree to which curricula, both past and present, achieved their goals - or notably failed to do so.

Schiffer (1980:95-105) pointed out some of the perennial problems of teachers. One of them, he states, is that teachers seldom - if ever - are given opportunities to participate in formulating educational policies: they merely carry out the plans of others: as a result, they derive little satisfaction in their work. Quite naturally, many of them are frustrated by this situation.

Gayford (1988) reports on students' disenchantment with high school science in the United Kingdom. He stresses that frequently this is the last encounter many of them will have with formal science and methods of scientific enquiry. Many students do not proceed to a university from school and continue their studies in science there; therefore it is important that what they learn at school is as relevant to daily life as it is to science. Gayford insists that science education should actively involve the students in, for example, hypothesising and developing science skills rather than passively absorbing content information provided by their teachers.

Fuls (1987) outlines a number of projects of varying depth and duration in which the focus is on the home, life at home and the cost of food. Adapted for use during science teaching, such an approach could help in breaking down learning barriers between home and school.

A survey by Fletcher (1983), at Rhodes University in Grahamstown, points out the need for developing, while in the senior secondary school, the characteristics of students - rather than merely learners - thereby taking on responsibility for their own studies. Implementing these suggestions would hopefully ease the transition from school to the first year at university.

These proposals regarding self-study, reflective thinking and the development of a student identity strengthen those put forward by Hart and Heyns (1970) at the University of Cape Town, when they investigated the learning problems associated with first-year study at that university.

Arzi et al (1984) investigated science curriculum development in Israel. They point out that if changes in science curricula are proposed, it is crucially important that teachers be involved during the curriculum development procedures. They also found that the perceptions of students and teachers regarding courses, differ: to the student, a course would be "some things to be learned", whereas for the teachers, the same course would, amongst others, involve their ego, an altered point-of-view, in-service training, learning etc. : i.e. a very much more complex involvement than merely the transfer of information.

Recent studies have drawn attention to both the fluctuation and the formation of attitudes during school science education.

Thus Ormerod and Wood (1983) reviewed the formation of interests and attitudes of boys and girls whose ages ranged between nine and fourteen years, and identified peaks and troughs in these students' interest in science, indicating the contribution their sex makes to the attitudes which are formed. Girls, for example, favour nature-directed activities, while boys prefer those relating to physical science.

Kelly (1986) studied essentially the same age group and reports on changes in students' attitudes; between eleven and fourteen years of age, students' interests change, and so do the attitudes to which they contribute. Their interests are less centred on nature than they are on human biology. Both the sex of the students and their social

class contribute to the attitudes which are formed. With these variables in mind it becomes easier to understand why certain schools are more successful than others in maintaining or improving students' attitudes to science.

The 1984 study of Okebukola, carried on fourteen-year-old biology students out in secondary schools in Nigeria provides evidence that competition, co-operation and individual effort during practical sessions in the laboratory all contribute to an all-round improved performance by a student.

In the light of researches such as those of Gayford, Kelly, Ormerod and Wood, it becomes clear that science education at its best accommodates both the group and the individual.

Rye (1983), working on the changes of attitudes of scholars in Great Britain, found discrepancies between verbal and written responses when he was assessing supposed changes of attitudes. These results indicated that during teaching, the changes of attitude described by Triandis (1971) and Van Zyl (1982) do not come about easily. An allowance needs to be made for the passage of time, for the selection and incorporation of the "new" with the "old" stock of information of the learners; this selection, resulting from the "selective attention" of the learners, was also outlined by Bynner (1972:30, 75) and Vurpillot and Ball (1979).

Jackson and Young (1987), at the University of the Witwatersrand, investigated the level of success of students during studies in biology in the university first year, using Matriculation Ratings. They found that when biology was used, it had little value in predicting success during the first year. However, a combination of two subjects, mathematics and physical science gave more reliable results. This investigation highlighted a number of learning problems

of students who are representative of the different races and cultures found in South Africa. Another problem area identified in the sample was a general lack of a range of the study skills vital to successful study at a university.

The work of Jackson and Young, Sanders and Van Zyl make it abundantly clear that while the restricted range of study skills students developed during their studies in science and biology at school enabled them to write a highly successful matriculation examination and so gain entry to science courses at a university, the same study skills were unfortunately not sufficient to provide the identical level of success for them during the first year of university study.

Ongoing research increases our knowledge of science education, yet the best efforts of curriculum developers are nevertheless found, in practice, and with time, to be inadequate for the task.

Possibly the International Union for Conservation of Nature and Natural Resources (IUCN, 1980) offer a solution where others might fail in the long run. They urge that the legislative bodies of governments, industry, commerce, trade unions, education and other organizations combine their efforts and jointly develop broad conservation policies. Those relevant to science would naturally include attitudes appropriate to this end, and they might conceivably have better success in the long run for science education than other less ambitious ones.

Also in a broad educational context, Pratt (1980:42-44, 59) stressed the need for meticulous planning in education, particularly during the phases where information, the means of transfer of the information and educational goals were under consideration, re-stating the ideas of Evans, and

which would later be confirmed by the research of Arzi et al in 1984. Children, states Pratt, spend twelve of the best years of their lives in school: their time and attention are non-renewable resources. Learning should therefore be meaningful.

Watts and Ebbutt (1988:213-218), interviewed science students in the United Kingdom, asking them to express their views on their studies in school science, from age eleven to sixteen years. They found that, on the whole, less than satisfactory conditions had prevailed in the science room. During studies relevance to the students' environment, coherence and continuity of studies, a sense of involvement and enjoyment together with responsiveness on the part of their science teacher were important to these students; their studies had not always catered for these expectations.

Shayer and Adey (1981) discussing science teaching in Great Britain, pointed out that the content of the curriculum should keep pace with the ages and differing abilities of the learners in content, concept and method of presentation.

In South Africa, the recent proposals made by Liebetrau (1984) on the evaluation of curricula and Fraser (1984) on the teaching of biology, incorporate excellent ideas and recommendations in the fields of curriculum evaluation and the implementation of learning theories during the teaching of high school biology. An address by Walters (1981 : 9) emphasized the role of interpreters of the curriculum. Critical comment on teaching biology, pointing out particularly that biological education should be rooted in the environment, was made by Milstein (1984).

Moodley (1983), working in Indian schools in South Africa, made it clear that little has been done at teacher level to develop educationally desirable attitudes for teaching high

school biology. One of the implications of his research is that if attitudes have not been developed amongst the teachers, they cannot pass them on to the learners.

Renzulli (1985:3-6), warns against too much reliance on the outcomes of testing, this holding good for class-tests, examinations and standardised tests such as those measuring intelligence. He suggests that we all-too-easily might be dealing with what he terms "schoolhouse" type of achievement. Students, during their studies at school should be given opportunities to develop behaviour which corresponds with their ability. Although Renzulli is primarily concerned with gifted students and he does not single out science education for attention, doubtless the same would hold good for science students.

Dancy (1982:22-23) proposed that science studies should be more closely linked with studies in the humanities. Although of earlier date, essentially his proposal combines those of Renzulli (1985), Watts and Ebbutt (1988) and others.

In recent years, in critical comment as well as research, the old "learning for learning's sake" has been successfully challenged in education as a whole. Science education has not been exempted from this challenge, yet for all too many students in schools, science education still implies little more than tests and examinations, even though, by and large, these tasks are successfully performed.

One of the fundamental questions: "Why are we learning this?" often is not answered successfully for the learners at school and university. When the answers to this question have been considered more carefully by the learners, and also by their teachers, appropriate attitudes might be developed which in all probability would result in greater

success for first-year students - and particularly for those at risk.

To illustrate some of the major points of attitude theory relevant to this research, a simple outline, based on the work of Allport, Evans, Fishbein and Triandis follows this survey of the literature.

3 ATTITUDES AND ATTITUDE THEORIES

3.1 What is an attitude?

To an enquiry about the nature of an attitude, a simple yet comprehensive answer would be that an attitude is a pre-disposition to action, directed towards something. Evans (1965:92) distinguishes between attitudes and interests: an attitude is broader, more general, while an interest is narrower and directed. Allport (1967:8) defined attitude as follows:

"An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects with all objects with which it is related."

This definition was originally put forward in 1935 and since that time many researchers in this field have used it as a guide. Allport's definition emphasises intention rather than action and that distinction has been borne in mind throughout this study.

Triandis (1971:3) suggests that attitudes have three components:

1. Cognitive, indicating identification, or at any rate, recognition of an object, situation or idea.
2. Affective: the emotional response. This response may be positive or negative, weak or strong.
3. Behavioural: this comprises an activity or a number of activities.

Fishbein and Ajzen (1975:12) endorse this point of view, and they outline attitudes as having a factual basis as follows (1975:287):

"At any point in time, a person holds a limited number of salient beliefs about any given object, action, or event, and these beliefs serve as the primary determinants of his attitude toward that object, action or event."

These authors recognize Allport's definition that attitude is a predisposition to behave (1975:12), rather than the behaviour itself.

From the above it is clear that attitude towards something requires, at the lowest level, recognition. On this framework of cognition an emotive response is based. The ultimate response would depend upon, and be almost inseparable from, the cognitive and affective components. A person to whom car is meaningless would have no attitude toward cars. Attempting to establish such a person's attitude towards the choice of and maintenance of a car would be a wasted effort.

Attitudes, although usually stable in adults, can unquestionably be modified. Brain-washing is an example of an extreme form of attitude change. In everyday life, a person's attitude to, for example, cars, would depend on a knowledge of cars, but the stability of this attitude would depend on further aspects of the behavioural component. Triandis (1971:8) mentions four: norms, roles, habits and reinforcement. A person on the subject of cars might seem to have contradictory attitudes when discussing cars with, respectively, his friends, his family, strangers, or with a car-dealer. Although this person might be driving a small, economical car, the person might want a larger one, but has

to consider the prices of new cars. In each discussion, the roles, norms, etc. are different and so might seem inconsistent. Yet the fundamental attitude - that to such a person a car is necessary - is hardly affected by each discussion.

While attitudes do vary from time to time, generally authors are in agreement that attitudes are persistent. Certain attitudes are, as it were, tenacious, and tend to resist change. The origins of resistance to change are diverse. Attitudes formed during growth and personality development of a person are most tenacious and resistant to change. When maturity has been reached and a definite national, class and financial identity has been established, a person will manifest a number of attitudes which are "typical" in terms of national, class and financial identity. The term self-esteem indicates a person's own identity, but this can also be indicative of resistance or susceptibility to attitude change. High self-esteem would be resistant to change, whereas low self-esteem would be more susceptible to attitude change. A person with a middle value in self-esteem would be susceptible to what Fishbein and Ajzen (1975:451) call "persuasive communication".

Intelligence, and the ability to discriminate, very subtly modify the traits outlined above. Intelligence and certain personality traits indicate an inherited, genetic contribution to the formation of attitudes. Differences in attitudinal behaviour would be the result of differences in the genetic complements of persons as well as the whole of the environment moulding them. Identical twins reared together should then be the only persons who might develop similar attitudes as they have virtually identical genetic complements and upbringing.

Parents who encourage their children to share a wide variety of experiences with them, know that during such guided

involvements attitudes are formed which are to some extent modelled on the attitudinal behaviour of the parents. It is, therefore, not surprising, that children often have attitudes similar to those of their parents (Evans 1965: 5-6).

During the formation, or change, of attitude, the various sources of information impinging on the person are significant. Certain sources have a high credibility, while others do not. To illustrate: a parent is a source of high credibility to a child while an uncle or aunt would in general have a lower credibility rating. Sources of information vie for the attention of parents and their children. In order to eliminate some of the conflicting opinions and information, certain sources are selected as being more trustworthy and dependable than others. The following sources would have a high credibility rating for an individual: newspapers, television, teachers, advertising, and friends; all have a differentiated input value. Triandis (1971:168-199) discusses these in some detail, listing sources, channel (i.e. medium), credibility differences, message style and content.

The greater the need to modify behaviour - whether learning a slogan or buying a particular brand of toothpaste - the greater the impact on the consciousness of the individual has to be. When the source, or sources, attain credibility for the individual, a foothold is gained for the beginnings of an ultimate change of attitude and hence behaviour. A resistance to attitude change in individuals, based on their individual stock of (and sources of) information can be overcome, or possibly made less credible, by the press of information from accredited sources. The attitudes of individuals can be altered, but in order to maintain a particular attitude, there should normally be reinforcement of some kind, ensuring that the desirable attitude is maintained.

3.2 Attitudes and education: some implications

The outcomes for education of attitude theory and research are far-reaching, both in the general, formative areas as well as in the specialized, subject areas. In both areas specialized as well as general information is passed on from one generation to the next. For each, attitudes would naturally be included during information transfer. There will be a general, but also a specific, moulding of the personality: these might complement or they might even conflict in what might be loosely termed "... the budget of the personality".

This "budget of the personality" proposes that a selection mechanism operates during the transmission and accumulation of information, resulting in the formation of different attitudes in individuals.

A popular teacher teaching a class might be able to teach and explain as effectively as an unpopular teacher teaching the same class. Yet during the transfer of information, different attitudes would be generated in the students, but these differing attitudes might not be reflected in the marks of the students taught by the different teachers. To establish what these attitudes are is usually neither easy nor practicable, as attitudes are continually being modified as a result of continued input and selection.

Establishing attitudes by measurement is time-consuming, costly and would almost seem like wasted effort. Yet if the outcomes of learning are established in terms of information transferred by teachers to learners, a number of reasonably predictable interests and attitudes will also develop in the learners, but in varying degrees, as inevitable outcomes of the learning process. A teacher, teaching, say, the

earthworm could be sure, at the end of the study, whether the factual content material has been transferred to the learners by giving them a test. An attitude assessment, possibly camouflaged as an "opinion poll", would supply feedback on the formation, maintenance or change in the attitudes of the learners brought about by the material taught. Needless to say, unless this attitude assessment is well designed, it will be a waste of time and effort!

According to current theories of attitudes (Evans 1965:8 and Triandis 1971:150) students attitudes can be changed more easily than the attitudes of persons not engaged in studies. Students at university are to a large extent a select, highly motivated group who are malleable and characterized by a substantially higher than average intelligence. They are also in contact with powerful moulding forces. What is imparted to them by the content material is of great importance to them while on the way to achieving their goals, for self-esteem and ego's are involved during their studies.

According to Evans, it would be comparatively much more difficult to bring about a similar attitude-change in the general public where the "hot-house atmosphere" such as exists on a university campus or in the varied activities of a school does not exist. Fraser (1984:50-51), indicates that the emphasis of teaching - and here it is understood that it might be in the broader or in the stricter sense of subject teaching - is also on successful learning by those involved.

Promoting understanding and enhancing learning experiences would then also promote the formation of certain interests and ultimately, in a shorter space of time than would have been the case with a less concerted effort. The curricula in use in the great majority of schools throughout the world

are excellent examples of concentrated, structured, participation in learning.

Allport (1970:126) mentions that goals are created by adolescents to give direction and dimension to their self-hood. The structured participation in learning brought about by school curricula, the goalsetting by learners, the interests and the attitudes which cluster around them would hopefully all be complementary, extending beyond formal education at schools and universities to jobs and careers. Jennings (1983) points out that these expectations are not always realized in our evolving society, indicating a need for co-ordination and co-operation of the activities of teachers, learners and education planners.

3.3 Measuring attitudes

Attitudes, unlike some other relatively stable personality components, such as, for example, degree of intro- or extroversion, may vary considerably, varying from person to person in addition to varying from group to group. A particular attitude like, for example, an attitude towards a car, would also vary with time or place; formation and maintenance of attitudes are brought about by increase of stock of information. Frequently the increase of stock of information is brought about by learning.

The constant changes in attitudes brought about by increases of information - and a considerable change in attitude can be brought about by intensive studies and the learning by which it is accompanied - make the assessment of attitudes more difficult to establish by means of a test than would be the case if more stable personality components were being tested.

During attitude assessment the approach is similar to that of testing knowledge of a particular subject. Researchers, teachers and other persons may want to know to what extent a particular attitude is present in an individual or a group. Ultimately they want to rank the outcomes of such assessments in order to establish the range and importance of attitudes present.

An assessment of the range of attitudes present in one or more groups could be a useful additional guide in establishing the overall effectiveness and range of an education programme. During the transfer of information, attitudes are formed, maintained or re-formed, although this might not be one of the primary educational objectives of the programme. At the end of the tuition a test of content material might be given in order to establish what has been learned. A test to establish the range of attitudes of the learners might also be given in addition to the test of knowledge. This attitude test could, for example, take the form of an "opinion poll" of the education programme. The outcome of the assessment of attitudes by testing might be compared with the results of testing of knowledge. Depending on whether the results of the tests - knowledge and attitudes - compare favourably or not (and of course the importance attached to developing attitudes in particular) a good test of attitude might be used either in the place of a test of knowledge, or as a reliable guide to the successfulness, other than gain of knowledge, of an educational programme. This test might, if change of attitudes of the learners is an important objective of the educational programme, be extended to a pre-instructional and post-instructional test of attitudes, with or without the back-up provided by the results of tests of knowledge, and without the stress which unavoidably accompanies tests of knowledge.

Attitude measurement tests have been constructed that give, for a split-half test, using the Spearman-Brown formula, a value of .92 for the corrected value of the reliability coefficient. Though such high correlations, varying from, generally, .75 to .90 (Evans, 1965) may seem very attractive, constructing a scale for attitude measurement is difficult, problems being encountered at almost every stage of scale and test development.

Some of the problems mentioned by Triandis (1971:40) are: pencil-and-paper versus interview, developing an equal-interval scale for word-association tests, and sampling to obtain random samples. Various researchers mention that during attitude sampling the persons being tested learn from these tests and that the results of subsequent tests may be influenced by such learning. A sampling of the attitude "prejudice" may have to be disguised as a test of "knowledge" (Evans, 1965:20). Reversing the scoring of selected items is another method that might be used (Youngman and Eggleston, 1979:14). The need for a well-designed test which, in addition to being reliable, is not overtly or covertly biased and overall is attractive in appearance is stressed by Youngman (1978:20), Thomas (1978:28) and Germann (1988:692).

Attitudes are assessed from the responses of the persons taking the test to the test-items used. Such test items take various forms, such as: statements, sentences or phrases, or italicized sentences in paragraphs requiring scrutiny; sentences with words omitted or even straight questions. Persons taking the test complete the items in the appropriate ways. A scale of 1 to 3 or 1 to 7, possibly accompanied by word cues, might also be used where a clean-cut distinction cannot be made in the responses. An example taken from Youngman (1978:11) illustrates this point:

SCHOOL IS

difficult 1 2 3 4 5 6 7 easy

Such items provide for sensitivity and flexibility in the responses. Often, "don't know" and "no option" responses accumulate when the middle scale value is chosen by persons taking the test. This tends to blur sharp distinctions and consequently some researchers have resorted to omitting the middle value.

Triandis (1971), Youngman and Eggleston (1979) and Thomas (1978) emphasize the need for validity and reliability in test construction. Youngman and Eggleston (1979:5) mention two further requirements: a table of specifications which outlines the domains or factors sampled by the test-items and also the necessity for piloting the test thoroughly before it is administered in its final form.

The final test, however, should not have too few items, for if so the reliability and particularly the validity of the test could be questioned. However, developing a test which has sufficient items to be both reliable and valid might result in an excessively long test which might be too time-consuming for best results. In addition, a test and re-test situation for determining attitudes might not be possible or acceptable. Finally, the statistical methods used for test analysis should be appropriate to the methods used to collect the data.

Yet in spite of the many theories, test and test-item developments and statistical methods employed, the suggestion made by Thurstone, namely that attitude can be measured in a manner similar to the measurement of knowledge, still seems to elude researchers. A study by LaPiere (1967) indicated a significant discrepancy between

the written responses and the equivalent behavioural responses which related to a particular attitude. Similarly, when interviews, during which an attitude is measured, are compared with the equivalent written assessment, discrepancies may well be found. This was neatly illustrated by the investigation of Rye (1983:20). A very similar situation was discussed by Triandis (1971:54) under the heading 'norms and roles', where subjects had modified their answers to please the investigator. Fishbein (1967a:257) indicated that attitude, envisaged as a single construct by researchers, might in fact have belief, attitudinal, intentional and behavioural components.

In the many studies carried out in the domain of attitudes and personality, various problems have emerged, amongst which are the following:

- 1 the results of attitude studies which were obtained from one group do not readily transfer to another group, even in the same population. Certain types of attitudes are more prevalent in some social strata than others, e.g. attitudes to university and education.
- 2 Often, statistical verification of research results fail to back up investigations of attitudes. This might be due to a variety of causes: poor experimental design, together with the methods employed: a too-wide or too-narrow domain of personality labelled as "an" attitude. The so-called attitude might be a mixture of attitude, belief, intention or possibly the interference by a "general" factor which is, proportionately, so large that the isolation of a specific attitudinal component is not possible with the statistical and other methods at the researcher's disposal. Attempting to establish an attitude, or a factor contributing to an attitude, of a too-select

group is another trap - indicative of a too-esoteric study, as is an overly mechanical approach to personality.

- 3 The sum of the parts - in attitude research - is often not equal to the whole, as a measure of personality. An example to illustrate this point: a person with a negative attitude to consuming alcoholic beverages and hating the tobacco smoking habit, might not also have, as a matter of course, a negative attitude to using other drugs like LSD. Some attitude researchers investigate abstruse topics, causing other researchers in the field to complain that, indeed, there is no concerted effort amongst researchers.
- 4 Attitude is certainly more than semantics, yet "an" attitude is present rather in the way that an electron is present around the nucleus of the atom: although often referred to, it is unseen.
- 5 Attitudes tend to persist, as already mentioned, but attitude change can be sudden, almost instantaneous, due to, for example, viewing a picture, hearing a radio programme, or attending a concert. Of course it could also be speculated that attitudes are innate as genetic predispositions, which are then modified or verified by experience and education.

In conclusion, it can be said, however, that those attitude tests which have been developed and which year after year, give reliable results and are, in addition, valid, definitely are testing more than superficialities!

4 ATTITUDES TO STUDY IN THE BIOLOGICAL SCIENCES: SAMPLING THE ATTITUDES OF ENTERING STUDENTS AT A UNIVERSITY

4.1 The development of a questionnaire for sampling students' attitudes

During the planning stage of this research, after considering a number of possibilities such as essays, interviews, observations, etc., it was decided that an attitude test as such would not be developed. It was decided instead that the most practical method of establishing students' attitudes would be to develop a questionnaire, administer it under carefully supervised conditions, use a computer to tally the scores and to employ appropriate statistical methods to analyse the responses of the students. Using a computer in the analyses of responses would be economical both in terms of time and effort.

The decision to develop and administer a questionnaire, rather than a test was made after carefully considering the fact, amongst others, that a blanket sampling of all the first-year students studying biological sciences at two major universities was envisaged and a preliminary survey showed that approximately one thousand students would be involved. The student sample group, although large, was also heterogeneous and therefore obtaining sufficient responses to create adequate sample groups from students' responses might create problems when using criteria in different combinations. For example, a problem that was envisaged was that students' school subject choice might include or might exclude biology. Having biology as a subject in the senior secondary school was an important factor in this research, for continuity of the same kind of education, which began with biology as a subject at school and

continued as studies in biological sciences at university, was under investigation.

With such a large sample under investigation, printing costs would be high and the questionnaires bulky; however, relatively problem-free processing, age and sex differences, the different school-leaving examinations the students wrote (bearing in mind that one of the two universities involved in this research, the University of Cape Town is predominantly English-medium, whilst the other, the University of Stellenbosch, is predominantly Afrikaans-medium), together with the other factors listed above all contributed to the final decision favouring development and administration of a questionnaire rather than a test or in-depth interviews.

4.2 The questionnaire and attitude theories

It was deemed necessary to establish as far as possible the students as learners in the biological sciences (rather than generators of data), and then to ascertain in what way they had learned while at school. The following were considered important factors during the development and administration of the questionnaire:

- 1 That, if at all possible, all the students taking first year courses in biological sciences at the two universities would be sampled, whether they had studied biological sciences at school or not.
- 2 That the term "biological sciences" at school should include not only the subject biology, but also other cognate school subjects such as botany, zoology and physiology. This would ensure that sampling would not be too narrow and therefore possibly limiting.

- 3 That the questionnaire would attempt to seek answers in the domain of attitudes formed at school rather than those related to the prospects of university studies.
- 4 That the time needed to complete the questionnaire should be approximately half an hour for the average reader, and that it should require a minimum of writing. The items of the questionnaire would provide a number of options from which the students would have to make appropriate choices.
- 5 That the students be given a few opportunities in the questionnaire to provide their own opinions and comments in order to best accommodate the breadth of their experience and that these would also receive attention during analysis of the questionnaire.
- 6 That the tone of the questionnaire would be friendly and candid, thereby hopefully eliciting frank and well-considered responses from the students.
- 7 That the students should complete the questionnaire as early as possible during their first academic year, i.e. before university-level tuition had modified their attitudes.

The questionnaire might, for example, be completed during a lecture period or during a laboratory practical session, whenever a half-hour was available, the major criterion being that of a controlled environment. Providing such an environment would be done in order to avoid, as far as possible, incomplete responses, mis-readings, omissions and misunderstandings.

- 8 That the final analysis should take account of incomplete responses from students.

- 9 That the students' responses would be checked and numbered sequentially; each completed questionnaire would be examined and checked carefully in order to eliminate, as far as possible, inconsistencies and inaccuracies in student responses which might hamper analysis by computer thereby resulting in data being discarded. During the checking and numbering of questionnaires, written information supplied by students might serve to highlight certain aspects of their school studies. This information might then be used to provide clearer insights into students' attitudes. Such insights would naturally only be possible if completed questionnaires were carefully checked and read and not if the responses were merely processed for computer analysis.
- 10 That it is highly probable that first-year student populations possess a wide variety of educational experiences and attitudes and that it is therefore important to seek as much of this information as possible via the questionnaire in order to give an added dimension to the research.
- 11 That the wide variety of learning experiences of the students during their studies in biology at school might blur different attitudes present in the sample. Thus the whole sample would have to be split a number of ways in order to highlight those differences and similarities which would be significant in learning at university level or in remediation, if necessary, at school or university level.
- 12 That as the questionnaire was being administered at university level in the Cape Province, a strict target group, with its origins in the Cape Province, was

envisaged within the whole sample group. This strict target group would be determined using a number of criteria. These students would have, inter alia, the following characteristics:

- 1 Registered as a student at a university in the Cape Province. In this study only students registered at the Universities of Cape Town and Stellenbosch would be considered.
- 2 Having studied a biological science subject during the senior secondary phase (i.e. the last three years) at high school.
- 3 Having written the Cape Senior Certificate examination as a school-leaving (i.e. matriculation) examination.
- 4 Having no previous record of studies at any university.
- 5 Studying biological sciences at university as a direct follow-on from biological sciences studies at school.

The last criterion was considered to be a very significant one in this research for it was believed that school biology would benefit those students who intended continuing their studies in this field at university. On the other hand, school biology might have for those students attributes which are not particularly beneficial during university studies.

The questionnaire which was developed, taking the above criteria into consideration, but within the inherent limitations imposed by use of questionnaires, was divided into two sections, A and B.

Both English and Afrikaans versions of the questionnaire are included in Appendix 2, while the two Tables of

Specifications for items in Sections A and B, are included in Appendix 1.

Section A of the questionnaire identifies the learners with regard to age, sex, place of origin, academic status, (i.e. whether they had previously been at university or not), in which year they had left school, and the school-leaving examination they had written. All the students had to complete this section, whether they had studied biology at school or not. After completing this section they thereupon completed Section B; this section was limited to only those who had studied biology at school.

The responses of students who had not studied biology at school were also important as they contributed information regarding their science studies at school. In this research, a particular effort was made to focus on the cities, towns and schools in South Africa where students had studied, their science-orientated activities and the problems they encountered during their studies in science.

The items in Sections A and B of the questionnaire were arranged to facilitate responses and often had, for example, key phrases of the items underlined.

Section B deals with students' existing attitudes to biological sciences, i.e. those formed while still at school. Two kinds of items are included here: those enquiring into the methods employed to teach students, and those investigating their attitudes.

In Section B the items provide numerical, word-cued and other options. These options provide selected responses as "answers" to enquiries into attitude formation in biological sciences and attempt to identify them by providing them as options. Taken together, the items constitute a systematic

enquiry into the interests in Nature of the students and enquire into different methods used in their schools during studies in biology, their outcome and the prospects they generated amongst the students for continued study at university in this field.

By interpreting response to items in Section B, attitude profiles can be assembled for students. Items in Section A provide supportive information for that of Section B, while details such as age, sex, course of study, university where the student is registered, etc. may be used as a basis in order to select a number of samples. In order to select and assemble such samples, appropriate computer programmes would be used.

A number of factors deemed operative during school studies in biology were listed. Seventeen such factors appear as options in items 1, 12, 13, 21 and 22 of Section B; their details are set out in Table 3. The specifications of the remaining eighteen items in this section are in Table 2.

Some examples of the above-mentioned factors are: parental influence and interest, exam-centred activities, ease-of-study of biology, self-awareness and career. Each of these factors was included twice in the five items probing attitudes. For example: "parental influence" appeared in items 1 and 13. "Salary and career prospects" as an option appears twice, but only in item 1. Provision of each option twice would hopefully reduce misreadings, omissions and other errors by the respondents. From the responses it was hoped that a clearer picture would emerge of which factors combine, thereby resulting in students choosing to study biological sciences at school. Questions like the following might then be answered:

- * To what extent does parental influence determine subject choice in biological sciences at school?
- * Does the ease-of-study of this subject influence its choice as a subject at school?
- * What are the roles played by experimental work, projects and examinations in this subject at school?

It was hoped that responses chosen and information supplied by students might provide guidance during analysis; that for example, the factors chosen by the students being as significant as those which were not chosen. Experience has shown that students, on entry to university, differ considerably in their maturity. Many are mature, having well-established, positive attitudes to their studies, while quite a number, however, are less - some much less - mature, with their attitudes less formed and positive than the attitudes of some of their class-mates.

During this research, differences in attitudes which reflect differences in maturity would be taken into careful consideration, particularly during analysis of results, and an overly too-mechanical interpretation of responses to the attitude items of Section B would, as far as possible, be avoided.

5 ADMINISTRATION OF THE QUESTIONNAIRE, PROCESSING OF THE RESPONSES AND TREATMENT OF THE DATA

5.1 Administration

At both universities the questionnaire was administered during laboratory sessions under carefully supervised conditions. To encourage a positive approach to the completion of this rather bulky questionnaire, it was introduced to the students either by the researcher or a member of the university teaching staff.

Although it was found that the allocation of time for completion was adequate for the great majority of students, extra time was allowed for those few students who read slowly. Students' enquiries, of which there were few, were answered.

The English version of the questionnaire was administered to first-year students studying biological sciences at the University of Cape Town on 20, 21, 24, 25 and 26 March 1986. Unforeseen circumstances resulted in the postponement of two sessions until 10 and 11 April 1986. Each batch of completed questionnaires was kept separate. The questionnaires were completed during the fourth, fifth and seventh weeks of the academic year.

The Afrikaans version of the questionnaire was administered to first-year students studying biological sciences at the University of Stellenbosch on 24 and 25 March 1986. Once again, the batches of completed questionnaires were kept separate. The questionnaires were completed during the seventh week of the academic year.

No further questionnaires were administered after the above dates.

5.2 Processing of the responses and treatment of the data

The completed questionnaires were numbered sequentially, each batch being kept separate. The responses were checked for inaccuracies, mistakes, omissions and student comments. Only three partially-completed questionnaires were discarded, yielding a total sample of $N = 893$, thus $N_T = 893$. This represents 84 per cent of the first year enrolment in biological sciences at the two universities concerned.

During the transfer of responses from the questionnaires on to the data catch-sheets the following changes were made:

Section A (See Appendix 2)

- Item 6 The list of school-leaving examinations was increased to eleven
- Item 10 A number of schools, with a country-wide distribution, could be clearly identified as schools providing the two universities with considerable numbers of science students

Section B (See Appendix 2)

- Item 15 Comment on teacher: three categories were created for positive, neutral and negative comments
- Item 20 Comment on learning problems: two categories were created for "no problems encountered" and "own solutions to problems devised"
- Item 22 Comment on school level biology: three categories were created for positive, neutral and negative comments

The changes, listed above, were included when the information was coded and finally punched on to computer cards for analysis.

Each student's responses, irrespective of whether or not Section B of the questionnaire had been completed, was allocated two computer cards. Information pertaining to Sections A and B was punched on to separate cards.

Selected criteria from Section A of the questionnaire were used during computer analysis to assemble sample sub-groups which were different from the original batches. Thus sample groups such as, for example, an exclusively female sample group or a medical sample group who wrote their school-leaving examination during the period 1981-1985, could be assembled during analysis.

Frequencies and percentages which resulted from student responses to questionnaire items were later used during analysis.

After due consideration, it was decided that statistical analysis would be carried out according to the following guidelines:

- 1 During statistical analysis, non-parametric statistics would most often be employed;
- 2 The results of statistical analysis would be carefully weighed against the educational significance.

During analysis, however, the percentages and frequencies generated by students in the samples were found to be of such a uniformly consistent and clear-cut nature, that, for the greatest part, formal statistical analysis was found to be unnecessary and an essentially descriptive approach used instead. Using this method, student attitudes would be in-

licated by the frequency of their response to attitude items, being supported by percentages reporting their response to the remaining items in Section B. This approach was considered as being entirely appropriate in this situation.

6 DESCRIPTION OF THE RESPONSE TO THE QUESTIONNAIRE OF THE WHOLE SAMPLE OF BIOLOGICAL SCIENCE STUDENTS (COMBINING STUDENTS AT THE UNIVERSITIES OF CAPE TOWN AND STELLENBOSCH)

6.1 Section A

For this section of the questionnaire $N = 893$ (i.e. $N_T = 893$), being the entire sample of first-year students studying courses in the biological sciences at the universities of Cape Town and Stellenbosch. Within the larger sample, the smaller one identifying students who had studied biology at school is $N_{TB} = 807$. Percentages and frequencies relating to their response are shown in Tables 4, 14, 15 and 16, in Appendix 1.

Percentages originating from the analysis of data are rounded off to the nearest whole number. The result of this procedure is that percentages listed or discussed in this section do not always total 100 per cent. Where appropriate, exact percentages are given.

Items of Section A of the questionnaire discussed below have been rearranged and clustered to facilitate description. The context of each item has been included in the descriptions which follow; hopefully this will reduce continual reference to the questionnaire in Appendix 2 in order to identify items and, by so doing, interrupt the flow of the description. Where items are clustered, they are listed one below the other and described in the same order.

Item 1 The student sample is unevenly divided between the two universities: 41 per cent study at the University of Cape Town and 59 per cent at the University of Stellenbosch.

Item 11 Only 3 per cent of our sample of students studying at the two universities, are from places other than South Africa or South West Africa/Namibia. Zimbabwe and the national states such as Transkei, Bophuthatswana, Ciskei, etc., account more-or-less equally, for most of this small percentage.

Item 3 The sample of students is divided almost equally between the sexes: males 51 per cent, females 49 per cent. In general, studies in the biological sciences do not favour either sex in the way that a course in, for example, engineering, would do.

Item 4 Eighty eight per cent of this sample are first-year students in the biological sciences in the true sense of the word. Most of the remaining 12 per cent are students who have attended other university courses, but still have first-year status, or are now in their second year at university, but have biological science studies as a specialized choice.

(Items 6 and 7, following below, serve as examples of items which have been clustered.)

Item 6

Item 7 Although the two universities concerned are situated in the Cape Province, the school-leaving examination of the Cape Education Department (the Cape Senior Certificate) was written by only 65 per cent of the whole sample. The rest of the sample is fairly diverse, the largest contribution, 12 per cent, being that of students who wrote the school-leaving examination of the Department of Education and Culture. Students from the Transvaal, Natal or those who have written the Joint Matriculation Board examination contribute about the same, approximately 6

per cent each, to the sample. The Orange Free State school-leaving examination contributes 2 per cent to the whole sample, while 3 per cent of the school-leavers wrote the National Senior Certificate examination. Seventy eight per cent of the students at the University of Stellenbosch wrote the Cape Senior Certificate examination, compared with 48 per cent of those at the University of Cape Town. Of the two universities, the University of Stellenbosch is much more representative of a student population having its origins in the Cape Province than is the University of Cape Town.

Item 9 The ages of the great majority of students in the sample lie between seventeen and twenty five, with older or younger students making an insignificant contribution to the sample. Seventeen to twenty two year olds account for 97 per cent of the sample. Eighteen year olds (46 per cent) and nineteen year olds (34 per cent) are most numerous in the sample.

Item 8 A very high percentage (97 per cent) of the students wrote their school-leaving examination during the period 1981-1985, with 75 per cent of the whole sample leaving school at the end of 1985. Military training for males helps to account for the spread into the 1981-1985 grouping. Only 3 per cent of the students of the sample wrote their school-leaving examination before 1981.

Item 10

Item 12

Item 13 Schools contributing students who are studying biological sciences in the first year at the two universities concerned have a country-wide distribution, but these schools are most frequently found in or near one of

the major South African cities, such as Cape Town, Johannesburg, Port Elizabeth, Durban, Pretoria and Windhoek. Schools in (or near) selected large towns such as Stellenbosch, Malmesbury, Durbanville, Upington, Somerset West and Bellville also contribute students to the group under investigation here. Schools in rural areas contributed few (usually no more than three) students to the group. The larger schools, a number of which are found in the cities and large towns listed above, contributed a variable number of students, from as few as six to as many as twenty to the group/sample.

About seventy schools, having a wide geographical distribution, contributed over half (56 per cent) of the whole sample.

Item 14

Item 15 Sixty per cent of the students had attended neighbourhood schools that is, a State school closest to the home, and 40 per cent selected schools (i.e. private, fee-paying schools or otherwise favoured State schools). Ninety one per cent of the student sample reported that they had studied biological sciences at school, that is, biology, botany, zoology or physiology).

Item 17

Item 18 Ninety two per cent of the students had studied physical science at school, 83 per cent studying this subject on the Higher Grade and the remaining 9 per cent on the Standard Grade. One per cent of the sample studied this subject either before a Grade system was introduced or at a school-leaving (i.e. matriculation) examination in which subjects were not offered at Higher and Standard Grade.

Item 16 The academic results of students while at school were excellent, irrespective of having studied biological sciences at school or not. Only 1 per cent of the whole sample report an average examination and test result of 50 per cent or less during their final year at school.

Almost 90 per cent of the sample report an examination average during the final school year which was higher than 60 per cent, with approximately 17 per cent of them represented in each of the following five intervals: 61 - 65 per cent, 66 - 70 per cent, 71 - 75 per cent, 76 - 80 per cent and 81 per cent and higher.

Item 19 Eighty six per cent of the student sample intend studying biological sciences at university for three or more years. Students intending to study these subjects for one or two years account for the rest of the sample, with only 3 per cent of the sample intending to study these sciences for two years. Fifty seven per cent of the students of the sample intend studying these sciences for four years. Forty three per cent of the whole sample of students intend studying biological sciences for more than four years. If $N_{TB} = 807$ for the number of students with a history of school biology, the last-mentioned value increases to 47 per cent. At the end of their studies, these students would have been studying biological sciences at school and university for eight years!

Item 20 When students were required to rate their interests in Nature and natural systems, very nearly all (98,5 per cent) of them rated their interests average or above average. The three highest ratings of this item were approximately 27 per cent each, totalling 84 per cent.

Item 21 When students had to rate their activities involved with Nature, and organized practical activities rather than recreational pastimes were indicated, a middle value of 37 per cent was the result and above and below this middle value, the two values totalled approximately 22 per cent. The highest value ("a great deal") was only 5 per cent, the lowest value ("very little") was 13 per cent.

Item 22 Finally, all the students had to rate their test and examination expectations in biological sciences at their respective universities. The distribution of their responses to this item matches reasonably well with their final year average mark (that is, for all their school subjects).

Two per cent of the students in the sample estimated that they would achieve less than an average mark at university, whereas 80 per cent expected an average or above-average mark and 14 per cent expected a "far above average" mark. Four per cent expected their marks to be "excellent - near the top of the class".

6.2 Section B

For this section of the questionnaire, $N_{TB} = 807$, being 90 per cent of the entire sample ($N_T = 893$) and representing those students who studied biological sciences (called Biology in the questionnaire) at school.

(A good response was made to items in this section with very few non-responses. The non-responses varied from only one to three per item, most frequently being two or three. Although for items 16, 17, 18 and 19 the frequency of these non-responses rose, varying between 6 and 8, this still represented a value of less than 1 per cent of the total

sample. These latter items probably required a perceptual awareness only moderately developed in many of the students, or related to areas in which some of the students had difficulties in making accurate responses.)

Items in Section B have been rearranged and clustered to facilitate their description. Once again the context of each item has been included in the descriptions which follow; hopefully this will reduce continual reference to the questionnaire in Appendix 2 in order to identify items and, by so doing, interrupt the flow of the description. Where items are clustered, they are listed one below the other and then described in the same order.

Percentages originating from analysis of data in this section are rounded off to the nearest whole number. The result of this procedure is that percentages listed or discussed do not always total 100 per cent. Where appropriate, the percentages are given exactly.

The five items testing students' attitudes are treated first:

Item 1

Item 12

Item 13

Item 21

Item 22 The attitudes developed by students during their studies in biology at school are reflected by the frequency of response to the seventeen factors provided as options by the five items listed above. The two frequency responses relating to each factor were added. Thereupon the

whole of the frequency response was ranked from highest to lowest. The highest totals indicate the greatest importance, and correspondingly, the lowest totals indicate their slight importance. The frequency response outlined above is shown in Tables 4 and 14, Appendix 1. The frequency response of Table 4 is shown, with the factors arranged in order of importance from highest to lowest, below:

- 1 a personal interest in Nature
- 2 biology is an interesting subject to study
- 3 biology is a subject which provides entry into a university for further study
- 4 the subject content of biology is useful in the home, in Nature and the environment
- 5 a positive attitude to Nature and Creation is brought about during studies in biology
- 6 biology is an information-centred subject
- 7 biology is an "easy" subject to study successfully
- 8 biology is concerned with good test and examination results
- 9 studying biology provides opportunities to demonstrate own ability
- 10 experimentation contributes to the study of biology
- 11 biology provides opportunities for student and teacher to communicate
- 12 biology provides opportunities for creativity such as thinking, reading, research, making models
- 13 there are prospects of interesting/top employment and careers with matching salaries after further studies
- 14 projects, on either a group or individual basis, contribute to the study of biology
- 15 good teachers play a part during studies in biology
- 16 parental interest and approval are important during studies in biology
- 17 school friends' choice of biology influence the student's choice of the same subject

The seventeen factors ranked above are not evenly distributed but are clustered with irregular intervals between them. Thus, for example, factors 1 and 2 are closely spaced and are not separated by a wide interval.

A numerical ranking of the frequency response by the student sample is much improved by taking these clusters into consideration. An interpretive rather than strictly numerical approach to their ranking generates more dynamic relationships between them than adhering strictly to a purely numerical ranking would have done. For example: "Good teachers" and "parental influence and approval" which rank as 15 and 16 in the numerical ranking, rank equally however, in the interpretive ranking. During interpretation of these factors, it could be suggested that teachers and parents, although they are of cardinal importance in creating and maintaining a learning environment in which students can study successfully and prosper academically, nevertheless seem to be considered by the students to be of little importance - at most as little as their friends and classmates.

The nature of the attitudes prevailing amongst the students in this sample can be judged more accurately by examining their responses to items 15 and 20, below, where the roles of biology teachers and parents are investigated.

Item 2 The language of tuition of school biology was equally divided between the Afrikaans and English languages, with 45 per cent of tuition taking place in each language. Nine per cent of the pupils studying this subject at school were taught in both Afrikaans and English, i.e. were in dual-medium schools.

Item 3 Biology was studied at school on the Higher Grade by nearly all (98 per cent) of the students. One and a half per cent studied it on the Standard Grade, with 0,5 per cent studying it with no Grade system being used.

Item 4 This item shows biology as having a very high popularity rating. Ninety-two per cent of the respondents rated the subject as having a popularity rating ranging from "average" to "very popular". Five per cent considered it as being of less than average popularity, and 2 per cent thought it "fairly unpopular". Only 1 per cent rated the subject "very unpopular". The below-average ratings totalled 8 per cent.

Item 5 Studying biology at school affected the students' interest in the subject as follows: 14 per cent were unaffected, their interests remaining unchanged, 29 per cent had their interests slightly increased, 40 per cent had their interest much increased and 13 per cent had their interests very much increased. The students whose responses indicated a slight decrease in interest in Nature only comprised 2 per cent of the sample. The two lowest ratings totalled 1 per cent: possibly this rating corresponds with the 1 per cent who rated this subject at school as being "very unpopular".

Item 15 Subject teachers contribute the following to pupils' involvement in the study of biology at schools, according to their students' responses. Ranking first was a teacher's interest in the students. This is followed, in the second place, by three values ranking almost equally as follows: a teacher interested in Nature, a teacher whose students did well in tests and examinations, a teacher being a knowledgeable person. Placed third is the ability of the teacher to explain well and solve students' learning problems. Fourth was the popularity and friendli-

ness of the teacher followed, while in fifth place was a teacher's intellectual attributes.

More than half the students chose the first two places in the ranking of the options of this item, with 64 per cent of the students assigning the first place. Such an involvement indicates more than normally strong convictions on the part of the students. The third and fourth places gained 46 and 40 per cent, respectively, of the students' responses. The fifth place also has a significant value as nearly 30 per cent of the students chose this option.

A small percentage, only 4 per cent, of students' responses included comments. Students' volunteered comments on teachers ranked positive qualities almost equally with negative ones. Comments were generally positive or negative; those considered neutral were only half of the positive-negative comments.

Item 14 Eleven of the more common sources of information were listed as options in this questionnaire. The students' responses to this item indicated that the eleven options could be reduced to six, due to the irregular distribution of responses, similar to that described earlier in this section.

First placed was the option "notes made by the teacher", followed, jointly in second place, by films together with the use of a single textbook. Each of the three sources of information listed above represents the responses of more than 60 per cent of the sample. Third place was shared jointly by the options: "more than one textbook" together with "charts and diagrams". Library use trailed in third place (only 37 per cent of the students chose this option). Fourth was periodicals and journals together with television and videotapes. Use of dictionaries and encyclopaedias was

assigned fifth place, with "help from specialists" and "commercially available students' notes" in sixth place. These last two sources of information had very low values - about 5 per cent each. The rank order of the first three places was assigned by more than 46 per cent while the fourth place was assigned by approximately 25 per cent of the students. Only 16 per cent of students assigned fifth place. The greatest reliance can therefore be placed on the first three places as contributing information on a regular basis to increase students' knowledge during their studies of biology.

To judge from their written responses, the sixth place's respondents expended considerable time, money and effort when they attempted to remedy their shortfall in information and understanding of this subject.

Item 20 When studies at school resulted in learning problems, students had a definite hierarchy of people who they consulted when they wanted to solve these problems. First: the biology teacher (63 per cent response). Second: "friends and classmates" together with "friends in particular" (about 22 per cent each). Third: resource persons not in the home and family or school (15 per cent), and fourth: parents together with "other teachers" (roughly 5 per cent each). Only the first, and possibly the second could, in practice, be said to make a definite contribution to studies in biology, as the remaining options have such low values.

Comments volunteered by students on learning problems totalled almost one hundred. The comments of seventy six students reported "no problems encountered", with a further twenty one comments indicating that the students had solved their problems using their own initiative.

Item 17 To an enquiry concerning the skills developed in the students during school biology studies - handling scientific apparatus, collecting and interpreting data, and similar activities - the responses were as follows: 20 per cent reported that they had, in their opinion, acquired a moderate, i.e. average, number of subject skills. Above and below this value lie two ratings, each being 15 per cent. These three ratings total 50 per cent of the student sample. At the extremities lie two further ratings: the top rating, 7 per cent, learned "a great deal", while the lowest rating, 42 per cent, learned "very little".

Item 6 The success of school biology in encouraging students to think about Nature and natural processes was assigned a middle rating by 28 per cent of the students, while 39 per cent assigned a better-than-average rating. A top rating was assigned by 17 per cent of the student sample. In descending order, below the middle value, the ratings were: "encouraged a little", 13 per cent, and for the lowest rating, "encouraged not at all", 4 per cent.

Item 7 Making good use of the human and natural environment is rated very highly by science educationists. In this sampling of school biology, students' responses indicated that 36 per cent of them assigned this item a middle value ("now and then"). The two values above the middle value totalled 26 per cent, while the two values below it totalled 19 per cent. The distribution of the responses is fairly symmetrical around the middle value, with the exception of the highest and the lowest. Highest, i.e. "very often", was 7 per cent, while the lowest value, i.e. "never", was 13 per cent.

Item 9 Nature reserves, zoos and, to a lesser extent, fertilizer factories and mines are places of potential employment for those making a career in biological sciences, as here learning is applied in scientific, medical, veterinary, commercial and other directions. The responses of the students to an item enquiring about visits to such places were that above a middle value of 15 per cent, the total of the two highest values was 11 per cent, about equally divided between the two ratings. The total of the two ratings below the middle value was 75 per cent, while the lowest rating ("never") had a value of 52 per cent: it is regrettable that this was the case.

Item 8 When examinations and tests in biology were announced, only 2 per cent of the students had negative feelings about the outcomes of these examinations and tests; a further 11 per cent were cautious, being unsure of the outcomes. The middle value ("irritated: tests are unpleasant but necessary") was chosen by 18 per cent of the students. Fifty per cent of the sample were optimistic about reasonable outcomes, while 20 per cent felt positive about the outcomes of testing in this subject. Seventy per cent of the sample was above the middle value while 13 per cent was below it.

Item 11 The personal satisfaction achieved by studies of biology at schools was as follows: a middle value of satisfaction was the response of 23 per cent of the sample. The two values above this middle value totalled almost 70 per cent, with 36 per cent of the students assigning studies of this subject the highest rating. The two lowest categories, totalling 9 per cent, indicated "little" and "very little" personal satisfaction; the lowest category was only 4 per cent of the sample.

Item 10 During their final school year, 99 per cent of the students achieved a mark of 51 per cent or higher in biology. The top category, "81 and above", accounted for 29 per cent of the sample. The 76 - 80, 71 - 75 and 66 - 70 per cent intervals were about 18 per cent each, totalling 54 per cent of the sample. The 61 - 65 and 56 - 60 per cent intervals were fairly evenly divided, each containing about 7 per cent of the sample. The 51 - 55 per cent interval only represented 2 per cent of the sample. Students who achieved 50 per cent or less totalled 1 per cent of the sample, with less than 1 per cent of the students achieving marks in the 36 - 40 per cent range.

The percentages and opinions reported by students for items such as 8, 11 and 10, above, undoubtedly reflect a considerable effort on the part of both biology teachers and their students.

Item 19 The tempo at which biology is taught at school seldom caused problems for the learners. Nineteen per cent of the students responded that they had problems with the speed of teaching "from time to time". Forty nine per cent responded that they "very rarely, almost never" had such problems and 29 per cent "seldom" had problems with the tempo of biology teaching. The responses "frequently" and "very often, nearly all the time" were given by only 2 per cent and 0,5 per cent of the students, respectively. When one considers the rate at which the content matter has to be taught in order to get through the syllabus, such a response represents an excellent effort by biology teachers and their students.

Item 16 The opinion of the students regarding the detail in which biology was studied at school varied considerably; a strong sense of awareness (or possibly a lack of it!) of the depth-of-study might explain this variation.

Students' responses are as follows: 11 per cent, "too little detail"; 50 per cent, "adequate detail"; 5 per cent, "too much detail"; and 34 per cent, "varied: sometimes too little, sometimes too much".

Item 18 The responses to an item enquiring into to what extent biology relates to other school subjects, was as follows. The middle rating, "moderately", was 40 per cent. The rating below the middle value, "little", was 30 per cent, while the lowest rating, "very little", was 13 per cent. The two ratings above the middle value, "quite a lot" and "a great deal" were assigned by 14 per cent and 3 per cent respectively. Above the middle value the ratings totalled 17 per cent while below it they totalled 43 per cent. A response such as that outlined here, when combined with those of items 7, 9, 19 and 16, above, hints that the students were mostly taught content, to the exclusion of much else that may have been of interest to them.

Item 23 The usefulness of a sound knowledge of school biology to everyday living, evoked very different responses from the students. The highest rating, "extremely useful", was chosen by 28 per cent of the students, while the lowest rating, "almost useless", was chosen by only 2 per cent. The middle rating, "moderately useful", was selected by 27 per cent of the sample. Above this middle rating, the intermediate high ratings gained 36 per cent (19 and 17 per cent) in ascending order of rating. In descending order, below the middle rating, the intermediate responses were 5 and 3 per cent, totalling 8 per cent.

7 DISCUSSION OF THE RESPONSES OF THE WHOLE SAMPLE OF STUDENTS (i.e. A SAMPLE COMBINING STUDENTS AT THE UNIVERSITIES OF CAPE TOWN AND STELLENBOSCH)

Note: In this chapter, where reference is made to questionnaire items, these are enclosed between brackets. For example, (B1.5) refers to Section B, item 1, option 5 of the questionnaire.

The basis of this discussion is the responses by the student sample to items 1, 12, 13, 21 and 22 of Section B of the questionnaire. These five items attempt to establish the attitudes developed by the students during their studies in biology at school. The responses to these five items are shown in Table 4, below and described in chapter 6, above.

The responses to the remaining items in Sections A and B of the questionnaire (also described in chapter 6, above) are also included in this discussion. By this means the attitudes developed amongst students in the sample group can be seen as being developed in the course of their studies in biology at school and not merely incidental to them.

From the discussion, a clear picture of the attitudes developed amongst the students in the sample emerges, and it could very easily serve as a model for the attitudes developed amongst the majority of them.

In five of the chapters which follow, i.e. chapters 8, 9, 10, 11 and 12, this sample will be split in various ways and the persistence of the model outlined below amongst those smaller sample groups will be examined.

As has been pointed out in a previous chapter, the theories developed by authors and researchers such as Allport (1967), Evans (1965), Fishbein (1967, 1975) and Triandis (1971),

enquiring into the fundamentals of attitudes, agree that well-established attitudes are remarkably persistent, being tenacious and resistant to change. Applying these theories to the sample group would mean that the attitudes they developed during their studies in biology at school would almost certainly emerge during their continued studies in closely related fields at university.

Based on the responses of our sample, we have found that very typically, a student who, following his studies in biology at school, and later continuing his studies in the biological sciences at university, is characterised by a specific ability to do well in school biology (B10), also has, in addition, an overall ability to do well during studies at school (A16). An interest in Nature (B1.5) together with an overall ability to do well during studies at school (A16.10 - 16.14 and B10.10 - 10.14), frequently encourages this student, during his studies in the biological sciences, to study botany, zoology, entomology and similar Nature-orientated courses. Such a student might, at the completion of university studies, qualify as a microbiologist, a biology teacher or a veterinary scientist.

From commencement of studies in biology at school, until the completion of the intended courses of study at university, might take eight years or even longer. To judge from their responses, nearly half of the student sample will be studying biological sciences, at both school and university, for eight years (A19) or even more. The costs for those pursuing such lengthy studies are naturally substantial.

Analysis of the sample shows that students' interest in courses in biological sciences at the commencement of their studies at university is more or less equally divided between females and males (A3).

While at school, the majority of students apply themselves to comprehensive studies in the sciences, studying both physical science (A17), usually on the Higher Grade (A18), together with biology, which is almost always studied on the Higher Grade (B3.2). The level of success in their studies can be judged by the fact that 83 per cent of the students report that they scored 66 per cent or more for tests they wrote in biology during their final year at school.

A student who includes biology in his subject choice at school and continues studying in that direction at university, is characterised by a very well-developed interest in Nature (B1.5), yet to judge from a comparison of the responses to items A20 ("choose a rating that describes your interests in nature") and A21 ("choose a rating that best describes your activities involved with nature"), the interest in Nature professed is not necessarily translated into action!

A student who commences studies in the biological sciences while at school and continues with them later at university, is a person who is very definitely interested in Nature (B1.2 + B13.2). While at school, this student expects that the biology teacher will share such interests (B15.2). The teacher should be equally interested in his students (B15.1), in Nature (B15.2), and be a knowledgeable person (B15.5). In addition, he should be able to encourage his students to achieve good test and examination scores (B15.3). The qualities of the teachers listed above need to also be linked with reasonably well-developed intellectual abilities (B15.6), as nearly 30 per cent of the respondents chose this option.

Biology is effectively taught by using the sources of information closest to the teacher's hand: textbooks, aided by teachers' notes, together with films and slides, head the

list with approximately 60 per cent each, although a wide variety of sources of information is in general use during teaching (B14). From the voluntary written responses of students, commenting on their teachers (B15.8) and on learning problems they encountered while they were still at school, it seems that frequently the biology teacher was perceived as a leader (the initiator, as it were, of the teaching dialogue) and very much in the foreground, perhaps also serving as a model for thinking and action. In their response to item B11, the students reported that the satisfaction they achieved during studies in biology at school ranged from average to very good (B11.3 - 11.5). Although some students report little satisfaction from school biology (B11.1 - 11.2), and some also make negative comments about their teachers, they nevertheless have continued, motivation apparently unaffected, with their chosen fields of study in the biological sciences, and intend studying for one, but more frequently three or more, years at university. The comparatively low ratings assigned to the options "good teacher" and "improved communication between teacher and students" (B1.3 and B22.3) make reasonable sense when seen against a background of students' well-established interests and individual achievements in this subject.

The importance of students' own interests, high ability levels, science orientated courses and motivations required for five, six or even more years of study is reflected in their responses to item A14; a moderately high percentage (40 per cent), of them attended selected schools as a first step towards achieving their goals; the rest attended "neighbourhood" schools, although such "neighbourhood" schools are chiefly found in cities and large centres. Both types of schools, however, channel, and at the same time bring science students together. Students studying at these schools usually have highly successful outcomes of learning

as a number of these schools are well-known for maintaining high academic standards. The students at schools such as these are consequently able to establish excellent records of personal achievement in the sciences, both physical and biological, combining this with their interest in Nature and further study at a university after matriculation.

Identifying large, urban schools which offer students both science subjects and regularly provide the two universities with considerable numbers of science students is one of the important outcomes of this study. This will become clear in the course of chapter 8.

The responses of students in the sample make it quite clear that their interests and abilities are very definitely directed towards the assimilation of content information (B12.1 + B22.1), which they consider to be moderately useful (B12.3 + B21.7). Both of these are almost equally as important as the positive attitudes (B12.4 + B22.5) they developed to Nature and Creation. This type of response was made by 40 per cent students in the sample.

During studies in biology at school, teachers are perceived as both conveyors of information and resource persons (B20.1). Friends, although seemingly not important (B1.4 + B13.5) at the time when biology was chosen as a school subject, become important during problem-solving and learning sessions; learning from fellow students (B20.3 - 20.4), accounts for 45 per cent of the student response. The students report that during their studies in biology, they seldom have unsolved problems relating to their studies (B20.6), their problems being solved either by teachers, friends or the students' own or outside resources. The tempo of teaching (B19) does not really present problems, reinforcing the idea that school biology is a subject in which students, by applying themselves, obtain good marks

(B12.1 + B22.2) and as a result consider the subject a reasonably easy one (B21.1 + B13.3). A heavy reliance on the use of the textbook (B14.1), together with notes supplied by the teacher (B14.3), provides supportive evidence for this idea.

The marks achieved during studies of school biology improve the average marks of the final school year (A16 compared with B10). It is therefore neither unexpected nor unreasonable for the students on leaving school to register a certain amount of self-satisfaction at their abilities and the successful outcomes of their learning, and to approach their studies at their chosen university with the same expectations of success as those they achieved at school. A moderately specific enquiry about the expected outcomes of university studies (A22) shows, in general, average to good expectations prevailing amongst students in the sample, their responses to this item matching well with other enquiries regarding their academic achievement (A16 compared with B10). It is clear from the favourable comparison that they expect to fare as well during first year studies as they did during their final year at school.

During studies in biology at school, parents acting both as influencers of choice of biology as a school subject (B1.1 + B13.4) and as resource persons (B20.5), are somewhat in the background, with the biology teacher and classmates featuring prominently in the foreground.

The specific nature of students' requirements is very well illustrated by their responses to items B20 and B1.1 + B13.4. Parents, for example, are very seldom (B20.7) seen as persons to whom students are able to turn when they develop learning problems during their studies in biology. By contrast, the teacher is of considerable importance (B20.2); even their classmates (B20.3) and special friends (B20.4)

appear to have been of more help! It would doubtless come as something of a shock to the parents of these students to know that they are placed sixteenth in a list of seventeen factors which influenced students' decision to study biological sciences; all the more so when "a love and appreciation of Nature" heads the list in first place!

The knowledge students gained during studies in biology at school contributes to its overall popularity (B4), with comparatively problem-free and convivial studies maintaining or improving their general interest in this subject, encouraging them to think more deeply about Nature and natural processes (B5 + B6).

During school biology studies, a job and career prospects are not revealed by student response as being seriously considered (B1.6 + B1.7). To illustrate this point: only 18 per cent of the students indicated that reasonable pay and interesting careers were one of the possible outcomes of a costly school, and later, university, science education (B1.6). Very few of them, in fact only 4 per cent (B1.7), envisaged excellent jobs and top salaries as possible outcomes of their decision at school to study science subjects. While at school, students were seldom provided with opportunities to see, as it were, a biological science education "at work" (B9.1 - 9.2).

Use of the environment during senior secondary biology studies, human and natural, is, according to student response, spread more evenly, with an encouraging "middle value" in environmental utilization of 36 per cent (B7.4), but one quarter of the students have either never or hardly ever (B7.1 - 7.2) incorporated, by using their environment, information originating in that environment into the relevant studies in biology at school. Responses such as these make it clear that the students were largely, although

not entirely, independent of their environment during their studies in this subject.

In the area of subject skills developed (B17) there is a deficit, with somewhat more than half the students (57 per cent) reporting that they learned comparatively few subject skills, whilst some of them (a further 20 per cent), claiming to have learned a moderate number of skills (B17.3). One implication of such a result is that considerable time and effort would be needed to teach students a number of basic subject skills during their first year of university studies in science.

The breadth of the studies in school biology, ranging as it does from protozoans to mammals and with particular emphasis on their vital processes, allows this subject to relate to other school subjects: chemistry, history, geography, art, languages, etc, yet the students overall did not believe this to be the case, judging from their responses to item B18. A high degree of boundary maintenance (that is, keeping strictly to the subject and not diverging from it) between biology and other subjects is clear from student responses. By concentrating on the subject in hand, the biology teacher would be able to more effectively teach the content matter relevant to tests and examinations, thereby achieving an important goal, namely good marks. Achieving this goal is important to both students and teachers because many university courses have a limited number of places available, and students are chosen largely on the basis of their school academic record.

During school biology studies, the content information is frequently presented in such a way by textbooks, the teachers, or a combination of both, that the appropriateness of the detail in which the subject is taught is confusing to the learners, who find it difficult to orientate themselves

in, as it were, oceans of information. To illustrate the point, the following is taken from the students' responses: Fully half of them consider the detail of school biology adequate. Thirty four per cent (in addition) regard the detail as "varied: sometimes too little, sometimes too much detail" (B16.1 and B16.4), while a further 11 per cent consider that there is not enough detail in this subject (B16.1).

Experiments, creativity and projects also received low ratings, indicating that the study of biology is not necessarily thought of in practical, verifiable terms; that, for example, experiments performed in a laboratory, designing posters for anti-litter campaigns at school or being fully aware of the importance of the prevention of fires on Table Mountain all contribute to the wider compass of a study of biology.

The emphasis of school biology seems to be consistently on learning and the assimilation of information. The students' responses to item 8 show clearly, using verbal cues, what is illustrated numerically by the responses to item 10, which show, using percentages, that a very high proportion of students (about 90 per cent), both expect and achieve a mark of 50 per cent or more in school biology.

Studying both physical science and biology on the Higher Grade, as many of the students in the sample have done, and having to cope with so much specialized information would naturally limit the time and effort available for such apparently esoteric pursuits as a pupil's own researches, poster-design, anti-litter projects, creativity and designing experiments. Yet these also need to be included in the science course to a much larger extent than is revealed here, as Behr (1985:111) and Renzulli (1985:7-11) have pointed out. At university, a background and knowledge

of some of the experiences and involvements listed above is certainly advantageous for successful studies in biological sciences. By creating opportunities for the students to express themselves by making models, founding "science clubs", etc., their creative energy and talents are fostered and directed. Yet it would seem, based on students' responses during this research, that the present South African biology school syllabus hardly encourages pupil participation to any appreciable extent in fields other than those of primarily learning content information. This omission results in a serious deficiency in the background of those who continue their studies at university.

8 SPLITTING THE SAMPLE: FIRST-YEAR STUDENTS STUDYING BIOLOGICAL SCIENCES AT THE UNIVERSITIES OF CAPE TOWN AND STELLENBOSCH

8.1 Introduction: selecting the sample

The sample was split by university; this was done in order to establish to what extent the attitudes developed among the students in each of them differs from that of the whole sample. At the same time more information would be gained concerning the students' background of studies in biology at school. The attitudes of the students would form the basis of discussion and following upon that, recommendations put forward in an attempt to remedy any problem areas encountered there.

The sample was split as follows: students numbered 0001 to 0525, the University of Stellenbosch; those numbered 0526 to 0893, the University of Cape Town. No other criteria were used to split the sample.

Separate computer printouts were obtained for each university sample. Rather than describe and discuss the responses of the university sample groups separately, they are described and discussed together. It was thought that the responses of students at each of the two universities might be very similar (or very different) and that these attributes would be highlighted better by this approach.

The Universities of Cape Town and Stellenbosch contributed 41 per cent and 59 per cent respectively to the whole sample. The sections A and B of the questionnaire are described separately below, being based upon percentages and frequencies shown in Tables 5, 6, 14, 15 and 16. The items in each section have been clustered, rather than described in numerical order, in order to bring the students'

responses into relationships which would promote analytical discussion better than a sequential description and discussion would. Where references are made to specific items, they are enclosed between brackets. A reference such as (B3.2) is to be interpreted as Section B, item 3, option 2 of the questionnaire.

8.1.1 Similarity of the responses at the two universities: an overview

The similarity of the responses at the two universities is striking. This is, however, not immediately apparent. For example, the responses of the students at the Universities of Cape Town and Stellenbosch to Section A of the questionnaire appear at first sight to be very different, with the students at the University of Cape Town appearing to be a much more heterogeneous group than those at the University of Stellenbosch. This is true, but only to a limited extent, as the following two comments will clarify:

- 1 Students studying courses in biological sciences at the University of Cape Town are very largely English-speaking students drawn from English-medium schools. In this respect, the equivalent student group at the University of Stellenbosch is less homogeneous, for they are, but to a lesser extent than their counterparts at the University of Cape Town, Afrikaans-speaking students drawn from Afrikaans-medium schools.
- 2 Each university draws its students from a number of schools. If the schools supplying each university were listed and those lists compared, they would be very different, although occasionally, a school's name would appear on both lists. Although the schools' names on these lists would differ, they would have the following attributes in common: they are large schools,

situated, for the most part, in or on the outskirts of South African cities, but also in major agricultural areas centred on towns such as Malmesbury, Oudtshoorn and Upington. These schools offer science education - i.e. physical science and biology as subject choices - and have traditions and status of being feeder schools to one or other of the two universities.

Section A of the questionnaire enquired into the background of interests in Nature and science of the students while at school. Superficially, the responses of students at the two universities were different. These differences, however, were not random, but were patterned by the schools which provide the universities with students; these schools contribute to the unique identity and character of each university's sample group; similarities in the attitudes prevailing in the students in each of them are nevertheless present.

The patterns of similarity which are discernible in student groups studying at the two universities are patterns of similarity in science education. The sample groups of students at the two universities, despite attending different schools (as revealed by the schools' names), and language differences (tuition through Afrikaans medium or English medium or, occasionally, both languages), exhibited many similarities and a few differences in their responses to Section A of the questionnaire. The similarities are reinforced when responses to items of Section B are combined with those of Section A and the responses to the questionnaire as a whole are considered.

When the responses of students at the two universities are compared, it almost seems as if the original sample had been split in half, each half mirroring the other.

In Section B, five items investigated the attitudes established by the teaching of biology at school. A further eighteen items investigated the day-by-day teaching of biology at school: the role of the teacher, sources of information during teaching, the development of laboratory skills, etc, were probed.

The students of both universities responded similarly, rather than differently, as might reasonably have been expected, to nearly all the items in Section B of the questionnaire; the responses of students to items of this section were, like those of Section A, patterned. Although responses of the students at the two universities to the attitude-enquiry items of Section B differed, the order of importance in which they arranged them was very similar.

The responses of students to the remaining eighteen items in Section B, which investigated day-by-day teaching of biology, was also very similar. From an analysis of the responses, it is clear that the overall pattern of student attitudes, as revealed by analysis of these five items, is firmly established during the day-by-day teaching of biology, as revealed by analysis of the remaining items.

The similarities in responses to Sections A and B of the questionnaire by the students at these two universities make it clear that at both the Universities of Cape Town and Stellenbosch students have firmly-established attitudes to their intended courses of study in biological sciences at the commencement of their university studies. The attitudes formed during their studies in biology at school will almost certainly be carried over to these universities and influence - for better or worse - the progress and outcomes of studies there.

In the more detailed discussion of students' responses which follows below, differences as well as similarities, outlined above, are highlighted. Discussion of these differences and similarities should be interpreted as a description of those factors which contribute to the unique character of each university rather than being in any way a comment on, or criticism of, these universities.

8.2 Section A: description and discussion

The responses of both first-year biological sciences sample groups are described and discussed below: questionnaire items have been rearranged and clustered. Such items are listed one below the other and then treated in that order.

Item 3

Item 19 At the commencement of university study of biological sciences, the responses of the students make it abundantly clear that they have more-or-less equally divided interests in this field; both samples are fairly evenly divided between the sexes.

Students in the two samples very frequently intend studying biological sciences for three or more years.

Item 4

Item 5 Not all the students in these sample groups are students who are at university for the first time: the percentage of first-time-at-university students is 83 and 90 per cent for the Universities of Cape Town and Stellenbosch, respectively. Approximately 3 per cent are repeating their first year and the remaining students either have completed other courses at colleges or universities, or are busy with studies of which a first-year course in

biological sciences forms a part. As can be seen from the percentages reported above, the first year sample group at the University of Cape Town is the more diverse of the two sample groups.

Item 8

Item 9 Almost all the students at both universities left school either the year before or within a year or two of commencing university study. The range of ages of students in the sample groups is very much the same, the great majority ranging from eighteen to twenty one years. At the University of Cape Town, however, some students are younger, while others are considerably older than their classmates.

Item 6

Item 7

Item 11 Nearly 80 per cent of the students studying at the University of Stellenbosch wrote the Cape Senior Certificate examination on leaving school compared with about 40 per cent of those who are at the University of Cape Town.

At the commencement of studies at the University of Cape Town, the first-year student population is, to judge from their responses, much more heterogeneous than that of the University of Stellenbosch: this is clear from the school-leaving examinations these students wrote (about twelve such examinations being represented) and the countries where they were at school: South Africa, South West Africa/Namibia, the National States, Zimbabwe and the United States of America. The students at the University of Stellenbosch only wrote seven of the twelve school-leaving examinations,

and attended schools in South Africa and South West Africa/Namibia. Doubtless the language of tuition, Afrikaans or English, or highly specialized courses offered only at one or the other of these two universities contribute, amongst other factors, to the homo- or heterogeneity of the student group studying biological sciences at the two universities.

Item 10

Item 12

Item 14

Item 15 The diversity outlined above seems to increase when the names of schools attended by the students are examined. Among the names of the schools, certain schools can be clearly identified as "feeder" schools. These schools provide each or, very occasionally, both of the two universities with appreciable numbers of science students. Approximately thirty five such schools can be identified: they supply about half of the students studying biological sciences at the two universities. These "feeder" schools are typically large, urban schools offering the science subjects physical science and biology in their subject choices. Of these schools, quite a number have both high status and reputation as well as a tradition of being "feeder" schools to one or other of the two universities, supplying them with a varying number of biological sciences students; as many as twenty over a period of five years (1981-1985). For the students at the University of Cape Town, the choice between a neighbourhood school (i.e. a State school nearest their home) or a selected school, (i.e. a private fee-paying school or a State school some distance from home) was a more important decision than it was for students at the University of Stellenbosch, as about 50 per

cent of the students in the University of Cape Town sample attended selected schools, as compared with about 30 per cent reported by students in the University of Stellenbosch sample.

When information regarding names of schools, places of schooling and choice of school is examined, a pattern becomes discernible: this is a pattern of a flow (as it were) of students through the selected schools offering science subjects, to one or the other of the two universities. Depending on whether the students are taught through the medium of Afrikaans or English, the flow is heavily, but not exclusively, to an Afrikaans-medium or English-medium university. Students might write one of almost a dozen school-leaving examinations, but a flow via a large, urban, science-subject school to one of these two universities is typical. Schools in rural areas contribute few students to the sample, usually no more than two per school during the same 1981 - 1985 period.

About 90 per cent of the students in both university samples studied biology at school.

Item 16

Item 17

Item 18 Students in the University of Cape Town sample report a more restricted range than those in the University of Stellenbosch sample for the average percentage of all subjects studied during the final year at school. The percentages reported by the former range from 31 per cent upwards, while those of the latter range upwards from 46 per cent.

The category of percentages ranging from 61 per cent upwards includes 93 per cent of the student sample at the University of Cape Town, corresponding with 85 per cent of the University of Stellenbosch sample. The top category, 81 per cent and more, accounts for 24 per cent of the University of Cape Town sample and 15 per cent of the University of Stellenbosch sample.

A very high percentage, about 90 per cent of the students in both samples, studied physical science at school, with about 83 per cent reporting that they had studied the subject on the Higher Grade; the rest either did not study it or studied it on the Standard Grade.

Item 20

Item 21

Item 22 When asked to express their interest in Nature, 85 per cent of the students in both samples expressed an above-average interest, with about 60 per cent of them reporting "well-established" and "a great deal" of interest. Only about 2 per cent reported having below-average interests in Nature.

When the students' above-average interests in Nature (A20.5-20.7) are compared with their practical and direct involvement with Nature, however, (A21.5-21.7), the percentages drop by more than half, from 85 per cent to about 30 per cent for both samples. As a result, the below-average options of these two items (A20.1-20.3 and A21.1-21.3) correspondingly increase from about 2 per cent each to 38 and 31 per cent respectively for the Universities of Cape Town and Stellenbosch. The lowest rating, "very little" (A21.1), rose to 18 per cent in the case of the Cape Town sample, as

compared with 9 per cent reported by the Stellenbosch sample.

Encouragingly, at the top of the scale, "a great deal of activity involved with Nature" (A21.7) was 5 per cent in both cases, but this percentage compares very poorly with A20.7 where about 27 per cent of the students in each sample expressed "a great deal of interest in Nature". It is quite evident that students' interest in Nature is seldom put into practice during their studies in biology at school.

When a comparison is made between the average marks students scored during their final year at school (A16) and those they expect during their first year of study at university, they compare very favourably. Student responses indicate that they clearly expect to fare as well during their studies in the first year at university (A22) as they did during their final year at school.

About 98 per cent of the students in each sample expect to score marks ranging from "average" to "excellent" (A22.4-22.7). The options (A22.5-22.7) from "above-average" to "excellent" total 72 per cent in the case of the University of Cape Town students, while those of the University of Stellenbosch students total 52 per cent. Clearly, the students at the former University have higher expectations of the outcomes of their studies in the first year than the latter. In the light of studies done at South African universities by workers such as Van Zyl (1982), Sanders (1986), Sanders and Fridjohn (1986) and Jackson and Young (1987), a student sample with more heterogeneous than homogeneous origins might encounter a number of problems they did not anticipate.

Despite their varied places of origin and school-leaving certificates, students in both university samples report the

success of their studies at school. Overall, the students' expectations fall into a definite pattern: that of continued success during university study.

It is unfortunate that many students will have to cope with outcomes of learning which, during the first year of university study, will compel them to change these expectations to a lesser or greater extent. This, as will be shown in a discussion of Section B, below, is not always due to a lack of endeavour on the part of the students, but rather to a mismatch: the outcomes of school science education create expectations, such as continued successful studies, which do not necessarily match the realities encountered during first-year studies at a university.

8.3 Section B: description and discussion

The items in Section B of the questionnaire investigate attitudes which are formed during studies in biology at school. Five items of this section, B1, B12, B13, B21, B22, identify selected factors which contribute to the formation and maintenance of students' attitudes during their studies in biology at school. In this investigation these attitudes are considered to be important outcomes of school biology and it is believed that they will transfer to university first-year studies and influence (for better or worse) learning outcomes of continued studies in the biological sciences there.

The response of the whole sample of students ($N_{TB} = 807$) is shown in Table 4, below; their attitudes are described and discussed in chapters 6 and 7, above. Their responses to the items testing attitudes are used as a basis for comparison in the discussion which follows.

The response of students in the University of Cape Town sample ($N_B = 329$) to items B1, B12, B13, B21 and B22 are shown in Table 5, while those of students in the University of Stellenbosch sample ($N_B = 478$) are shown in Table 6, below. They are, however, described and discussed together. The factors with the highest frequencies - and hence greatest importance - are included first, and are followed by those with lower frequencies. The order of inclusion in the description is based on the ranking of the frequency responses at the foot of each of the columns. The similarity of each sample's response to that of the whole sample will be clear from a comparison of that sample with that of the whole sample.

The influence of the day-by-day subject teaching of school biology on the learners was investigated by sixteen items: B3, B4, B5, B6, B7, B8, B9, B10, B11, B15, B16, B17, B18, B19, B20, B23. The responses to these items by the students at each university show how the learners were influenced by different aspects of school biology, e.g. the effects and outcomes of testing, use of the environment, the differing influences of parents, teachers and friends, the boundary-maintenance (that is, the extent to which the subject matter does - or does not- relate outwards to other subjects and everyday life) during the teaching of this subject, the usefulness of this subject during everyday living, etc.

(Items in this section of the questionnaire are rearranged, clustered and discussed, in a manner similar to Section A).

Item 1

Item 12

Item 13

Item 21

Item 22 At the top of the list of factors of both samples is a cluster of six headed by students' interest in Nature and their interest in studying biology while at school. This is followed by factors such as a positive attitude to Nature generated during studies in this subject, studying this subject in order to provide them with entry to courses of study at a university, the usefulness of the content material of biology in the home and environment and the subject being a highly information-centred one.

It is quite clear that the factors involved with studying this subject successfully highlight achievement and progress related to absorption of information, positive attitudes to Nature and a strong interest in studying biology.

The upper middle cluster of factors, that is those ranking from about seventh to twelfth, are concerned with the more practical, everyday aspects of studying this subject, such as biology being a test and examination-centred subject, although a comparatively "easy" one to study, a subject giving students opportunities to show what they are able to achieve, together with the role of experimentation during studies in this subject.

The lower middle cluster, ranking from eleventh to fourteenth, highlights the improved communication between teacher and students resulting from studies, the role of creative approaches (model-making, photography etc.) together with that of projects and the students' prospects for employment after graduation.

The three factors at the foot of the list of both samples are the influence of teachers, parents and friends.

Although the ranking described here might seem a very natural outcome of teaching biology, with, for example, learning content information taking priority over, for example, creativity, experimentation and the influence of parents, past experience has shown that similar priorities incorporated into many students' attitudes, generated learning problems among them during the first year at university. This was chiefly on account of the static, unvarying relationships between the factors. In such cases a considerable effort was required to alter them and develop different relationships between them.

As with the whole sample, widespread learning problems are foreseen for many students in the two university samples because the rank order of the factors shaping their attitudes is so similar.

Item 2

Item 3

Item 4

Item 5 Eighty eight per cent of the students in the University of Cape Town sample attended English-medium schools, and 6 per cent Afrikaans-medium schools. The rest attended dual and/or parallel-medium schools. By comparison fewer students, only 73 per cent of the University of Stellenbosch sample, attended Afrikaans-medium schools, and 16 per cent English-medium schools. Twelve per cent attended dual and/or parallel-medium schools. The students at the University of Cape Town are therefore more representative of the English-speaking group than the corresponding group at the University of Stellenbosch is of the Afrikaans-speaking one.

Very nearly all (about 98 per cent) of the students in both samples studied biology on the Higher Grade, with very few of them studying this subject on the Standard Grade or with no Grade system in operation; these latter were students who studied this subject before the Grade system was introduced in South Africa or were from countries outside South Africa and South West Africa/Namibia.

The students report that biology was a popular subject at school: about 70 per cent of them in both university samples report an above-average popularity for this subject, with 34 per cent of them giving it the top rating "very popular". Eight per cent of both university samples assigned this subject a below-average rating, with 1 per cent of them assigning it the lowest rating, "very unpopular". The figures given here for item B4 almost exactly replicate those of the whole sample.

The students in the two university samples assign almost identical ratings to an enquiry into how studies in biology affected their general interest in Nature. Eighty three per cent report an increased interest in Nature, with about 13 per cent of them reporting that their interests were "very much increased". Four per cent of the students in both samples, however, report a decrease in their interest in Nature as a result of their studies in this subject.

Item 15

Item 14

Item 20

Item 17 About 64 per cent of the students in both university samples report that their biology teacher's

interest in them was of great importance to them. Their teacher's assistance in enabling them to score high marks for the tests and examinations they wrote in this subject was nearly as important as their interest in Nature and a sound knowledge of the subject. Being able to solve students' problems was another important desirable attribute of biology teachers, as was their popularity and friendliness, together with their intellectual ability.

The students in the University of Stellenbosch sample rate highest their biology teacher's interest in his students, together with a thorough knowledge of the subject, while the University of Cape Town sample rate highest the interest of the teacher in his students, his interest in Nature and the excellent test and examination results the biology teacher helped them achieve.

Students in both university samples were taught biology at school by teachers who made most use of the following sources of information: textbooks, class notes provided by the teacher, films, charts and diagrams, television and videotapes and using the resources of a library.

Textbooks, teachers' notes and films are very important sources of information, and top the lists of the whole and the two university samples.

When students encountered learning problems during their studies in biology, their chief resource person was their teacher. Subject teachers made a more important contribution in solving students' problems to those in the University of Cape Town sample (68 per cent) than they did for those in the University of Stellenbosch sample (59 per cent). It is very possible that as a result of such a marked dependence upon their teachers, students at both

universities will transfer this dependence to the university learning environment and to the teaching staff there.

During their studies in biology at school, 62 per cent of the students in the University of Cape Town sample developed subject skills which they thought were below average, corresponding with 55 per cent in the University of Stellenbosch sample. Above-average subject skills developed in both samples total 23 per cent. It is clear that many students are aware that their grounding in the basics of biology is less than adequate, with those in the University of Cape Town sample more aware of this deficiency than those in the University of Stellenbosch sample.

Item 6

Item 7

Item 9

Item 8

Item 11 While about 17 per cent of the students in both samples report that their studies in biology encouraged them "not at all" and "a little" to think reflectively about Nature and natural processes, many more (an average of 56 per cent for the two samples) were encouraged "quite a lot" and "a great deal". The three samples, that is the whole and two university samples, responded very similarly to this item, and it is clear from the response that the content of this subject offers "food for thought", although the level of reflective thinking as such was not investigated.

About 36 per cent of the students in both university samples report that they made reasonably regular use of their

environment during their studies in biology; about 13 per cent in each "never" made use of their environment during their studies in this subject, a further 20 per cent of the students in both samples report slight and below-average use of their environment during studies. The total of the percentages above the middle value of 36 per cent is 32 per cent for both samples, the top value "very often", being about 6 per cent in both cases. It is to be regretted that the totals relating to the below-average use of the environment are so high, that the students in the samples are aware of it, but are seldom in any position to remedy such a state of affairs.

Item nine enquired into the frequency of students' visits to mines, museums, fertilizer factories, etc. About 50 per cent of the students in both samples reported that they "never" visited such places. The below-average options, "never" and "seldom" total 77 per cent in the case of the University of Stellenbosch sample, but only slightly less (74 per cent) in the case of the University of Cape Town sample. The above-average percentages total 11 per cent for both samples - a disappointingly low figure.

The response of the student samples to items seven and nine make it clear that in general, this subject is studied with little reference to the world in which the students live, and it is a great pity that this is the case for so many of them.

As can be judged from the response to these two items, students' studies were chiefly concerned with absorbing content material successfully. The students expressed their personal satisfaction with their studies in biology as follows: 72 per cent of the University of Cape Town sample report above-average satisfaction with their studies in this subject, with 42 per cent of them expressing "a great deal"

of satisfaction. The percentages of the University of Stellenbosch sample for the same options are 66 and 33 per cent respectively. About 8 per cent of the students in both samples express varying degrees of dissatisfaction with their studies in biology at school.

Item 10

Item 19

Item 16 Very nearly all the students in both samples (98 per cent in both cases) scored more than 50 per cent for the tests and examinations they wrote in biology during their final year at school. Ten and 21 per cent of the students, in the Universities of Cape Town and Stellenbosch samples respectively, scored percentages ranging between 51 and 65 per cent (B10.8-10.10) for tests they wrote in this subject. The categories (B10.11-10.14) ranging from 66 per cent upwards scored for tests and examinations in biology, is occupied by 90 per cent of the University of Cape Town sample and 79 per cent of the University of Stellenbosch sample. The top category, B10.14, representing test marks above 80 per cent, is occupied by 35 per cent of the University of Cape Town sample, with the corresponding figure for the University of Stellenbosch sample being 25 per cent.

The concerted efforts of school subject teachers and their students are very favourably reflected in the high percentages reported by the students in both samples.

Roughly half the students in both university samples reported that they "very rarely" had problems with the rapid tempo at which this subject was taught at school. The remainder experienced problems of this nature "seldom" and "from time to time". Unfortunately nearly 3 per cent of the

students in both samples reported that they had problems with the rapid tempo at which this subject is taught "frequently" and "very often". All three samples, that is, whole and the two university samples, made almost identical responses to this item.

Responding to an enquiry regarding the detail in which biology was studied at school, 56 per cent of the students in the University of Cape Town sample responded that it was "sufficient", while only 46 per cent of the University of Stellenbosch sample responded in the same way. About 11 per cent of the students in both samples reported that the detail in which this subject was studied was "too little", while about 5 per cent regarded it as "too much". Twenty six per cent of the University of Cape Town sample thought the detail was "varied: sometimes too little, sometimes too much", as compared with 39 per cent of the University of Stellenbosch sample who thought the same.

Roughly 40 per cent of the students in both university samples reported that their studies in biology at school related "moderately" (B18.3) to their other subjects. Below this "middle" value, about 44 per cent of the students in both samples reported that their studies in this subject related "very little" and "little" (B18.1 + 18.2) to others. Twenty per cent of the University of Cape Town sample reported that their studies in this subject related to others "quite a lot" and "a great deal" (B18.4 + 18.5), compared with 15 per cent reported by the students in the University of Stellenbosch sample.

Roughly 30 per cent of the students in both samples reported that they found the content of biology "moderately useful" during everyday life and living, with about 60 per cent of both giving this subject some above-average rating in usefulness (B23.5 + 23.6 + 23.7). The below-average ratings

for usefulness of this subject (B23.1 + 23.2 + 23.3) total roughly 10 per cent. Thirty three per cent of the University of Stellenbosch sample gave this subject's usefulness a top rating (B23.7), compared with the 21 per cent response by the University of Cape Town sample.

Although, in this investigation, the students' attitudes are not so much described in detail as outlined, they nevertheless can serve as an attitude framework (similar to a model) of the students currently studying biological sciences at the Universities of Cape Town and Stellenbosch. The outline described below very nearly replicates that of the whole sample described in chapter 7, above.

The following attitude framework is suggested for the two university samples. Their response to the five attitude-testing items (B1, B12, B13, B21 and B22) is combined with their response to the remaining sixteen items in Section B, together with their response to relevant items in Section A.

Biology is a popular - quite often very popular - subject during the Senior Secondary (i.e. matriculation) phase of the high school (B4.1 - 4.4). In a few schools it is a compulsory subject. However, most frequently it is chosen because the students are very interested in Nature (B1.5 - B21.6), and this subject is able to fulfil these needs by supplying the students with information (B12.1 + B22.1) and activities which cluster around their interests: useful information, a positive attitude to Nature, experimentation, projects, opportunities to be creative, opportunities to demonstrate their abilities, improved communication between teacher and learner and, very importantly, make a start with science studies which will lead to further studies in biological sciences at university.

Biology and physical science (A17.2), combine to form a grounding in the sciences at school, which will serve as a necessary background to further studies at university (B13.1 + B22.4). Although students find this subject highly information-intensive (B12.1 + B22.1), it is considered relatively "easy" (B13.3 + B21.1), and in addition supplies them with much information which is found useful during everyday living (B23.4 - 23.7). Student responses make it clear that a positive, respectful attitude to Nature and Creation is brought about during school biology (B12.4 + B22.5).

In addition, the subject gives a small group of students (varying, but approximately twenty per cent for each university sample group) opportunities to show what they are able to achieve during tests and examinations (B12.2 + B22.2), although for the more average students this achievement must needs be done mainly by absorbing information.

The teachers, by creating links between information and learners (B15.1 - 15.7), help the students realize their learning potential. Teachers, in the opinion of students, need to be good teachers: this is a taken-for-granted.

Teachers, as will be shown later when students' responses are cross-checked, have ambiguous roles when they teach school biology; during this subject the students focus on their own ambitions and prospects, to judge from responses to B1.5 + B21.6, B13.3 + B21.1, B13.7 + B22.4, with friends (B1.4 + B13.5), family (B1.1 + B13.4) and teachers (B1.3 + B13.6) taking, literally, lowest position in their ranking of factors.

Experiments, projects and creativity (B12.5 + B13.2, B12.6 + B21.3, B12.7 + B22.6, respectively) are accorded low priorities by the students: these activities do not,

according to interpretation of students' responses, make clearly defined contributions to the study of biology at school; prospects of careers and salaries do not relate well to this subject either (B1.6 + B1.7).

Although the framework outlined above is rather general in nature, it nevertheless outlines the priorities of those factors which have been found during this research to be significant in determining attitudes.

For those students intending to study biological sciences at university, biology at school is almost always studied on the Higher Grade in conjunction with physical science, which is also almost always studied on the Higher Grade. Together, these two subjects form a background of school science which a biological sciences student ideally requires as background to further study at university. Many teachers are aware that the content-matter of school science overlaps to some extent into first-year biological science courses and inform their students accordingly. In all probability this would encourage their students to increase their efforts at learning in order to assimilate "useful information".

The students, while at school, generally find biology a popular subject: a certain ease-of-study, based on, amongst other things, excellent teaching, the availability of textbooks, teacher's notes, films, video-tapes and the students' own background of interests in Nature, increase the students' appreciation of Nature by providing information and developing insights via nature-orientated activities. It seems - based on students' responses - that the rate of transfer (B19.1 + B19.2) of a mass of information which constitutes this subject does not create problems for the students (B13.3 + B21.1); the subject is considered, in addition, to be relatively "easy" (B13.1 +

B21.1). Tests and exams are successfully written (B10.5 - 10.14) and, it seems, without undue stress (B8.3 - 8.5).

The teacher is, not unexpectedly, usually the initiator and convener of the learning process, which, to judge from students' responses seems heavily focussed on the efficient transfer of information. Although students might not be fully aware that good communication (B21.5 + B22.6) between teacher and learner is an important factor during teaching, they were certainly aware of many attributes of their biology teacher (B15.1 - 15.7). Teachers used textbooks, their own notes and films to good effect during the teaching of biology. The role of the teacher during transfer of information is very much to the fore during school biology. Based on interpretation of items such as B4.1 - 4.4, B5.4 - 5.7, B6.3 - 6.5, and those responses being measured against the responses of students to items B7 (use of environment) and B9 (visits to factories, mines, places of employment bioscience graduates) and then combined with B11.3 - 11.5 (personal satisfaction achieved from biology) it seems as if many teachers, to the exclusion of much else (i.e. projects, creativity, experimental design) have transferred content-material to many of their students, without the modifying effects of selection, reflective thinking, planning and other skills which would have been developed to a greater extent during project work, experimentation and fieldwork.

Such a "closed circuit" of learning, as suggested above, can only serve to reinforce existing links between facts, rather than create opportunities to learn by questioning them, and, by asking questions, revitalize what has been learned, creating fresh opportunities for learning. Possibly this is one of the reasons why the final item in Section B, B23 (usefulness of a sound knowledge of the content of school biology to everyday living) has, above a "middle value" of about 27 per cent, two further values of about 20 per cent

and 17 per cent in ascending order, and a top value of about 27 per cent. One explanation for this distribution might be that those students who, due to their studies, consider biology to be a "closed" subject (i.e. that the content-material of the subject is, for the greatest part, fixed and unvarying), would assign this a high rating, whilst those whose approach is more realistic, would assign a lower rating.

The nature of the content-material - often time-consuming to learn - and the press of learning often exclude, for students involved with studies, time or even opportunity, while at school, for "outside" influences to have much effect on this "closed circuit" of learning. Under such conditions, inflexible attitudes to teaching and learning and the value of information can easily be acquired. Due to the persistent nature of attitudes, such attitudes can, equally easily, be transferred to university study.

Gifted or talented students will hopefully have fewer of the negative attributes of the attitudes outlined above. Hopefully their gifts for strongly individual, sustained effort would enable them to circumvent some of the negative attributes touched on above.

The more average learner, more dependent on absorbing information is naturally more at risk. An inflexible attitude to learning content information could very easily have developed during his studies at school and thus transfer from there to university. This student has a higher dependance on absorbing information and teacher guidance and is more at risk chiefly because an unvarying, fact-absorbitive approach to learning information has developed. In a case such as this the teacher forms a link between content material and the student and chiefly transfers the information that has to be learned, the student having a

very passive, chiefly fact-absorbitive role. A student learning under such conditions would most lack the interpretive skills and flexible attitude to information which characterises so much of university learning. A student having developed his attitude to studies under the conditions described above is almost certain to develop learning problems on transfer to university. If those learning problems cannot be solved, the outcome is predictable: courses failed and the prospects of repeating the first-year, either in part or as a whole, are highly likely.

In the framework proposed above, as well as in the earlier discussion, similarities of responses by the students at the two universities were stressed. There are, however, some differences which also merit attention:

The students in the University of Cape Town sample are culturally more diverse than those in the University of Stellenbosch sample.

If the percentage of students who wrote the Cape Senior Certificate examination on leaving school is taken as a guide, then the students in the University of Stellenbosch sample are more representative of a large, uniform student population within the Cape Province than those in the University of Cape Town sample, that is, attending schools situated within the province and writing the Cape Senior Certificate examination on leaving school.

A higher percentage of the students in the University of Cape Town sample attended schools which were specially selected for them by their parents than those in the University of Stellenbosch sample. Such schools might be either private fee-paying schools or State schools, but both types of school are linked by long-standing tradition to one or the other (but seldom both) of the two universities.

The percentages the University of Cape Town students report for tests and examinations they wrote at school are generally higher than those reported by the University of Stellenbosch sample.

The only difference which is of great importance in this study is the greater cultural diversity of the students at the University of Cape Town. While contributing to the unique character of this university, at the same time cultural diversity and a heterogeneous student population are linked with the need for academic support programmes. This is chiefly as a result of the increase in the numbers of educationally disadvantaged students who would find it extremely difficult, if not impossible, to pass subjects and courses without the assistance provided by the teaching of academic support programme staff. The work of Behr (1985), Sanders (1986), Sanders and Fridjohn (1986), Jackson and Young (1987) and Gayford (1988) make important contributions to our knowledge in this area by increasing our knowledge and awareness of this problem.

Many students in both samples report high percentages for their studies at school, and such marks are achieved by hard work and perseverance. Medical students are particularly well known for both these attributes and in chapter 9, below, the attitudes to study of such a sample, combining students at both universities, is examined. The long and difficult medical course attracts students who are highly talented or gifted, and almost any medical sample would contain a high percentage of these students. The particular attitudes developed by students in the medical sample are discussed in the light of recent work by Renzulli (1985).

9 ADDITIONAL SPLITS OF THE SAMPLE: THE MEDICAL SAMPLE

9.1 Introduction: selecting the sample

An additional split of the whole sample ($N_T = 893$) was made in order to produce a medical sample combining students from the Universities of Cape Town and Stellenbosch.

Two criteria were used to select students for inclusion in the medical sample: the numbers allocated to completed questionnaires during processing and the dates of completion of the questionnaires by the students, as follows:

At the Universities of Cape Town and Stellenbosch medical students completed the questionnaire on 20/21 March and 24 March 1986, respectively. The numbers 0001 to 0173 and 0526 and 0640, allocated to completed questionnaires were combined with the dates listed above to select the sample. The numbers above refer to students at the Universities of Stellenbosch and Cape Town, respectively.

The medical sample ($N = 288$), represents 32 per cent of all the students who completed this questionnaire ($N_T = 893$).

The University of Cape Town, with 115 students, contributed 40 per cent to this medical sample, whilst the University of Stellenbosch, with 173 students, contributed the balance, that is 60 per cent.

The medical sample, $N = 288$, was finally reduced to $N_B = 260$ by including only students those in the smaller sample who had studied biology at school.

The size and educational importance of the medical sample was considered sufficient to merit a detailed description and analysis of the responses obtained from these students. Please refer to Tables 7, 14, 15 and 16, in Appendix 1, for details.

9.1.1 Description of the responses to Sections A and B of the questionnaire: an overview

Note: Where reference is made below to items in the questionnaire, these are enclosed between brackets. A reference such as (A16.14) is thus to be interpreted as Section A, item 16, option 14.

Overall, there is a pronounced similarity in the responses of the medical sample to the questionnaire when compared with that of other samples, e.g. the whole sample ($N_{TB} = 809$) and the samples of the Universities of Cape Town ($N_B = 329$) and Stellenbosch ($N_B = 478$). The similarity is quite clear despite the somewhat smaller sample size.

Splitting the sample in various ways - by course, for example medicine, or by university, here the Universities of Cape Town and Stellenbosch, does not noticeably affect the overall similarity of response of the students. This overview of the response of the medical sample will therefore inevitably include much of what has been described above in chapters 6, 7 and 8.

The origins of students coming to the two universities was commented upon during discussion of responses in the above chapters. They largely originated in large, urban Afrikaans, English or dual/parallel medium schools offering science subjects. Not unexpectedly, the medical sample also had a very similar origin in terms of schools.

While they were at school, the medical students, in common with the students in other samples above, had excellent academic records but with the noteworthy addition that the medical sample was clearly the top-scoring sample. The medical sample included exceptionally talented learners: no less than 37 per cent of these students reported an average for all their school subjects in the "81 per cent and more" category for tests and examinations which they wrote during their final year at school (A16.14). This all-round academic excellence was particularly noteworthy in the results obtained in biology, with 46 per cent of the students averaging 81 per cent and more during the final year at school (B10.14). Medical students had more realistic expectations of the results of their studies at university than the students of other samples, primarily because they were more modest in their overall expectations (A22.4 + 22.5).

The responses of medical students paint a picture of serious study and earnest endeavour in the sciences during their school careers. Nearly all of them studied both physical science and biology on the Higher Grade. When one reflects on the time and effort necessary to achieve the percentages they reported for these two Higher Grade subjects during tests and examinations during their final year at school, there is little doubt as to both their capacity for hard work as well as their ability. This talent and enthusiasm for successful study is fortunately found to transfer from school to the university learning environment.

To judge from the responses of medical students, biology was a popular subject at school and its overall effect on the learners was in general a positive one. The students reported that their general interest in Nature was increased during their study of biology. Tests and examinations in biology posed very few or no problems.

Although 16 per cent responded to item B6 that school biology encouraged them to think about Nature "not at all" (4 per cent) and "a little" (12 per cent) - and on this point the medical sample corresponds very well with the whole and the two university samples - the balance of the sample, i.e. 84 per cent, were encouraged to think more deeply about Nature, with the students' responses ranging from "somewhat" to "a great deal". The last-mentioned options of this item were also in agreement with the responses of the three other samples.

Analysis of the responses of the medical sample to items B7 and B9 showed disappointingly little use of the environment (B7) and this was also seen in their visits to mines, factories, zoos etc. (B9) during biology studies at school. Eleven per cent of the medical sample responded "never" when describing their use of the environment during their studies at school. This response was similar to that of the whole sample and the two university samples. Approximately 50 per cent of all four samples (the medical sample and the three other samples), responded "never" to item B9, which enquired into the frequency of visits by the senior biology class group to mines, nature reserves, zoos etc. From this response it can be judged that medical students as much as those in the other samples are not made fully aware of some of the major avenues of employment for biological science graduates.

The response of the medical sample to item B11, enquiring into the personal satisfaction they gained during their studies in biology at school, assigned the subject a high rating. Forty one per cent reported "a great deal" of satisfaction. The high ratings assigned by the medical sample almost equalled the 42 per cent rating given by the University of Cape Town sample. The high rating given by the other two samples mentioned above might be due to some

other outside factor operating for these two samples - for example the highly individualized or exceptionally stimulating tuition, provided at selected schools. By contrast the responses by the whole and the University of Stellenbosch samples were respectively 33 and 36 per cent for this option of item B11 - significantly less than for the other samples.

To judge from the responses briefly commented upon thus far in this overview (and discussed in more detail in 9.2 and 9.3 below), at school the attitudes of the medical sample to science and biology were not systematically developed. In addition, within the boundaries of those attitudes which they did develop, the overall similarity of their attitudes to those of science students can hardly equip them better for a course which becomes progressively more demanding and specialized year by year. This is borne out by an examination and comparison of the responses of the medical sample and those of other samples to items 1, 12, 13, 21 and 22 of Section B, as set out in Tables 4 (the whole sample), 5 (the University of Cape Town sample), 6 (the University of Stellenbosch sample) and 7 (the medical sample). The ranking of the frequency of response to these five items by the medical sample is almost indistinguishable from those of the other three samples.

The totals set out in Table 7 show that an interest in Nature, together with a subject-focussed interest in biology, studies at university after leaving school, the general usefulness of the content of this subject and the positive attitudes created during studies in this subject all feature very strongly in their responses. Comparing Tables 4, 5 and 6 with 7, the same overall pattern is seen in the responses in all four tables. Thus in all four tables, the five factors under investigation nearly always occupy the first five (the highest and consequently the most

important) positions although not necessarily in precisely the same order as listed above.

An examination of the responses of medical students to items B15 and B17 reveals that unlike those of the other three samples, these students were able to learn more than their classmates at school during studies in biology at school. Thus in the responses of the medical students to item B17 (enquiring into the use of laboratory equipment and the development of science skills), the top two scale values (signifying "considerable" and "a great deal") total 30 per cent compared with 22 per cent of the other three samples. In their response to item B15 (which enquired into their choice of the qualities manifested by the senior secondary biology teacher), the students made it clear that they had a stronger response to qualities like the teacher's interest in his/her students, and the teacher's subject-knowledge. The other options of this item - popularity, the ability to solve students' problems, and the intellectual attributes of the teacher, etc. - had consistently higher ratings allocated to them by the medical sample than by the other three samples. It should be noted, however, that although the overall ratings allocated by medical students were higher, they were not invariably the highest ones.

All students studying biology need to master the content-material of this subject. According to the current theories of attitudes pertaining to this - or any other - subject, attitudes will inevitably be formed during the learning process. The responses show that despite medical students' undoubtedly superior talent for learning, their attitudes, during studies in biology at school did not develop differently to those of their classmates.

Possibly another medical sample, such as the one described and discussed in chapter 11, below, and chosen from within

the whole sample ($N_{TB} = 807$), might give evidence of attitudes which differ from those described and discussed thus far.

It is quite clear, however, that the ability of medical students to learn with a high degree of success was developed to a remarkable degree during their studies at school. Unfortunately, during these studies deliberate attention was not given to the development of attitudes which either prepared them for their specialized course of study in biology, medical science or even attempted to develop attitudes which are generally appropriate to the learning of science. Doubtless the students in the medical sample will fare better than those of other samples due to their high ability and high motivation, but will nevertheless be significantly hampered by their inadequately developed attitudes resulting from their studies in this subject at school.

The medical sample's responses also make it quite clear that in general the teaching methods the biology teachers currently employ do not cater for the differing needs of individuals at their own level. Instead, the subject - and frequently despite excellent efforts on the part of the teacher - caters for students at a "beyond-the-individual" level which does not attempt to methodically develop attitudes related either to the subject (biology) or the individual.

By neglecting the systematic development of attitudes appropriate to the needs of the individual and/or subject discipline, the subject as it is taught at present does not satisfy one of the basic requirements of education which is that education is a means to an end. Here, science education did not provide, even for the very talented medical sample, the means to an end; in this study this would lay

special emphasis on the formation of attitudes appropriate to science and more particularly to the biological sciences. Within these wider and narrower ranges of attitudes outlined above those which focus on specific areas of scientific endeavour such as medicine should be developed.

By largely ignoring or leaving attitude development to chance, science education lays itself open to adverse criticism from those who consider the development of attitudes appropriate to a subject to be of vital importance.

9.2 Section A: description and discussion

The items of Section A have been re-arranged and clustered during description rather than described in strict numerical order: this procedure will hopefully facilitate a discursive comparison of responses rather than a mere enumeration of the response of the sample. Clustered items are listed one below the other and following that, described in the same order.

The response of the medical sample to Section A is very similar to that of the other three samples (the whole sample and the two university samples). The description of this sample's response therefore inevitably includes much which has been described in chapters 6, 7, 8.2 and 8.3 above, and to avoid unnecessary repetition of responses already dealt with in considerable detail, descriptions here have been kept brief.

Item 3 In the medical sample, males predominate over females in the ratio 60:40. In other samples (the whole and the two university samples) males and females were more-or-less evenly distributed in a 50:50 ratio, but here the interests and prospects of male students are advanced.

Item 4

Item 5 Similar to that of other samples, a high percentage (88 per cent) of the medical sample are at university for the first time. The balance of the students in this sample (12 per cent), have been at university for one or more years.

Item 8

Item 9

Item 11 Very nearly all (98 per cent) of the students of the medical sample left school during the period 1981 - 1985. Seventy eight per cent left school at the end of 1985 (the year prior to the commencement of university study), and 20 per cent during the period 1981 - 1984. Similar to the whole and the two university samples, very few (2 per cent) contribute to the group of students who left school before 1980.

The ages of the students range from seventeen to twenty two years. They are chiefly eighteen year olds (47 per cent) or nineteen year olds (37 per cent), together with relatively few seventeen year olds (4 per cent) and twenty year olds (6 per cent).

Medical students are chiefly of South African (93 per cent) and South West African/Namibian (3 per cent) origin. Four per cent of this sample originated in Zimbabwe, the National States and countries abroad, for example the United States of America.

Item 6

Item 7

Item 10

Item 12

Item 13

Item 14 The students of the medical sample wrote eleven school-leaving examinations, ranging from those overseas (1 per cent) to the Cape Senior Certificate examination (about 60 per cent). It is interesting to note that more than 20 per cent of the medical sample at the two Cape universities are drawn from three outside provinces: Natal, Orange Free State and Transvaal.

The schools the medical students attended were frequently large, urban, Afrikaans and/or English medium schools offering science subjects. These schools were commented upon during description and discussion of the whole and the two university samples in chapters 6 and 8.2.

Sixty per cent of the medical students attended neighbourhood schools (i.e. a State school nearest their home) whilst 40 per cent attended schools selected for them by their parents (i.e. a private or a State school, but not the one nearest their home).

Item 16

Item 17

Item 18

Item 15 The medical students' ability and dedication to study during their final year at school is evi-

dent. This holds good for their all-round percentages (A16) as much as for the percentages they achieved in biology (B10).

In response to item A16 (enquiring into final-year average percentages at school) approximately 80 per cent of students reported averages of above 70 per cent. (When reporting on the same average - above 70 per cent - other samples ranged between 50 and 60 per cent.) Nearly all the percentages medical students reported ranged from 60 per cent upwards, whereas in other samples percentages ranged upwards from slightly below 50 per cent.

In their physical science and biology studies at school medical students certainly made their ability to work hard and achieve success very evident: nearly all of them (98 per cent) studied physical science at school (A17), virtually all of them (97 per cent) on the Higher Grade (A18). About 90 per cent of the medical sample studied biology at school: this percentage is very consistent in all four samples. (University lecturers cannot therefore correctly assume that all their first-year medical and life science students have a background in biological sciences.)

A very high percentage of the medical students (98 per cent) who studied biology at school (B3), did so on the Higher Grade.

Item 20

Item 21

Item 22 Items 20 and 21 were Likert items, both having scale values ranging from 1 to 7. Whilst item 20 enquired into students' interest in Nature, item 21 enquired into Nature-orientated activities. The last men-

tioned item focussed on active involvement in Nature, such as anti-litter campaigns, rather than essentially passive involvement like watching Nature films.

Eighty six per cent of the medical sample responded to item 20 that they had an interest in Nature ranging from "above average" to "a great deal". This response very nearly replicates the response of the whole and the two university samples.

The medical sample's response to item 21 (enquiring into Nature-orientated activities) in the "above average" to "a great deal" range showed that only 29 per cent of them had been involved. (This very much lower percentage was closely replicated by the other three samples.)

When the response of the medical sample to item 20 is compared with that of item 21, it is quite clear that the keen interest in Nature shown by these students was much less frequently supported by practical investigation. (Similarly, the high percentages of the whole and the two university samples - about 85 per cent - dropped to about 28 per cent for these two items.)

From the above it can be concluded that medical students - like those in the whole and the two university samples - did not have their keen interest in Nature supported and fostered by involvement appropriate to their interests.

When the final-year school marks of medical students (A16) are compared with their expectations of marks during their first year at university (A22), the results are as follows: The response to the percentage range above 60 per cent (options 10, 11, 12, 13 and 14 of item A16) totalled 97 per cent. The response to item 22, for the "above average" (i.e. 60 per cent) to "excellent" (i.e. more than 80 per

cent) range of options of this item totalled 65 per cent. A considerable drop in total, from 97 to 65 is seen over the same percentage range of these two items when "school" and "university" performance is compared.

To judge from this response, medical students, despite their capacity for hard work, are nevertheless cautious of the outcome of their first-year university studies.

When the outcomes of the whole and the two university samples are compared with that of the medical sample, the same overall result is seen. The drop from the high 93 per cent response (A16) to 72 per cent (A22) of the University of Cape Town sample, however, perhaps indicates either over-confidence or a lack of awareness of the difficulty of study at university.

By being cautious rather than overly optimistic about their expected results and combining this with a history of successful study due to, amongst other things, hard work, medical students are very definitely better equipped than the students in the other three samples to meet the challenges of the first year at university.

9.3 Section B: description and discussion

Whilst Section A investigated the origins of medical students in this sample, Section B attempted to establish the attitudes formed amongst them during their studies in biology at school.

The response of the medical sample to five selected items (1, 12, 13, 21 and 22) of Section B is set out in Table 7, below. The response of the students to the remaining eighteen items of this section is described in the text below. However, students' responses to the five selected,

as well as the remaining items, are combined in the description and discussion which follows below. As in the case of Section A, the items of Section B have been rearranged and clustered during description.

The options constituting items 1, 12, 13, 21 and 22 represent seventeen factors deemed operative during the formation of attitudes in biology at school. The rest of the items aim at, amongst other things, which teaching methods were employed in the biology classroom and to what effect.

LaPiere (1967) and Rye (1983) found during their investigations of attitudes that on two separate occasions, two different responses were possible to what was essentially the same enquiry. The response of the medical sample - like that of other samples in this research - to items 1, 12, 13, 21 and 22 were examined very carefully to ensure that they were in agreement, supporting or modifying the responses to the remaining eighteen items in this section.

In an overview of the response made by the medical sample in chapter 9.1.1, above, mention was made of the remarkable similarity of the response these students made when compared with those of the whole and the two university samples. To avoid replication of the description of the response to items in Section B, much of which has been dealt with in detail in chapters 6.2 and 8.3 above, that of the medical sample has deliberately been kept brief.

Item 1

Item 12

Item 13

Item 21

Item 22 The response by students to these five items is set out in Table 7, below. The frequencies of responses to the options were added and the totals ranked from highest to lowest - the highest representing the most important and the lowest the least important factors.

The top six (i.e. most important) factors were the following: a personal interest in Nature, the usefulness of biology for university entry, an interest in Nature focussed constructively by studies in biology, biology contains useful knowledge, the formation of a positive attitude to Nature during studies in biology, and biology at school is an information-centred subject.

The responses of the whole and the two university samples are almost identical with respect to the sequence of factors listed above, although the exact sequence of the top six places of the other three samples varies a little: see Tables 4, 5, 6 and 7.

The first-mentioned three factors form a top cluster emphasising a personal involvement with Nature, with study at school and university as a means of bringing them together. The next three factors form a separate cluster focussing on the supportive roles played by information and a positive attitude to studies.

A "middle" cluster is formed by the factors occupying seventh, eighth and ninth positions in the ranking, and this outlines the mechanics of successful studies in this subject; the factors are the ease-of-study of biology, biology being a test and examination-centred subject and

this subject giving students an opportunity to show what they are capable of achieving.

At the lower end of the scale the factors are: the prospects of a career and salary, the incidence of and need for creativity during studies in biology, the need/incidence of projects in biology and the supportive roles of parents, teachers and friends during studies in biology at school.

It is clear from the overall response of the medical sample to these five items that the main thrust of biology at school is a factual and achievement-orientated one. Unfortunately, the equally vital aspects of the contributions made by people (teachers, parents, friends) to the experiences and perception of this subject and the important role of experimentation, creativity and project work during studies are low on the students' list of priorities, and it is indeed unfortunate that this should be so.

(The response of the other three samples as regards the placing of the last six factors, i.e. in the twelfth to seventeenth position in the rank, is very similar to - in fact almost replicates - that of the medical sample.)

When the top six factors (i.e. information, Nature, continued study at university, background knowledge) are contrasted with the bottom six (projects, creativity, career prospects, the supportive roles of parents, teachers and friends) it is evident that the students of this sample are set upon a course of study with little influence evident from those persons who are instrumental in supporting and instructing them; only cursory attention is paid to the methods (projects and experimentation) which are so characteristic of science.

Medical students are not alone in such an "educational vacuum"; their counterparts, science students, distributed throughout the whole and the two university samples, responded similarly and developed similar attitudes.

(Another split of the whole sample will investigate the similarity of difference in attitudes of a pure "science" sample of students: see chapter 11, below.)

Item 3

Item 4

Item 5

Item 6

Item 7

Item 8

Item 9 A very high percentage (98 per cent) of the medical sample responded that they had studied biology on the Higher Grade at school (B3); most of the remaining 2 per cent studied it in a non-graded examination system.

Biology was a popular subject at school for the students in this sample; just over 30 per cent responded to item B4 that they considered it "very popular". Altogether 71 per cent of the students in this sample considered this subject as being of above-average popularity (B4.1 + 4.2 + 4.3). Eight per cent, though, described the popularity of this subject as below-average (B4.5 + 4.6 + 4.7).

Eighty one per cent of the medical students had their interest in Nature increased (B5.5 + 5.6 + 5.7) whilst the

interest of 15 per cent of the group was unchanged (B5.4). Five per cent had their interest in Nature decreased to a varying extent (B5.1 + 5.2 + 5.3).

Studies in biology at school encouraged the students to think about Nature and natural processes (B6). The total of the options B6.4 and B6.5, corresponding to "quite a lot" and "a great deal" was nearly 60 per cent; a further 26 per cent were encouraged "somewhat" (B6.3) in their thinking whilst 16 per cent in total were encouraged "a little" and "not at all" (B6.1 + 6.2).

Similar to the response of the whole and the two university samples, the decrease in response of the medical sample to options B6.4 and B6.5 (corresponding to "quite a lot" and "a great deal") was about half. These two options represent the two highest values of this item; judging by this sharp drop in response, there seems to be a limit to the degree to which this subject can encourage reflective thinking. Many students perceive the subject as having very definite boundaries; this is borne out by analysis of item B18, below.

In response to an enquiry by item B7 regarding the use of the environment during studies in biology at school, the medical sample responded as follows: 11 per cent "never" (B7.1) made use of the environment. The following two options (B7.2 and 7.3, denoting increasing use) were each 10 per cent, bringing the total of these three options - denoting the very occasional use of the environment - to 31 per cent. The option "now and then" (B7.4), which denoted infrequent use of the environment, was 38 per cent, bringing the total of these four options (B7.1 + 7.2 + 7.3 + 7.4) to nearly 70 per cent. The remainder of the sample, about 30 per cent, made moderate to very frequent use of the environment during their studies in biology at school.

Tests and examinations in biology, investigated by item B8, did not cause problems for the medical students. Seventy three per cent had optimistic or positive feelings about the outcomes of testing in this subject (B8.4 + 8.5). The remainder were "irritated" (17 per cent), "cautious" (9 per cent) or had negative feelings about the outcomes of testing in biology.

In response to item B9, which enquired about the frequency of visits by the senior secondary biology class to places like mines, nature reserves, fertilizer factories, etc., a response of "never" (B9.1) was returned by 51 per cent of the medical students. Only 5 per cent answered that they "often" (B9.5) visited zoos, nature reserves, etc. - places where graduates could be employed. Overall, the response by the medical sample emphasised the infrequency of visits to such places of study/interest/employment during their school studies in biology.

Although a comparison of responses of samples was not intended during the description of responses to items 3, 4, 5, 6, 7, 8 and 9, upon examination the response made by the medical sample was found to be very similar to that of the whole and the two university samples. This similarity of response continues the similarity of response seen in items 1, 12, 13, 21 and 22 for all four sample groups described above.

Item 10 Medical students report considerably higher percentages in biology than other students during their final year at school. Nearly half of them reported percentages in this subject which are above 80 per cent, with a further 37 per cent reporting percentages in the 71 - 80 per cent range.

A very high percentage (about 95 per cent) report percentages above 65 per cent during their final year. In the other three samples this percentage was about 80 per cent.

Item 11

Item 14

Item 18

Item 20

Item 23 In response to item B11, enquiring into the personal satisfaction gained by medical students during their studies in this subject, 93 per cent of these students produced responses varying from "moderate" to "a great deal" with regard to satisfaction during their studies in biology while the rest, 7 per cent, reported they had gained "little" and "very little" satisfaction.

Item B14 enquired into the sources of information used by the biology teacher. The response by medical students was as follows: Teacher's notes (70 per cent) combined with the use of one or more textbooks (60 and 47 per cent, respectively) together with films and slides (62 per cent), charts and diagrams (48 per cent), the use of a library (39 per cent) and periodicals and journals (28 per cent) formed the major sources of information. Help from subject specialists and the use of commercially available students' notes both received low ratings - about 7 per cent each.

When asked about the extent to which biology relates to other school subjects (B18), approximately 40 per cent of the medical students responded "moderately". Overall, this sample's response reflected a "relates little" relationship rather than a "relates well" one during teaching. Forty two

per cent of the students in this sample responded to options B18.1 + 18.2, reflecting the "relates little" relationship: the total of B18.4 + 18.5, that is "relates well", came to only 20 per cent.

When medical students developed learning problems during their studies in biology at school (B20), their most important resource person was the subject-teacher: 64 per cent of them provided this response. Considerably less, and in descending order of importance, were: one or two special friends (25 per cent), and friends more generally (20 per cent). Parents and relatives, together with teachers other than the subject teacher, were not considered important and were rated accordingly (8 and 3 per cent, respectively).

Students' volunteered comments on their school studies in response to item B20.6 ("no problems" or "insoluble problems" or "an outside resource person") yielded little significant information and thus did not alter the outcome of this item, but comment (not only originating from the medical sample) made the following abundantly clear: A good-natured, lively teacher who can teach well is very important to hard-working students who take their studies - school and later, at university - seriously; they have little patience with unqualified and therefore ineffectual teachers. Students praise biology teachers who teach by clarifying the work and whose students consequently do well in tests and examinations.

When asked to point out the usefulness of a sound knowledge of school biology to everyday life (B23), 29 per cent of the medical sample responded that they found the subject "moderately useful". Above this middle value (B23.4) the total for the options B23.5 + 23.6 + 23.7, which denote an above-average and more rating in usefulness, was 61 per cent. The response to the values below the middle value

(B23.1 + 23.2 + 23.3) totalled 11 per cent. Thus it may be concluded that, overall, medical students find this subject a very useful one.

There are peaks in student response to the middle value (B23.4 is 29 per cent) and top value (B23.7 is 28 per cent) of this item, but with a drop to about 17 per cent for each of the two values lying between them (B23.5 and 23.6). This could reasonably be interpreted as a belief that this subject is very useful in terms of its implementation in students' lives. In addition the subject advances their prospects of entry into university rather than simply providing information relevant to everyday life and living.

The spread of response hints strongly that the traditional methods employed in biology teaching could very easily divorce the reality of everyday living from the restricted academic studies in which learning takes place.

In their response to items B11, B14, B18, B20 and B23 the responses of the medical students differ very little from those of the whole and the two university samples; the overall response of each of the four samples to each of these items and, in addition, to the options of each item, was very similar - in fact almost indistinguishable.

The response of the medical sample to items B15, B17 and B19 differs noticeably from that of the whole and the two university samples. The similarities mentioned above are doubtless due to similar conditions which prevail in all biology classrooms; the differences, however, throw the individual and group attitudes of medical students into relief when they are compared with those of science students.

Item 15 This item enquired into some of the attributes of the senior secondary biology teacher. Medical stu-

dents responded highest (70 per cent) of all the samples to the option "a teacher who was interested in his/her students". In comparison, other samples' response to this option was about 65 per cent. Combining with this high percentage was consistently high - though not necessarily the highest - percentages for the whole range of options mentioning teacher attributes. High ratings were given to teachers' knowledgeability (60 per cent), interest in Nature (57 per cent) and their ability to inspire their students to achieve high marks during tests and examinations (58 per cent).

The teacher's popularity and ability to clarify information also received very positive ratings (45 per cent). Although not primarily regarding the teacher as an intellectual, medical students' rating for this teacher quality was slightly higher than that of other sample groups: 33 per cent.

Medical students clearly expect more from their biology teacher than other, perhaps less dedicated, students do. They have a pressing need to achieve high marks and thus ensure entry into the highly selective medical course at university; the contribution made by the biology teacher is therefore, not surprisingly, an important one.

Students' response to option B15.8 (students' own comments on their biology teachers) was minimal and yielded no significant new information. The comments originating from the serious-minded students in this and the other three samples emphasised students' clearly expressed need for competent teachers. These students were very aware of incompetence on the part of the teacher; some of their comments were indeed withering!

On the other hand, students were lavish in their praise of competent, enthusiastic teachers; to judge from the few responses to item B20.6 (regarding insoluble problems or problem-free studies in biology at school) the biology teacher is frequently cast in the role of a problem-solver.

Item 17 This item enquired into the use of laboratory equipment and learning skills during practical work in the laboratory or in the field. Medical students believed that they learned more in the laboratory and the field, under the same circumstances, than their classmates did. This is borne out by their response to this item: the response of the whole and the two university samples to the option signifying "learned a little" averaged 43 per cent, whilst that of the medical sample was 36 per cent.

The option denoting "a great deal of learning" received a 11 per cent response from the medical students, while the other three samples' percentage for this option ranged from 6 to 8 per cent.

Although the values lying between B17.1 and 17.5 do not readily bear out the conclusion that "medical students learnt more", the total of B17.4 and 17.5, that is, the top two values of this item, was 30 per cent, whilst that of the other three samples (whole and two university samples) was only 23 per cent.

Item 19 The rapid tempo of teaching seldom adversely affected medical students. Fifty six per cent reported that they "very rarely", whilst a further 28 per cent reported "seldom", were inconvenienced by the rapid tempo at which biology was taught at school. Fourteen per cent were affected by the rapid tempo of teaching "from time to time" (B19.3), but very few (2 per cent) were "frequently" affected. While the hard-working medical students are

troubled the least (14 per cent) by the rapid tempo of teaching, other samples report percentages varying from 16 to 22 per cent for the same option B19.3 ("from time to time").

There is a small percentage - about 3 per cent of the students in all four samples (the whole, the two university and the medical) who unfortunately report that they "frequently" and "very often" (B19.4 + 19.5) were affected by the tempo at which this subject was taught at school.

In chapter 9.1.1, the overall similarity of response by the medical sample to that of the whole and the two university samples was outlined. The medical sample showed its individual nature by the noticeably different response to various items scattered throughout both sections of the questionnaire.

The difference in response outlines the success of this sample's students during their Higher Grade studies in physical science and biology at school (A17, A18, B3) and their excellent test and examination results relating to their general achievement (A16) or a specific one, i.e. in biology (B10). The rapid tempo of teaching affected them very little (B19). They were more aware of the wide range of attributes required of a teacher to teach the biology course successfully (B15) and made good use of them in order to solve the learning problems they developed during their studies. This approach was almost certainly a factor in enabling them to learn more successfully (B17) than their less talented classmates. The scores they reported (A16 and B10) were the highest of all those reported by students during their final year at school, while the excellent school results they reported were achieved, for the most part, during studies at large, urban, science-subjects schools.

To judge from the response by medical students, the group as a whole was very aware of the teacher's role as a leader during studies in biology (B15). It is not surprising therefore that the teacher is rated as being their most important resource person (B20.1) when problems relating to studies in this subject arose. The medical students' response to item B15 made it clear that they were more aware of a wide range of teacher qualities, but whether all of these were operative during teaching was not ascertained during this research.

The attitudes developed amongst the students of the medical sample were, according to this study, strongly related to their inborn love of Nature and Creation, their ability to study with a high degree of success together with their anticipation of university study. These traits and aspirations of students were emphasised - almost overemphasised - during the course of their studies at school.

Comparatively less importance was assigned to those characteristics which centred on science and the use of scientific methods (e.g. experiments, projects done on an individual basis or group projects, the contribution to science of imagination and creativity, and improved communication between teacher and student on a person-to-person level).

The contribution of people, that is, parents, teachers and friends, was rated as negligible. In the rank they occupied the lowest and consequently the least important position.

Reflecting on the overall similarity of attitudes of the medical sample to those of others in this research, this general outcome is not unexpected. The medical students attended the same schools, were taught in the same classrooms by (probably) the same teachers using the same

methods. Their first-hand experiences of biology were similar to those of other students and as a consequence they developed similar attitudes.

According to fundamental theories of attitudes, particularly where the persistence of attitudes is under discussion - Allport (1970:321), Evans (1965:107) and Triandis (1971:136-143) - the attitudes developed in one learning situation will almost certainly transfer to a similar situation, influencing the outcomes there. Thus, according to this theory, medical students, transferring from school to university, will transfer from the school to the university learning environment, desirable, as much as haphazardly developed or unbalanced attitudes.

The strong motivation and excellent scholastic record of medical students will doubtless contribute towards ensuring success during studies at university, but they nevertheless will be hampered in their continued studies by the inappropriate/undesirable attitudes which were developed at school.

Attitudes can be modified, and this would hold for appropriate as much as inappropriate ones prevailing amongst students in the medical sample. Evans (1965:17) points out that changes can be brought about in attitudes and this is endorsed by Van Zyl (1982), Hadden and Johnstone (1983), Parker and Rennie (1986), Gayford (1988) and others who suggest various strategies to bring about this change. Unfortunately for those students having inappropriately developed attitudes, the pressure and stress of studies at university seldom allow the luxury of a slow change of well-established attitudes. However, the best-motivated students in the medical sample (together with science students who are similarly motivated) doubtless are able to successfully accomplish this change.

Furthermore, Evans (1965:13) suggests that clever persons, being decision-makers, would be able to develop their own attitudes, whilst the dull, by contrast, take over other people's attitudes. By the same token, medical students' attitudes should differ significantly from those of students in other samples, yet apparently do not. If this is so - and there is evidence based on this research to bear this out - then medical students are being hampered by the similarity of their attitudes to those existing amongst science students.

Evans (1965:16), together with Triandis (1971:5,117), clarify the situation as regards the formation of attitudes as follows: If the formation of attitudes is deliberately attempted, more homogeneous and predictable attitudes will result than if such attempts are not made. The homogeneity and predictability of attitudes developed during a course of study like science would naturally facilitate their measurement by attitude tests.

10 ADDITIONAL SPLITS OF THE SAMPLE: THE CAPE SENIOR CERTIFICATE SAMPLE (i.e. STUDENTS WHO WROTE THE SENIOR CERTIFICATE EXAMINATION OF THE CAPE EDUCATION DEPARTMENT, 1981-1985)

10.1 Introduction: selecting the sample

This sample, being a precisely-defined target group within the whole sample, was selected using the criteria outlined in chapter 4.2, above. The items of the questionnaire which constitute these criteria and which were used to select a sample are set out in Table 8, below. The table has three sections: the criteria of Table 8.1 define a sample combining medical with science students. Table 8.2 defines a sample of science students alone and Table 8.3 defines a sample of medical students alone.

The criteria of Table 8.1 are used in order to select a homogeneous sample having the following characteristics:

1. The students are registered at the Universities of Cape Town and Stellenbosch.
2. They studied biological science, that is biology, at school.
3. They wrote the Senior Certificate examination of the Cape Education Department at the end of their school careers.
4. They have no record of previous study at any university, and they are therefore newcomers to the university, i.e. being first year students in the true sense of the word.

5. They plan to continue their studies in the biological sciences at university for three or more years.

The results in this sample, the precisely-defined target group outlined in chapter 4.2 above, would exhibit some of the more typical attitudes found amongst the current medical and science students who wrote the Senior Certificate examination and are studying at the two universities. They would come to university from schools situated within the Cape Province, being taught science and biology there by teachers employed by the Cape Education Department; the syllabuses used during teaching would be those used by the Cape Education Department.

This sample group, selected by using the criteria of Table 8.1, contains 382 students (i.e. N and $N_B = 382$). This represents 47 per cent of the whole sample of students who studied biology at school ($N_{TB} = 807$), and 43 per cent of the whole sample of students ($N_T = 893$). The sample is therefore large enough to merit a detailed description and analysis.

The students of this sample are distributed by university as follows: the University of Cape Town, having 82 students, constitutes 21.5 per cent of the sample group while the University of Stellenbosch, having 300 students, constitutes the balance, that is 78.5 per cent.

The students of both universities, that is, the strict target group who wrote the Senior Certificate examination of the Cape Education Department, are hereafter called the "Cape Senior Certificate" sample.

The responses of this pre-defined target group are very similar to those of other samples - the whole sample, the sample split by university and the medical sample - and to

avoid, as far as possible, repetition of descriptions of student responses, a more comparative approach has been used here than is the case in the descriptions of other samples.

In the description and discussion of items which follow below, reported percentages are rounded off to the nearest whole number. The result of this procedure is that percentages reported in full might not always total 100 per cent. Where appropriate, however, percentages are given exactly.

10.1.1 Description of the responses to Sections A and B: an overview

Although this sample group represents somewhat less than half of the original sample, examination of students' responses shows a strong similarity of response of this sample to that of the whole sample ($N_{TB} = 807$).

In preceding chapters, the similarity of responses of sample groups resulting from splitting the whole sample a number of ways was made clear. Thus the University of Cape Town sample ($N_B = 329$), the University of Stellenbosch sample ($N_B = 478$), the medical students sample ($N_B = 260$) and the whole sample ($N_{TB} = 807$) all seem to replicate one another in the responses of students to Sections A and B of the questionnaire. The responses of the target group under consideration in this chapter ($N_B = 382$) are similar - in fact almost indistinguishable - from those comprising the other samples.

A brief overview of an interpretation of the responses of students of this strict target group is given below. Some of the implications of the outcomes which characterise this, and other samples, are as follows:

Seemingly irrespective of where students are taught at schools in South Africa - Transvaal, Orange Free State, Natal or Cape Province, the end-product of school biology is remarkably consistent. During their studies at school, the students achieved high marks and were very interested in Nature and Creation. They were, in addition, well-motivated towards successful studies in the biological sciences at the university of their choice. Their expectations of test and examination results during their first year at university are, broadly speaking, very similar to their final year marks at school.

Their attitudes to study (based on interpretation of items 1, 12, 13, 21 and 22 of Section B of the questionnaire) make it evident that during biology studies at school the attitudes to study which were developed laid emphasis - possibly over-emphasis - on a number of factors contributing to the formation and maintenance of attitudes in these subjects.

During biology studies at school, there seemed to be heavy emphasis on students' inborn appreciation of Nature and Creation, and this was developed to a significant degree. In addition, the subject provided students with content information which enabled them to understand Nature and natural processes very well. Such a background of interest, knowledge and understanding advantages students during their continued studies in the biological sciences at these two universities.

Student responses lead us to believe that their own examination performance takes precedence over other equally important aspects of science and biology, namely, experimentation, project work, improved communication between teacher and pupil, the contributions of poster-making and

anti-litter campaigns during studies in this subject, together with job and career prospects.

In all likelihood, according to the current theories of attitudes, the attitudes developed by students at school will transfer to the university learning environment to influence the outcomes of students' studies there. The responses of the target group make it abundantly clear that the attitudes of this group are, in general, inappropriately developed. If these attitudes transfer to the university learning environment and remain unremedied, a number of students will inevitably be at risk during their first year studies.

Further, if the students' attitudes developed during school studies in biology do not reasonably fall into line with, or cannot be modified to fall into line with, the expectations of attitudes of university teaching staff (in particular when these expectations lay stress on underdeveloped aspects such as, for example, the ability to design projects and experiments and to work alone), learning problems will almost certainly accumulate for many of the students in proportion to the seriousness of the mismatch of developed and expected attitudes.

In the past many students found that during their first-year studies at university they did not attain the same degree of success as they did during their final year at school. This lack of success is found amongst those students - as doubtless also amongst others - who continue their studies of science and biology, begun at school, at university. If attitude formation is recognized as being an inevitable outcome of all learning, and well-balanced attitudes contribute substantially towards successful outcomes of learning, then the target group will fare as well (or as badly) as the students of other sample groups during their

continued studies in the biological sciences at the two universities. From the results of Table 9, below, it is evident that in general the development of balanced and appropriate attitudes amongst the students of this sample was not deliberately undertaken at school. It is therefore suggested that unless students are able to develop appropriate attitudes during their first year at university, either as a result of their own endeavours or by seeking assistance (from lecturing staff, fellow-students, student counsellors, parents, etc.) many of them are almost certain to develop learning problems related to their inappropriately developed attitudes, faring as well or as badly as students of other samples during the first year.

10.2 Section A: description and discussion

A descriptive but also comparative approach has been used for the items of Section A. This approach will hopefully avoid a replication of responses which are very similar and have been dealt with in earlier chapters. Percentages and frequencies reporting this sample's response can be seen in Tables 9, 14, 15 and 16, in Appendix 1.

The items of Section A have been re-arranged and some of them have been clustered during description, rather than kept in their numerical sequence and described individually; this will hopefully facilitate a discursive treatment rather than a simple enumeration of responses. Clustered items are treated in the order in which they are listed.

Item 3 On entering the university, the interest of students in studying biological sciences is reasonably evenly divided between the sexes. This spread of interest is seen in the following samples: the whole sample, the two University samples, the Cape Senior Certificate

sample. The medical sample however is exceptional, for in this case the percentage of males to females is 60 to 40.

Item 9

Item 8 The ages of the majority of students of this sample vary between eighteen and nineteen years, the eighteen year olds predominating by 57 per cent over the 35 per cent of the nineteen year olds. Only 7 per cent are older than nineteen, their ages varying between twenty and twenty two years. One per cent of this sample are seventeen year olds.

All the students in this sample left school during the 1981-1985 period, 90 per cent of them leaving school at the end of 1985 and the rest during the 1981-1984 period.

The Cape Senior Certificate sample is the most restricted as regards age and year of leaving school, their age being almost exclusively eighteen or nineteen years and with 90 per cent of the students leaving school at the end of 1985.

Item 11

Item 10

Item 14 Nearly all the students of this sample who studied biology at school and who wrote the Cape Senior Certificate examination, did so at schools in the Cape Province. Three per cent however, studied and wrote this examination in South West Africa/Namibia, which also makes use of the Cape Senior Certificate examination.

More than half the students of this sample attended large, urban Afrikaans, English or dual/parallel medium schools offering science subjects. These schools, accepted and

known for having high academic standards and well-established traditions of being "feeder" schools to one or the other of the two universities, provided varying numbers of science and medical science students to the two universities during the 1981-1985 period, up to a maximum of fifteen per school. The "flow" of students to both universities from large, urban science-subject schools is evident in all the samples. For many students (66 per cent in this sample), the above-mentioned urban school was a neighbourhood school, that is, the State school nearest their home. For 34 per cent however, their school was a selected school, i.e. a private school or a State school not necessarily the school nearest their home.

Slightly more than half the students at the University of Cape Town had previously attended selected schools, this percentage including those who were in private, fee-paying schools, and offering science subjects. Thirty two per cent of the students at the University of Stellenbosch were in this type of school. Comparatively, the students at the University of Stellenbosch reflect the neighbourhood-versus-selected school situation more sharply than do those at the University of Cape Town. The whole, the University of Stellenbosch, the medical and the Cape Senior Certificate samples were very similar in having approximately 63 per cent of their students coming from selected schools.

Item 16

Item 17

Item 18 All the students in this sample studied biology at school and to judge from their responses to item B10 of the questionnaire, an enquiry into their biology marks during the final year at school, possess the scholastic ability necessary for successful studies in this

subject. During their final year at school, 90 per cent of the students scored above 60 per cent for tests and examinations they wrote in all their subjects.

Students who studied biology almost invariably also chose physical science, thereby hopefully developing during their studies at school the broad background in science which is so important for university science studies. A very high percentage of the students (85 per cent) studied physical science on the Higher Grade: for medical students the last-mentioned percentage is 97 per cent.

Item 20

Item 19 In responding to an item (A20) enquiring into their interest in Nature, nearly all the students of this sample chose the options which ranged from "average" to "a great deal". This great interest students have in Nature is also evident from the responses of the four other samples (the whole sample, the two university samples and the medical sample).

The interest of the students compares very well with their responses to an enquiry (A19) concerning the number of years they intend studying at university. Sixteen per cent of the students intend studying for three years, while 35 per cent and 49 per cent, respectively, intend studying for four or more years.

Approximately 43 per cent of the students of four of the samples: the whole sample, the two university samples and the Cape Senior Certificate sample, responded that they intend studying at university for more than four years.

Altogether, students' responses show a remarkably high degree of interest in science studies of long duration.

Item 22

Item 21 Students' responses to a moderately specific enquiry concerning the marks they expect to gain at university make it clear that they anticipate approximately the same marks/percentages as those they achieved during their final year at school. Ninety seven per cent of the student responses showed that they expected average and better-than-average marks during first-year studies. Only 3 per cent responded that they might get marks ranging from below-average down to far-below-average.

The students in all five samples have an optimistic outlook on university studies during the first year; only about 3 per cent of each of the samples are prepared to admit that they might not fare as well during first-year studies at university as during their final year at school, achieving below-average marks.

Although, to judge from their responses to item 20, the students are very interested in Nature - 99 per cent of the responses are in the "average" to "a great deal" range - the response to item 21, which enquires into structured involvements with Nature rather than recreational pastimes, does not compare very well. The responses to item 21 are widely spread over the options; 69 per cent (as compared with 99 per cent in the case of item 20) are in the "average" to "a great deal" range. The balance, 31 per cent, ranged from "very little" to "below average".

In the two lowest categories of item 20 ("very little" and "slight"), there was no response: in item 21 the two lowest categories ("very little" and "slight"), the response totalled 18 per cent.

The totals of the three lowest values for item 21 ("very little", "slight" and "below average") vary little amongst the five samples, the total being about 30 per cent.

The response to the "very little" option of item 21 varied between 9 and 13 per cent for four samples (the whole sample, the University of Stellenbosch sample, the medical sample and the Cape Senior Certificate sample). The University of Cape Town sample's response to this option however, was 18 per cent.

The widespread incidence of a great interest in Nature by students is therefore unfortunately not accompanied by their appropriate investigation into Nature and natural processes. This imbalance might partly account for the disillusionment of many students when, at university, they are required to attend practical sessions in addition to completing assignments. The overall lack of experience of these students in sifting and synthesising information into new, coherent relationships comes very much to the fore during first year studies at university.

10.3 Section B: description and discussion

The description and discussion of responses which follows below is based on analysis and interpretation of five items (1, 12, 13, 21 and 22) and supported by analysis and interpretation of the remaining eighteen items (2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 19, 20 and 23) of Section B of the questionnaire.

In Table 9, Appendix 1, the frequency of student responses to items 1, 12, 13, 21 and 22 is set out. The frequencies of responses have been ranked, from highest to lowest, and are described below in their rank order.

As mentioned earlier in chapter 10.1.1 above, the responses to Section B of the questionnaire by this student sample (that is, the Cape Senior Certificate sample) are very similar to those of other samples, e.g. the whole sample, the two university samples and the medical sample.

The attitudes outlined below are based on interpretation of the responses of the students of this sample and might serve as a model for the more typical attitudes which are prevalent amongst them.

In the description and discussion which follows below, the items have been rearranged and clustered in a manner similar to those of Section A, bringing them into a more dynamic relationship with one another than would have been the case if they were described in strict numerical sequence.

Item 1

Item 12

Item 13

Item 21

Item 22 These five items investigate a selected number of factors deemed to be operative during students' studies in biology at school. The frequency of response to these five items is shown in Table 9, below, and are arranged in descending order of importance, from highest to lowest, as follows:

- 1 an interest in Nature, stimulated by studying this subject
- 2 biology is an interesting subject when studied at school

- 3 biology is a useful subject for entry into university
for continued studies
- 4 attitudes, e.g. a respect for Creation and a love of
Nature
- 5 facts and information which had to be learned for this
subject
- 6 usefulness of school biology in the home, in the
environment and Nature
- 7 biology is an "easy" subject to study
- 8 good test and examination marks in this subject
- 9 own ability to achieve success is demonstrated during
studies in this subject
- 10 improved communication between teacher and student
- 11 experiments to investigate Nature and natural processes
- 12 the prospects of reasonable/excellent pay and
correspondingly, interesting careers
- 13 creativity, involving reading, research, making models,
etc.
- 14 projects, either one-man or group projects
- 15 a good teacher of this subject
- 16 there is parental approval and interest as regards the
student's choice of biology
- 17 school friends influenced the student's choice to study
biology.

The sequence of the frequencies of this sample (the Cape Senior Certificate sample, $N_B = 382$) above, is very similar to that of the whole sample ($N_{TB} = 807$). This similarity can be seen at the foot of Table 9, Appendix 1 where the ranking of the frequencies of both these samples (i.e. Cape Senior Certificate and whole sample) is given. It will be seen that small differences occur, but they do not appreciably affect the overall outcome of the ranking of factors.

When the ranking of factors, as set out in Table 9, representing the responses of students who wrote the Cape

Senior Certificate examination ($N_B = 382$) is compared with those of the whole sample ($N_{TB} = 807$), shown in Table 4, the Universities of Cape Town and Stellenbosch samples, ($N_B = 329$) in Table 5 and ($N_B = 478$) in Table 6, respectively and the medical sample ($N_B = 260$) in Table 7, a very similar ranking is seen. Small differences occur, but overall the sequence of factors in each of these tables is remarkably similar.

In each sample, the exact sequence might differ slightly, but the position of each of the factors relative to that of the other factors remains almost unaltered. For example, the factors an own interest in Nature, biology is an interesting subject and studying biology is important for entry into university are in the top cluster of factors, nearly always in the order listed above and nearly always in the first three places.

At the opposite end, that is, at the bottom of the ranking, the factors are: projects, subject teachers, parents and friends. These four factors are almost invariably in the order listed above, occupying fourteenth to seventeenth places, that is, the last four places in the sequence.

The lower-middle frequencies, occupying eighth to thirteenth places, are the following: good examination and test marks, the opportunity to demonstrate own ability during studies in this subject, experiments, teacher-pupil communication, creativity, and reasonable to good salary and career prospects, often in the order listed.

The middle-to-upper frequencies, occupying fourth to seventh position are: usefulness of the information content of this subject, learning facts and the content material of this subject, a positive attitude to Nature results from a study

of biology and biology is an "easy" subject. Usually these four factors were in the order listed above.

Overall, the fourth to fourteenth positions showed the greatest - albeit slight - variation in ranking. The top-ranking and lowest-ranking frequencies were almost unvarying.

The overall similarity of the outcomes make the homogeneity of the student sample very clear. It seems that almost irrespective of the schools in which biology is studied, one of the outcomes of these studies is that students' attitudes are remarkably similar. This research therefore suggests a "typical" attitude is formed during school science and biology. As mentioned above, this "typical" attitude could serve as a model for the attitudes of students on entering university.

This "typical" attitude or model has already been described above, following analysis of Section B of the whole sample the two university samples and the medical sample. To avoid repetition, this "typical" attitude is only briefly sketched, below:

A study of biology in the Senior Secondary phase at school is begun as a result of a student's natural curiosity in Nature and Creation. Certain other factors contribute a great deal to choosing this subject: the subject-matter of biology, which is seen to be intrinsically interesting, and the fact that the subject also provides a background of knowledge and experience for continued studies in various fields at university. A school student realizes that the knowledge and insights gained during studies in this subject provide him/her with knowledge which is generally useful in the home and in the environment, giving school biology a very good rating.

Other recommendations for choosing this particular subject is that it is frequently considered to be a comparatively "easy" subject although even as such it still demands the understanding and assimilation of a great deal of subject-matter. Acceptable test and examination results, however, are frequently observed to compensate for all the learning. Finally, in biology a student can demonstrate his/her ability to study successfully.

This last-mentioned reason for studying the subject almost certainly reinforces the positive attitude to Nature, Creation and hence the overall study of this subject.

During the study of biology at school, however, certain factors, which are vital contributors to the learning of the subject, do not receive the attention due to them. They are: experimentation, employment and career prospects, creativity and project work.

The student, very involved with his/her interests and studies and prospects would appear to have little - not much more than passing - recognition of the vital and supportive contributions of parents, friends and the teacher of biology.

The "typical" attitude described above highlights the restricted range of factors contributing to the development and firm establishment of students' attitudes during science and biology at school.

A description of the remaining eighteen items of Section B follows below. The descriptive aspect, because it very largely replicates material that has been dealt with in earlier chapters, concentrates more on a comparison of this

sample with others. (Clustered items are treated in the order in which they are listed.)

Item 2 The language of instruction of biology at school of this sample (Afrikaans, English or both languages), favours Afrikaans medium (58 per cent) with English being considerably less (29 per cent), while only 13 per cent of the students were taught through the medium of both languages, that is, Afrikaans and English.

Item 3

Item 11 Nearly all (99 per cent) of the students of this sample who studied biology at school studied it on the Higher Grade. In all the samples the percentage of students who studied biology on the Higher Grade was above 95 per cent: these figures reflect the interest and ability on the part of the students for successful studies in this subject, as much as on the schools and the ability of biology teachers there to teach with a high degree of success.

Thirty four per cent of this sample gave their personal satisfaction resulting from studying this subject top rating. In assigning this subject such a high rating they were in agreement with the whole sample and the University of Stellenbosch sample. The medical students and the University of Cape Town students both had approximately 40 per cent of their students assign this subject top rating for the personal satisfaction they gained from studying it.

The two topmost scale values (4 and 5) of the Cape Senior Certificate sample, on a Likert scale ranging 1-5, totalled 68 per cent. Comparatively, the lowest two scale values (1 and 2), were very much less, totalling only 10 per cent. The middle value (3 on the Likert scale) was 22 per cent.

Aside from the two topmost values of the University of Cape Town and medical samples, above, which were higher than the others, the remaining three values of all five samples showing the personal satisfaction achieved by students during biology at school were very similar, from lowest to highest scale values.

Item 4

Item 5

Item 6 The popularity ratings students assigned biology reinforce the ratings they assigned to the personal satisfaction they experienced during studies of this subject. On a 1-7 Likert scale with the lowest value 7, signifying "very unpopular", and the value 1 signifying "very popular", the lowest and highest scale values were 1 per cent and 38 per cent respectively. The middle value 4 ("neither popular nor unpopular") was 19 per cent. The topmost three scale values of this item totalled 75 per cent and the lowest three 7 per cent.

The percentages reported above are repeated, with minor variations, in all the samples.

The popularity of the subject had a positive effect on students' interest in Nature. They reported the following: only 5 per cent had their interest decreased during studies in biology at school (B5.1 - 5.3), the interest of a further 12 per cent was unchanged (B5.4), while 84 per cent had their interest in Nature increased (B5.5 - 5.7).

The above description of item 5 reports, with minor variations, the outcome of this item for all the samples.

The ability of the subject to stimulate a reflective interest in Nature by students is as follows: 4 per cent reported that the studies encouraged them "not at all", while 14 per cent were encouraged "a little". Twenty nine per cent were encouraged "somewhat" and 38 per cent were encouraged "quite a lot". Finally, 15 per cent were encouraged "a great deal". The last-mentioned response represented the top scale value (B6.5).

The decrease of the top scale value (B6.5), 15 per cent, when compared with the scale value immediately below (B6.4), 38 per cent, implies that the subject, as it is currently taught, has only a moderate ability to encourage students to think reflectively about Nature. The availability of free time, but also the need for further effort, are very probably non-school limiting factors. It is regrettable, though, that there is such a drop-off in the highest scale value - and that this drop-off should be so clearly seen in the ratings of all five samples.

The above-mentioned similarities are reflected in the overall similarities of all five samples' responses to item 6.

Item 8

Item 10 The description of items 4, 5, 6 and 11 above made it clear that the studies in biology at school are attempted in good spirit and with high expectations of successful outcomes of study. This is borne out by their responses to items 8 and 10.

Sixty nine per cent of the students had optimistic and positive attitudes towards the outcomes of tests and examinations in this subject during their final year at school. Only 13 per cent, by contrast, had a fear and hatred of testing and were unsure about the outcomes. The

balance, that is 19 per cent, were "irritated" by tests and examinations, but felt that, though unpleasant, they were necessary.

The outcomes of item 8 for all five samples were very similar, exhibiting only minor differences.

(A comparison of the percentages of items A16 and B10 shows that the student sample's average percentage for all their school subjects and the average percentage for biology in their final year at school compare very well.)

The outcomes of students' tests and examinations in biology during their final year at school are very impressive. Given the students' overall ability for successful study in the sciences, and biology in particular, it is little wonder that nearly all the marks they report are above 50 per cent. Eight per cent of students' marks are in the 51-60 per cent range and 24 per cent are in the 61-70 per cent range. Thirty four per cent are in the 71-80 per cent range, while 33 per cent scored 81 per cent and more.

This overall pattern of excellence is repeated four times: the whole sample, the two university samples and the Cape Senior Certificate sample described above. In the medical sample all the scores are above 55 per cent, and nearly half of the students (46 per cent) scored over 80 per cent during their final school year - a most remarkable record.

The University of Cape Town's student sample showed a slightly (about 4 per cent) higher positive response to the highest value ("positive attitude to tests and examinations") of item 8 and corresponding with these high expectations of success at school, for item 10, the number of students who scored more than 80 per cent is slightly (about 3 per cent) higher. This not only reflects effort

and a high degree of success on the part of the students, but also indicates the stringency of the selection of students for entry to their courses at the University of Cape Town.

Item 14

Item 19

Item 18 Biology is effectively taught at school by the materials closest to the teacher's hand: the textbook together with teacher's notes, slides and films, with approximately 63 per cent each, head the list. Other important sources of information are the use of a second textbook, using charts and diagrams and using a library, with more-or-less 40 per cent each.

The sources of information listed above are the most important ones for all the sample groups. The responses of students at the University of Cape Town, however, showed less reliance on one, and correspondingly more reliance on more than one, textbook during subject teaching at school. The teacher's notes played a very important part, together with charts and diagrams. The University of Cape Town sample reported higher percentages for help from subject specialists and the use of television and videotapes than did the other samples.

The effective use of these sources of information by teachers managed to solve students' problems relating to understanding the subject content: this is indicated by the "no problems" comments students added to item 20, option 6.

To judge from their responses the rapid tempo of teaching seldom affected students. Eighty per cent reported that they "very rarely" and "seldom" had problems with the tempo

at which school biology was taught. Eighteen per cent experienced problems with the tempo of teaching "from time to time". Only 2 per cent had problems of this nature "frequently" and "very often, nearly all the time".

Here also, all five samples showed similar responses, with only small variations. The medical sample reported (almost predictably!) the least problems with the rapid tempo of teaching.

The rapid tempo of teaching, as well as keeping strictly to the subject in hand, might well affect the students' perception of the extent to which this subject relates to others. Forty four per cent of this sample consider that this subject relates "very little" and "little" to other subjects. The middle value of this item is 41 per cent. These students think that this subject relates "moderately" to other subjects. Only 14 per cent think this subject relates "quite a lot" and "a great deal" to other subjects.

The above distribution of percentages is seen in all five samples, with only small differences.

Item 20 When learning problems arose during biology for the students of this sample, the resource persons who helped them solve their problems were the biology subject teacher (59 per cent), classmates, and friends in particular (about 20 per cent each). Parents were seldom consulted to help solve problems (8 per cent) and other teachers hardly ever (2 per cent).

Once again, the responses of this sample are repeated, with small differences, by all the samples.

Item 15 A wide range of teacher qualities is perceived by students during biology: probably the teacher

serves as a model of sorts for a "science person". As can reasonably be expected from them, students assign high ratings to the teacher's interest in his/her students (65 per cent) and the teacher being a knowledgeable person (61 per cent). Also important, although somewhat less so, is the teacher's ability to induce the students to score high marks during tests and examinations (51 per cent) and being able to explain well and solve students' problems (46 per cent). The popularity and friendliness of teachers is perceived as being less important (42 per cent) than the ability to clarify information. Somewhat surprisingly, biology subject teachers' intellectual qualities rated only 30 per cent.

The responses of the five samples to this item was very similar, with only one noticeable exception - that of the medical students who are the most aware of biology teachers' interest in their students, assigning a rating of 70 per cent to this option.

Item 17

Item 9

Item 7 In recent years the necessity for practical work as an essential component of a balanced biology course at school has been repeated with ever-increasing emphasis. Item 17 reports on the skills students believe they acquired during laboratory and/or field-work: "very little", 38 per cent, "a great deal", 6 per cent. The middle value, signifying "a moderate amount" was 23 per cent. The scale values immediately above and below the middle value, signifying "quite a lot" and "little", were 15 and 19 per cent respectively.

The low incidence of practical experience is seen in all the samples with a single exception: the students at the University of Cape Town have the highest percentage, namely 50 per cent, for the lowest scale value, "very little", of this item.

Practical experience in laboratories could successfully be combined with visits to fertilizer factories, zoos, etc, where biological science graduates might later find employment. Fifty three per cent of the students reported that they "never" visited such places, and a further 24 per cent indicated "seldom". The middle value was 12 per cent, signifying a "moderate" number of such outings. The following value, indicating increasing frequency, was 5 per cent and the top scale value, "often", was 5 per cent.

Using the students' environment during practical investigations in biology also showed a low incidence. On a seven-value Likert scale, the lowest three values, starting off "never" (9 per cent), together with the two following scale values, totalled 28 per cent. The top value "very often" was 7 per cent, while the three topmost scale values together totalled 35 per cent. The middle value, reporting on occasional use of the environment ("now and then") was 37 per cent.

The response of this sample was seen, with small variations, in all the samples, with the Cape Senior Certificate sample having the lowest percentage (9 per cent) for the lowest scale value of item 7, "never".

These three items (17, 9 and 7) make it very clear that prospective biological science students seldom gain adequate experience in their chosen field and are in all likelihood not made fully aware of the possibilities of their eventual employer, place of employment or, sadly, the necessity to

practice scientific investigations if they want to qualify as scientists.

The teachers, for their part, largely seem (or are perhaps compelled) to perform within the confines of the classroom, the syllabus, the limitations of a single textbook and the students' requirement for a final mark in their examinations which gains them entry to university. With these restrictions placed upon them, it is little wonder that many teacher's initiative is stunted!

Unfortunately, in the end it is the students who will have to bear the cost of this approach to science and biology teaching when they transfer from school to university.

Item 16

Item 23 When students were asked whether they thought biology was studied in sufficient detail, 12 per cent responded "too little detail". A further 46 per cent thought the detail in which they studied this subject "sufficient". Four per cent responded that the subject was studied in "too much detail" and 39 per cent thought the detail was "varied: sometimes too little, sometimes too much".

The outcome of item 16 was very similar for all five samples, with one exception, as follows: though all the samples assigned a rating of approximately 37 per cent to the option "varied: sometimes too little, sometimes too much", the corresponding rating for the University of Cape Town sample was 26 per cent. A number of students there are not sure that the depth-of-study of biology varies considerably: their response to option 2 of this item "sufficient", was 56 per cent, about 7 per cent higher than any other rating for that option.

When students of this sample were asked to rate, on a seven-value Likert scale, the usefulness of a sound knowledge of school biology to everyday life, of this sample on a seven-value Likert scale, 27 per cent gave the top value "extremely useful". The two values below this total 39 per cent, signifying "fairly useful". The middle scale value, "moderately useful" was 26 per cent. The two values below the middle value totalled 7 per cent. The lowest scale value was only 1 per cent of the response.

This distribution of percentages described above was seen in all the samples. Students in the University of Cape Town sample, however, being either more cynical, or more aware of the knowledge as applied to rather than relating to the everyday, assigned an "almost useless" rating of four per cent and an "extremely useful" rating of 21 per cent, compared with the more usual 28 per cent of the other samples. On the other hand, 33 per cent of the students at the University of Stellenbosch assigned biology the highest rating ("extremely useful") for its usefulness during everyday living.

The inconsistencies in the outcomes of items such as 7, 9, 16, 17, 18 and 23 hint strongly that the pressures on teacher and pupil force many teachers into teaching this subject to a large extent in an educational vacuum, the subject relating only incidentally to everyday existence rather than stemming from an enquiry into life and everyday existence.

In the preceding section of this chapter, the response of the Cape Senior Certificate students to the questionnaire was described. In the course of the description of Sections A and B, the overall similarity of response of this sample to that of other samples was pointed out.

Earlier it was mentioned that this sample replicates the responses of other samples, apparently irrespective of whether they were, for example, the whole sample of students or whether the sample was split, either by university - the Universities of Cape Town and Stellenbosch - or by course - medical students - or by virtue of the school-leaving examination they wrote - Cape Senior Certificate examination.

The responses of the whole sample, the two university samples and the medical sample were first described and then later discussed in chapters 7, 8.2 and 8.3 and 9.2 and 9.3, respectively. A discussion of the response of this sample would necessarily include much of what has already been dealt with in the chapters listed above. As a result, only a brief discussion of the response of this sample group is given below:

The responses to Section A of the questionnaire outline the school background of students who continue their studies in biological sciences at university. The responses of students show that a school background which includes biology as a school subject nearly always includes physical science as well, both subjects being studied on the Higher Grade, with 99 per cent studying biology, but only 85 per cent physical science on the Higher Grade. This inclusion of "science subjects" in the school subject choice provides students with the knowledge, background and understanding necessary for them to tackle successfully their continued studies in biological science at university.

The responses of this and other samples suggest the existence of a "mastery learning" situation in the final year at school. "Mastery learning" implies that all, or at any rate a very high percentage, of the students have

learned and understood the content-material of a learning task and as a result score very well in tests and examinations based on it. An examination of the reported average percentages achieved in this subject - outlined in chapter 10.3 - will confirm this.

From the response of this sample it is clear that euphoric conditions could very easily prevail in the biology classroom at school. The students have chosen biology and physical science to gain them entry to the courses of their choice at university. In addition to this, they score very well in biology, a subject they consider relatively easily learned. Added incentives are that biology builds upon students' innate interest in and appreciation of Nature; not the least is that the content-material of this subject is very fascinating.

The positive outcomes of learning reinforce these students' initial decision to study this subject, based on their love of Nature. By the time they enter university, their interest in Nature and the attitudes which direct their activities have escalated to such an extent that roughly half of this (and other) samples showed in their responses that they planned to study biological sciences at university for more than four years (item A19). Medical students, having a much longer course of study and training are of course not included in the above generalization.

Quite naturally, when they transfer from school to university, the students expect continued success in their studies equal to that of their final year at school. (See description of item A22.4 - 22.7 and compare with item A16.8 - 16.14 and B10.8 - 10.14 of the questionnaire.)

The extent to which students' decisions to study biological sciences at university and for such a length of time are

influenced by their school science and biology studies is difficult to ascertain with certainty, but what is clear is that there is, on entry to university, a very positive attitude towards studying biological sciences. This prevalent attitude is based on students' own experiences in the biology classroom at school.

The schools many students attended were large, urban schools, offering science subjects in their subject choice for students. Quite a number of these schools traditionally provide one or the other of the two universities - Cape Town or Stellenbosch - with appreciable numbers of science students. According to students' response the study of biology at school was strongly centred on information-transfer from teachers to students. Exploration of the environment during studies in biology at school, providing as it does an essential apprenticeship to the investigative methods of science, in all too many cases did not receive the attention it unquestionably merits.

Teachers and learning, excellent test and examination results together with the prospects of continued study at university seem (not unnaturally) to spearhead students' inborn love and appreciation of Nature. At school, studies in biology mould attitudes to both Nature and its study by increasing knowledge and understanding. Positive outcomes of learning biology reinforce and consequently firmly establish attitudes.

According to the current theories of attitudes, due to the persistent nature of attitudes the attitudes formed during science and biology at school will in all likelihood transfer to the university learning environment where the students have, as has been noted, expectations of the same degree of success in biological sciences there as they had at school.

Unfortunately the prevailing teaching methods at school do not consciously attempt an approach to the study of this subject which includes a wide range of activity on the part of the students. Thus the attitudes which are inevitably formed during learning this subject at school and which are consequently firmly established in the students are almost inevitably deficient, and these then transfer to the university learning environment.

(A more balanced approach would not only avoid concentrating one-sidedly on information-transfer almost to the exclusion of much else, but would introduce problematising and creativity, to name just two of the many, varied activities characterising a balanced study of a subject.)

It should be noted in passing that if the attitudes of students are poorly developed during school science and biology, having developed, for example, a neutral or even negative attitude to the practical aspects of studying biological science, and they are confronted later at university with practical sessions lasting a whole afternoon, they will quite naturally be puzzled, baffled or even resentful! In this way, by neglecting the balanced outcomes of studying biology, as reflected in students' attitudes during continued study at university, it might be said that the students all too frequently are not adequately prepared for further study at university by their choice of biology at school.

Earlier, mention was made of the fact that during their school studies in biology, many students experienced a very passive, mainly fact-absorbent role. If such an attitude transfers to the university learning environment, it is very easy to understand that, as a result, many students will experience problems with those aspects of their studies

which are not necessarily concerned primarily with absorbing information. Students might also have difficulty in identifying their own learning problems.

For the students, the facts of the textbooks they have to master are essentially the same as at school, yet if they attempt to learn information en bloc - as they were accustomed to doing in school - they now frequently find the task very difficult. The vital skill of the selective absorption of information relevant to the particular topic - a practice in which many students have little practice - has not been developed at school during studies in either science or biology.

Unless they can first identify their problems and then set about redressing the imbalance resulting from their school studies, they can very easily be at risk during the first year of university study, doing less well than expected in tests and examinations and possibly even failing courses.

11 ADDITIONAL SPLITS OF THE SAMPLE: SCIENCE AND MEDICAL SAMPLES WITHIN THE CAPE SENIOR CERTIFICATE SAMPLE

11.1 Introduction: selecting the samples

The Cape Senior Certificate sample ($N_B = 382$) was selected using the criteria in Table 8.1; by including the criteria shown in Tables 8.2 and 8.3, the sample was split into science ($N_B = 248$) and a medical ($N_B = 134$) sample, where "science" students, as used in this chapter, are defined as all students who are not specialising in medicine.

The science sample represents 65 per cent, and the medical sample therefore 35 per cent, of the Cape Senior Certificate sample. In its turn, the last-named sample represents just under half (47 per cent) of the whole sample of students, $N_{TB} = 807$, and consists solely of students who studied biology at school and who intend continuing their studies in the biological sciences at university, specialising, during their studies, in one or other direction such as microbiology, botany, medicine, etc.

11.1.1 Similarity of the responses of the science and medical samples to the questionnaire: an overview

In chapters 6 and 7, 8.1.1 to 8.3 and 10.1.1 to 10.3, above, the responses to the questionnaire of, respectively the whole, the two university and the Cape Senior Certificate sample were described and discussed. Each of the samples, above, consisted of approximately two-thirds science students and one-third medical students and therefore the responses of each of these samples, above, included those of both science and medical students.

In chapter 9.1, above, a medical sample was selected. The sample which resulted was a "pure" sample in that no science

students were included. The response of this sample, which was described and discussed in chapter 9.1.1 to 9.3, very nearly replicated that of the others, from the whole sample right through to the Cape Senior Certificate sample. The degree of similarity of student response was such that the medical sample's response could hardly be distinguished from that of other samples; one of the few clues to its identity was the exceptionally high percentages reported in Sections A and B (items A16 and B10) together with the highest incidence of Higher Grade studies (items A18.3 and B3.1).

In an attempt to establish more precisely the differences and similarities between science and medical students, "pure" science and medical samples were selected by splitting the Cape Senior Certificate sample. Percentages and frequencies relating to the resulting two samples are shown in Tables 10, 11, 14, 15 and 16 in Appendix 1.

When the response of each of these samples was examined, the outcomes were once again very similar. This held for the similarity of the two samples, one to the other, as much as it did for their similarity to other samples. Almost the same relationship was evident from an overall comparison as when the medical sample ($N_B = 260$) was compared to the other samples (whole, universities, Cape Senior Certificate); they too were very nearly indistinguishable. The science and medical samples included many students who had had very similar - in fact almost identical - experiences during their studies in science and biology at school. Perhaps many of them were at schools where these two subjects were taught by the same teacher. Despite the overall similarity, however, a number of differences were evident. These differences very neatly bear out the consequence of what Vurpillot and Ball (1979) termed the "selective attention" of students, i.e. the outcomes of very similar or identical

experiences of students differed individually due to their differing selection mechanisms. Such differences, however, were not clear when the responses of less precisely defined samples were examined.

The different nature of the two samples became evident, however, in their response to the last four items of Section A of the questionnaire, i.e. items 19, 20, 21 and 22. These items probed students' number of years of study at a university, interest in Nature, participation in Nature-orientated activities and their expectations of test and examination results during their first year of university study. Three of them (A20, A21 and A22) are briefly outlined below to illustrate the nature of the similarities and differences encountered.

The response showed that although an exceptionally high percentage of the students in both had well-developed interests in Nature (A20), their practical involvement with Nature was not on the same level (A21). Science students were practically more involved than medical students. The latter, as regards the test outcomes of their studies during the first year (A22), differed only slightly from science students, despite substantial differences in the percentages they report for their final year at school.

Differences and similarities such as those outlined above might usefully serve science educators and planners of remedial programmes attempting to cope with learning problems students develop during their first university year.

Five items of Section B tested the attitudes students developed during studies in biology at school. The response of the science and medical samples to these items (1, 12, 13, 21 and 22) were tabulated in Tables 10 and 11

respectively, below. Upon examination the responses of the two samples were found to be very similar.

The similarity of the responses of medical sample to those of the science sample was of particular interest and importance as the similarity of the responses of a top group such as this to that of a less highly selected group perhaps indicates an area where learning problems might develop during studies at university.

In 1981, Shayer and Adey, in suggesting that science education should cater for students at their individual level of development, illustrated how a number of students were able to develop their abstract thinking to levels which were nearly impossible to reach by their fellow students, despite their best efforts. This would quite naturally also hold good for the attitudes developed in the course of learning by the top group of students when contrasted with their less hardworking and dedicated fellow-students.

If medical students are representative of a top group, the similarity of their attitude responses to those of science students highlights the fact that their studies in science at school had not catered very successfully in satisfying their differing need for information. If these differing needs were successfully catered for, they doubtless would have been taken up into students' framework of attitudes and would doubtless have been reflected in their differing responses.

In addition, students' responses made it clear that the development of their attitudes was largely left to chance or ignored. The results of this attitude assessment showed that an appreciation of Nature, the prospects of university study and good test and examination results took precedence over typical science-orientated factors such as investiga-

tion by experiment and the contribution made by project-work.

The necessity for developing attitudes amongst the students which are appropriate to the subject can be illustrated quite neatly by means of a selected example, that of investigation by means of experiment. Between 50 and 60 per cent of both these samples responded that they thought they had developed "below average" and "very little" (item B17.1 + 17.2) skills during practical work and/or field work during biology studies at school. Accordingly, this lack of practical experience would be taken up into the framework of attitudes; under such circumstances students would not pay due attention to the vital role played by practical investigation in science. On arrival at university, a course heavily dependent on investigation by practical methods is almost certain to cause problems for such learners almost from the very start.

Based upon student responses to such items as B15 (enquiring into the role played by the biology teacher) and B14.3 (the teacher's notes making an important contribution to students' understanding of the subject) the strong leadership of the biology teacher is very evident. This evidence of leadership on the part of the teacher leads one to conclude that the students, for their part, had a comparatively passive role, chiefly that of successfully assimilating information.

Much of successful university study relies on students finding, selecting and assimilating information on their own. If students from one year to the next and transferring from school to the university learning environment, are required to work on their own this might come as a most unwelcome surprise to them, particularly if they have had little practice in this method of learning while at school.

It is therefore easy to understand why many students, influenced by their inappropriately developed past attitudes could become confused. As in the past, those who for some or other reason do not adjust successfully to the university learning environment, might fail courses or subjects without really understanding why.

11.2 Section A: description and discussion

In the brief description and discussion of student responses which follows below, differences rather than similarities between the science and medical samples are emphasised. By so doing, this will hopefully clarify where remedial programmes could assist in providing solutions to learning problems and where, during curriculum development, obvious pitfalls could be avoided. During this description and discussion, items have been re-arranged and clustered; this will hopefully facilitate a discursive rather than simply an enumerative approach. Clustered items are listed one below the other and then treated in the same order.

Item 3

Item 8

Item 9

Item 10

Item 17

Item 11

Item 14

Item 16 In the large samples which were not strictly defined in this study, females and males were more-or-less evenly distributed. This strictly defined science sample showed a 6:4, female to male distribution. That of the medical sample was likewise 6:4, but in this case with males in the majority.

About 90 per cent of the student sample entered university the year immediately after leaving school. The balance (i.e. about 10 per cent) followed them there within five years of leaving school. (Two years' compulsory military service for most of the males, study at another university and temporary jobs probably account for the greatest part of the balance).

The students, on entry were chiefly eighteen (57 per cent) or nineteen (35 per cent) years old.

Between 60 and (very nearly) 75 per cent of the students in the two samples attended large, urban schools offering science subjects. About twenty five such schools supply the great majority of science students to science and medical courses at the Universities of Cape Town and Stellenbosch. The high quality of the teaching at these schools no doubt accounts in no small measure for the excellent percentages students reported during their final year there. Traditionally, these schools supply one or the other (rarely both) of the two universities with substantial numbers of students.

Sixty six per cent of the students in both samples attended "selected" schools, being either State schools or private, fee-paying schools. The high incidence of such schools, as compared to "neighbourhood" schools (the State school nearest the pupil's home), reflects the considerable cost and long-term planning of parents for their children at school and thereafter at university.

Generally speaking, good marks are essential for students who wish to be accepted into courses in science. This is very definitely the case with medicine. The marks they achieve at school have to be high for them to be accepted and this is borne out by the average percentages they report for the final year at school. More than 90 per cent of the medical sample's marks are above 65 per cent, while about 40 per cent scored more than 80 per cent during the final year at school for tests and examinations. Although only 14 percent of the science sample's marks are above 80 per cent, about 90 per cent of their marks are also above 60 per cent.

Item 19

Item 20

Item 21

Item 22 In the description and discussion of these four items, both similarities and differences between the samples were seen.

Medical students require a minimum of six years of study at a university for a first degree. Science students, by comparison, need a minimum of three, and occasionally four, years of study for a first degree. Only 25 per cent of the science students intended studying for the more usual three years, while 75 per cent of them reported that they intended studying for four or more years. This indicates that many planned to continue their studies at the post-graduate level. Whether these studies will actually take place is of course uncertain, but there certainly appears to be great enthusiasm for lengthy science studies!

To judge from their response to item 20, about 90 per cent of both these samples had an above-average interest in

Nature. This Nature-directed response by science students was slightly less in the case of medical students.

However, science and medical students' interest in Nature was not very well matched by their active participation in Nature-orientated activities. In their response to item 20 (enquiring into students' interest in Nature) very nearly all the responses of both samples were above the middle value. In the response to item 21 (enquiring into Nature-orientated activities) the below-average and above-average totals of both samples were nearly identical: each about 30 per cent. Frequently, to judge from the response to these two items, interest in Nature is of a passive rather than an active kind. The response of the medical sample makes it clear that despite their professed interest in Nature, their appreciation is not expressed in active participation to the same degree as that of science students.

A certain sober reality is evident in the response of medical students' to item 22. This item enquired into the marks they expected for tests and examinations written during the first year at university. Despite the excellent percentages they reported for their final year at school (item A16), they are conservative in their predictions regarding their first year test marks. This is in contrast to the science students who have less of a school record of academic excellence - to judge from the percentages they reported for item A16 (average mark for all subjects) and B10 (average mark for biology). These students expect to score as well for tests written during the first university year as they did during their final year at school.

11.3 Section B: description and discussion

In the description and discussion which follows below, items have once again been re-arranged and clustered to facilitate

a discursive rather than merely enumerative approach. Clustered items are listed and then treated in the same order. References to items included in the questionnaire are enclosed between brackets and a reference such as (B3.1) should be interpreted as Section B, item 3, option 1.

Item 1

Item 12

Item 13

Item 21

Item 22 The responses of the science and medical samples to these items are shown in Tables 10 and 11, below. The frequencies of student responses to these items have been arranged from highest (signifying the most important) to lowest (the least important).

When the responses to these five items made by science students were compared with those of medical students, they were found to be almost replicates. At the foot of Tables 10 and 11 each of them was compared with that of the whole sample. Once again strong similarity was evident. The similarity between the whole and the other samples (universities, medical and Cape Senior Certificate) was pointed out in chapters 8.1.1, 9.1.1 and 10.1.1, above.

In those chapters it was made clear that the attitudes developed amongst students who studied science and biology at school equipped them inadequately for their continued studies in the biological sciences at university. Problems stemming from these inadequately developed attitudes would, to a greater or lesser extent, be shared by all the students included in this research.

A ranking of the factors outlining the attitudes students developed during science and biology at school is given below: those with the greatest frequency rank highest in importance.

The most important ones heading the list are: an inborn interest in and appreciation of Nature and Creation, followed by the directing and fostering of a love of Nature by studies in biology at school and the prospects of continued study at a university. These factors form a "top cluster" of factors.

Learning the subject content of biology, the comparative ease of studying this subject with a high degree of success, a positive attitude to Nature which developed during school studies in biology and the usefulness, by and large, of what was learned continue the rank downwards to below the halfway mark; they formed a "middle-and-upper" cluster of factors.

Experimentation, project work, the improved communication between teacher and student, the results of model-making, reading and research, together with the prospects of a career in science occupy the lower third of the rank; they form a "lower" cluster of factors.

Parents, teachers and friends occupy the lowest positions in the rank; these factors are accorded the position of least importance.

Although in this research, students' attitudes are deemed either neglected or inadequately developed, it is noteworthy that the attitudes developed amongst the science and biology students are consistent in all the samples.

Item 3

Item 4

Item 5

Item 6 The responses of both samples to the items in Section B, examining the teaching of biology at school, re-emphasise a "typical" pattern, seen repeatedly when the responses of other samples, the Cape Senior Certificate in particular, were examined. "Typical" responses include ones such as: Very nearly all (about 97 per cent) of the students studied biology on the Higher Grade (B3.1); it was very definitely a frequent school subject choice. Studies in this subject increased the students' interest in Nature considerably (B5) and very definitely encouraged them to think more seriously about Nature and natural processes (B6). Medical students, more than science students, were stimulated to think about Nature, to judge from their response to item B6.

Item 7

Item 9

Item 17

Item 8

Item 11 Similar to other samples, about 30 per cent of the students in each of these two samples report that their use of the environment (B7) was less frequent than "now and then e.g. twice a year". This below-average use of the students' environment is even greater for item B9. Here the two below-average responses (B9.1 + 9.2) total about 80 per cent. Science, it becomes clear, is taught mainly in

classrooms and laboratories with only infrequent reference to the world outside the classroom. In all the samples, about 60 per cent of the students reported that they developed "very little" and "little" laboratory skills during sessions there (B17.1 + 17.2). With much time and attention being given to teaching, learning and drill, students do not fear tests and examinations, being confident of results which varied from reasonable to very good (B8). About 90 per cent of the students expressed their satisfaction - about one-third expressed "a great deal of satisfaction" - with their studies in biology at school (B11).

Item 14

Item 15

Item 19

Item 20

Item 18

Item 23

Item 16 Biology students at schools in the Cape Province rely on their textbooks, teacher's notes and charts and diagrams to clarify this subject (B14.1, 14.2, 14.3, 14.7). Generally, medical students rely more on their textbooks and teacher's notes than science students do. This great dependance on leadership and guidance by the teacher was seen in both medical samples' responses to item B15.1 - 15.7. Biology teachers take the lead during teaching dialogues, while the overall excellence of their teaching is illustrated by a number of comments volunteered by students. Students praised effective teachers (being for the greatest part quite aware what they expected from them)

and had little patience with those who were neither knowledgeable in their subject and interested in Nature nor in their students and their progress. (B15.1, 15.2, 15.3, 15.5).

Students were seldom affected by the speed at which this subject was taught (B19) and their learning problems were solved as they arose, chiefly by the subject teacher or their friends (B20). It might have been a single-minded application to studies in biology that resulted in about 42 per cent of the students reporting that this subject related to other subjects "very little" and "little" (B18.1 + 18.2), but it was more probably due to the fact that the material covered in this subject is frequently taught in such a way that it bears little relationship to that in other cognate subjects such as physical science or geography. More than 90 per cent of the students in the science and medical samples rated this subject's usefulness to everyday living (B23) "average" or better than that (B23.4 - 23.7).

An item enquiring into the varying depth of studies in biology and its detail (B16) elicited "typical" answers from these samples. About 45 per cent considered the detail "sufficient". Nearly as many answered that it was "varied; sometimes too little, sometimes too much detail." About 12 per cent thought the detail "too little." This response probably indicates that the students are none-too-aware of the depth of their studies!

It was very clear from students' responses that they considered that their school studies in science and biology benefitted them greatly. Unfortunately this benefit is of a nature where studies in biology are closely associated with learning and testing under the strong leadership of a teacher. Reference to the outside world, where careers and environment occupy important positions, was accidental

rather than deliberate. The development of attitudes appropriate to science and biology was largely neglected or left to chance.

An important outcome of the analysis of the responses of these two samples is the clear indication of strong leadership by their science teachers. They clarify the work during their teaching and provide notes: they help solve their students' problems in learning science. This caters very well for the students while they are at school, but inevitably creates problems for them when they arrive at university, where they are expected to work independently.

The uniformity of students' responses can possibly be attributed to adherence by teachers to the requirements of a tightly-structured system of science teaching. This allows even the most enthusiastic science teachers and their students relatively little freedom and time to pursue their own interests in the field of science.

(A more comprehensive outline of the "typical" attitude developed amongst these students replicates much of what has been described at length in chapter 10.3, above, and a reader requiring greater detail is referred to those sections.)

12 ADDITIONAL SPLITS OF THE SAMPLE: FEMALES AND MALES

12.1 Introduction: selecting the samples

The whole sample, $N_T = 893$ and $N_{TB} = 807$, was split by sex into female and male samples using the two variables of item A3: i.e. by alternating A3.1 and A3.2. Splitting the whole sample resulted in two samples of very nearly equal size; female, with $N = 436$ and $N_B = 405$ and male, with $N = 457$ and $N_B = 402$. These samples reflect the 49:51, female:male ratio reported in chapter 6.1, above.

The very nearly equal numbers of females and males suggested that they might be advantageously compared to one another, and also to the whole sample. By this means, differences could be highlighted and similarities emphasised. Where appropriate, reference to other samples could also be made.

12.1.1 Description of the responses to Sections A and B of the questionnaire: an overview

The very nearly identical sample sizes - 49 per cent female and 51 per cent male - might have suggested that their combined responses, reported in chapter 6, above, and discussed in chapter 7, were either very different or, alternatively, very similar. If different, then the responses would represent "average" (i.e. mean) values.

On examination, the latter of the two suggested alternatives was clearly appropriate: the responses of the female and male samples, considered overall, were very similar - in fact they were virtually replicas of one another. The proposals put forward to remedy problem areas of the whole sample would, within reasonable limits, therefore apply equally to both sexes.

Despite the similarity of their responses, a number of small differences were nonetheless discerned. It is usually possible to put forward a simple yet plausible explanation for these, as in the case of the example which follows: Item A8 of the questionnaire enquired into the year when students left school (i.e. the year in which they wrote their matriculation examination). Eighty two per cent of the females responded that they had left school at the end of 1985, commencing study at the beginning of the following year, that is, 1986. Seventeen per cent of them left school during the four years before 1985, that is, during the period 1981-1984. The response of males to the same options was that 69 per cent of them had left school at the end of 1985, whilst 27 per cent had left during the four years before that. The difference between the two samples, as regards proceeding straight from school to university, was 13 per cent. It is almost certain that this comparatively large difference was chiefly due to the males completing their two years of compulsory military service during this period, and then commencing their studies at university. They might equally well have attempted studies at some other university for one or more years, or taken temporary jobs, but this is much less likely.

Unfortunately, other differences are not explained with the same ease. One such example is the response by males to item B4. This item enquired into the popularity of studies in biology at school, with responses ranging from 1 ("very popular") to 7 ("very unpopular"). Twenty six per cent of the males rated this subject "very popular". This was in sharp contrast to the popularity ratings given by other samples, whose ratings ranged between 32 and 42 per cent. This, however, was not accidental; the response by males to the top three ratings of this item (B4.1 + 4.2 + 4.3) totalled 65 per cent. This also contrasted with the totals, with the same options ranging between 69 and 76 per cent of

other samples. Females gave the highest popularity rating, i.e. 76 per cent. Here, clearly, sex differences played a part, but their exact nature and extent could not be ascertained with any degree of certainty during the course of this research. What is quite certain, however, is that the studies in biology catered somewhat better for the interests of females than it did for males; this statement is based on a comparison of the percentages reported by the two samples for their studies in biology during the final year at school (item B10).

Despite the differences commented upon above, the responses by females and males clearly emphasised similarities rather than differences. This similarity constituted one of the important outcomes of this split of the sample; studying biology while at school only rarely developed attitudes noticeably different in the two sexes.

The attitudes developed amongst female and male students, respectively, are illustrated by the frequencies of their response to the attitude-testing items and are shown in Tables 12 and 13, below. An examination of these tables clearly indicates the similarity of the attitudes which they outline. A comparison, seen at the foot of each of these two tables, compares the response contained therein with that of the whole sample, and makes it quite clear that, for all practical purposes, these three are virtually replicas of one another.

When the frequencies in these three tables are compared with those in table 5, 6, 7, 9, 10 and 11, near replicas are seen each time and this would also hold for the attitudes they reflect. Thus the attitudes of science students registered at the University of Stellenbosch (Table 6), would be nearly indistinguishable from those of students registered at the

University of Cape Town (Table 5), whether medical students (Table 7), females (Table 12) or males (Table 13).

According to Triandis (1971), when students develop similar attitudes during their studies, this constitutes a positive outcome of the learning process. It follows that if the same methods are in constant use, year after year, similar attitudes are continuously being developed amongst the students, and as a result their attitudes will be largely predictable (Triandis 1971:5). This would hold for appropriate as well as for inappropriately developed attitudes. During discussion of the attitudes identified in the whole sample (Table 4, below) it was suggested that their attitudes were inappropriately developed, and possibly even neglected. The responses of a number of sub-samples (Tables 5, 6, 7, 9, etc.) made their almost unvarying nature clear.

Based on the foregoing, it is easy to understand that when remedial programmes are proposed to deal with inappropriately developed attitudes, the same or very similar programmes would be appropriate for both sexes. Possibly sexual differences could be used to good effect during attempts to bring about balanced attitudes, but that avenue was not explored in any detail in the course of the recommendations which follow in chapter 13, below.

A model for the development of attitudes amongst female and male students during the course of their studies in school biology is outlined below: it is attempted in order to outline their striking similarity to that of the whole sample. Although based upon the responses of both sample groups, the description makes it abundantly clear that they were taught with but little regard for their sex, so that sex, as much as anything else, could hardly serve to discriminate between them. Reference to the details of the

student response is, for the most part, omitted, but this is deliberate as such details will be included in the course of description and discussion which follow in chapters 12.2 and 12.3, below.

When students at the commencement of their senior secondary phase in high school chose science subjects, they frequently chose biology; it continues to be a very popular subject. Very nearly equal numbers of both sexes completed their studies at school during the period 1981-1985, thereafter to continue their studies in the biological sciences at university. Almost all - about 90 per cent - of the students had studied physical science and biology at school, frequently studying both on the Higher Grade.

In order to promote their intended studies to the fullest extent, considerable numbers - about 40 per cent, boys as much as girls - attended schools which were specially selected for them by their parents. Frequently these were large, urban schools, doubtless chosen on the grounds of important criteria such as the schools' well-established records of academic excellence and their time-honoured link with one or the other of the two universities under study here. Another recommendation was the choice of science subjects (physical science and biology) these schools offered their students.

The balance of the students - about 60 per cent - were taught at "neighbourhood" schools, where they were offered the closest approximation to their requirements for studying science which was available. Frequently, the choice of a school offering both science subjects as well as also being a "neighbourhood" school coincided.

For the greatest part, studies in biology for students of both sexes at school were initiated and guided by the

subject-teacher. In the science room, but with occasional use of laboratories and fieldwork, students' inborn love and appreciation of Nature and Creation was developed further.

Both sexes' efforts at learning were highly successful, as the marks they reported for their last year at school show, and they were able to successfully compete for, and gain, entrance into the university courses they had chosen. To judge from students' responses, there was little reference to the world outside the science room, where parents, their environment and opportunities for employment after graduation might materially affect the way in which they learned science.

During their studies, much of it taking place at a rapid tempo, highly detailed information was assimilated successfully, and possibly uncritically, by both sexes. It is very probable that the learners seldom had adequate time to reflect on the relevance of such information to their daily lives.

The teachers of biology, being quite naturally interested in their students' welfare, kept a check on their progress and helped them to solve their learning problems as they developed. Boys and girls, taught under these conditions outlined above, and quite often in the same classroom in co-educational schools, would quite naturally develop attitudes which are virtually indistinguishable by sex.

One of the most characteristic attributes of much school science teaching, that of strong leadership on the part of the teacher, cast their students in a very passive role, principally that of observer and absorber. As a result, many students developed attitudes accurately reflecting these methods.

A number of points relating to studies by students of different sex in biology at schools in South Africa have emerged in the course of this investigation, one being that in certain domains the interests and prospects of one sex are advanced over those of the other. Females, for example, find the subject considerably more popular than do males (B4.1), in addition to their faring appreciably better in the tests and examinations they wrote in all their subjects (A16.10-14), as well as in biology (B10.13-14). Females provide evidence of their being more studious than males, judging by the almost invariably higher percentages they report for both their sources of information (B14.1-11) and their concern with the attributes of their biology teacher (B15.1-7). They are somewhat more realistic than males in their expectation of reasonably successful, as opposed to highly successful, outcomes of study during the first university year (A22.4-6).

The interests and prospects of females might be disadvantaged by the fact that nearly ten per cent fewer attended "selected" schools (A14.2) than did their male counterparts in addition to them planning to study at a universsity for fewer years (A19.3-5) than males. It would be interesting to speculate on the combination of factors resulting in a 60:40, male:female distribution ratio in the medical sample; what is fairly certain, though, is that the female science students represent a more highly selected group than do the males, the females in the medical group probably being the most highly selected group in this study.

On the whole, males were less enthusiastic than females about school biology (B4.1-3) and felt the lack of use of their environment during studies slightly more than females did (B7.1), as they also did about their lack of contact with places of interest and possible employment after graduation (B9.1). Males were somewhat more involved on a

practical level with Nature than females (A21.5-7). Generally, males showed less enthusiasm than females for the kind of activity centering on studying; possibly the rather restricted range of activities in which they could participate did not match up with their interests and expectations as well as it did with that of females.

In the past, students might have developed vaguely-defined problems associated with learning biological science successfully at university. This research has, however, highlighted those areas where students' problems originate, and the recommendations proposed in chapter 13 address those problems at both school and university level.

(The reader is referred to Tables 12, 13, 14, 15 and 16, in Appendix A, where percentages and frequencies relating to these samples are given.)

12.2 Section A: description and discussion

As outlined in chapter 12.1.1, the responses of the female and male samples very nearly replicate one another, and hence also that of the whole sample. Despite their overall similarity, a few differences are present in the results of the male and female samples. Such differences might be put to good use when, for example, remedial programmes aimed specifically at one of the sexes are being planned, or might perhaps be included during curriculum development in biology.

The items described and discussed below have been rearranged and clustered to facilitate a discursive rather than an enumerative approach; clustered items are listed and then treated in the order in which they are listed.

Item 1

Item 11

Item 3

Item 4

Item 5

Item 6

Item 7

Item 9

Item 8 Although the female and male samples are very nearly the same size, their students are unevenly distributed between the two universities. Thus forty four per cent of the females study at the University of Cape Town and the balance, that is, 56 per cent, study at the University of Stellenbosch, while about 60 per cent of the males study at the University of Stellenbosch and about 40 per cent study at the University of Cape Town.

Nearly all the students, both male and female, are of South African and South West African/Namibian origin. A small number came to these universities from Zimbabwe, the National States or elsewhere outside the African continent.

Approximately 87 per cent of the students in each of these two samples is at university for the first time, the rest having been at university for one or more years, or having completed their studies at, for example, teacher training colleges or similar institutions.

The students in the two samples wrote school-leaving (i.e. matriculation) examinations for no fewer than eleven examination boards; the percentages they report paint a clear picture of the two universities' ability to attract students from outside their "home" province, for only approximately 60 per cent of the students of both sexes wrote the matriculation examination of the Education Department of the Cape Province. A further twelve per cent wrote the examination of the Department of Education and Culture. Eight and 2 per cent of the students of both sexes wrote the matriculation examinations of the Transvaal and Orange Free State Education Departments, respectively, while about 5 per cent wrote that of the Education Department in Natal. Six per cent wrote the matriculation examination of the joint Matriculation Board while about 4 per cent wrote the National Senior Certificate examination.

Sixty nine per cent of the female sample responded "Yes" to item 7, which enquired whether or not they had written the matriculation examination known as the Cape Senior Certificate examination. Sixty two per cent of the male sample gave the same response.

The ages of entering students in the samples is very consistent: the great majority are eighteen and nineteen years old. About 20 per cent of the males are older, i.e. twenty and twenty one year olds. Few (5 per cent) of the females are older than eighteen or nineteen, while a few (4 per cent) are younger.

Very nearly all the students left school during the period 1981-1985. In contrast with females, 82 per cent of whom left school at the end of the year immediately prior to commencing study at university, only 69 per cent of the males did so. As discussed in chapter 12.1.1, above,

compulsory military training for males is undoubtedly one of the major reasons for this 13 per cent difference.

Item 10

Item 12

Item 13

Item 14

Item 15

Item 17

Item 18

Item 16

Item 19 Slightly more than half (56 per cent) of the students in each of the female and male samples were at large, urban, Afrikaans, English or dual/parallel medium schools situated in urban areas. Such schools, a considerable number of which are located in the Cape Province, catered for the science education of both sexes.

In the whole sample, forty per cent of the students attended selected schools, that is, private, fee-paying schools or state schools selected by the parents and not necessarily the closest school to home. These schools were quite often at a considerable distance from the student's home. Sixty per cent of the whole sample attended "neighbourhood" schools, that is, State schools close to the students' home. Sixty five per cent of the female students were at "neighbourhood" schools, whilst 56 per cent of the males were at such schools. The difference is perhaps due to a

greater concern by parents for their sons' as against their daughters' education. Doubtless there are a number of cases where students, of both sexes, were at school together and proceeded from there to university to continue their studies in science.

Forty four per cent of the males attended selected schools (thus approaching the 51 per cent reported by the males at the University of Cape Town), while 35 per cent of the females were at such schools. In these samples, males are therefore advantaged in that about 10 per cent more were at selected schools than was the case for the female sample. The above percentages are doubtless linked with the number of years students study at university (see item 19 below).

While at school, roughly 90 per cent of both sexes studied biology, while a slightly higher percentage (about 93 per cent for both sexes) studied physical science. Approximately equal percentages studied this subject on the Higher Grade (83 per cent in both cases) or on the Standard Grade (about 10 per cent). Between 5 and 7 per cent of the students of both sexes went from school to university having only studied one of the two science subjects. Lecturers in the biological sciences at university cannot therefore assume that all their students have knowledge and background of both physical and biological sciences as a consequence of their studies at school.

Students of both sexes reported excellent average percentages for their studies during the final year at school. Although nearly all the marks were above 50 per cent, the females were clearly the more successful students, to judge from the marks they reported. Thus 42 per cent of them reported percentages above 75, while the percentage of males reporting above 75 was only 30 per cent. Twenty three

per cent of the females scored more than 80 per cent, whereas only 14 per cent of the males scored in that range.

Item 19 reports the number of years students intend studying biological sciences at university. In considering students' responses to this item, it should be remembered that most bachelor's degree courses in the sciences at South African universities require three years of full-time study. However, selected degree courses such as Domestic Science and Agriculture (both specialised courses offered at the University of Stellenbosch) require four years, whilst medicine requires a minimum of six years of study. The number of years of study necessary to complete a degree course will naturally be a factor in determining how long a student intends studying a particular subject, whilst specialised degree courses, as in the case of the two examples mentioned above, may restrict a student even further. Despite such restrictions, however, it is clear that females intend studying biological sciences at university for fewer years than males, as is borne out by their response below.

About 12 per cent of the students of both sexes intend studying biological sciences at university for only one year, while about 3 per cent intend studying in this direction for two years. This is probably due to these subjects frequently being studied as "fillers" as part of, for example, a degree course for intending teachers which may require only one year of study in the biological sciences. Nineteen per cent of the females and 14 per cent of the males intend studying biological sciences for three years.

Thirty three per cent of the females and 21 per cent of the males intend studying biological sciences for four years. A number of them will receive their first degree at this point

whilst others would have completed one year of post-graduate study.

Thirty three per cent of the females intend studying biological sciences for more than four years, while 52 per cent of the males intend doing so. This large discrepancy is perhaps due to the fact that at South African universities males traditionally have been more committed to post-graduate (i.e. higher degree) studies than females, who have traditionally left university after completion of their bachelor's degree - although this situation is changing rapidly. The percentages reported above include those of medical students (115 females and 172 males), who, after five years of study, have not yet received their degree.

Item 20

Item 21

Item 22 When asked to rate their interest in Nature, nearly all the students in both samples gave an "average-and-better" rating. The totals for the top three ratings ("above average", "well-established" and "a great deal") of item 20 for both sexes totalled approximately 85 per cent.

In item 21, which enquired into the students' active participation in nature-oriented activities, such as anti-litter campaigns, etc., the response differed considerably from that to item 20, above. The below-average responses of both sexes totalled 34 per cent. The "average-and-better" ratings totals of both sexes were about 66 per cent. The totals of the top three ratings of this item, that is, 21.5 + 21.6 + 21.7, averaged out at about 30 per cent for both

sexes, with males being more actively involved than females by about 10 per cent.

The large difference between this total and its equivalent from item 20 - 85 per cent - is striking. Large differences like that reported above can be seen in the responses of all the samples. Clearly, students' enthusiasm for Nature is not necessarily translated into action; however the male sample reported a greater degree of practical involvement with Nature than any of the other samples.

Nearly all the students in these two samples - as much as those in the others - expect their first-year studies at university to have "average-and-better" outcomes for the tests and examinations they will be writing. Approximately 74 per cent of the students of both sexes expect the outcomes of these tests will be "average and/or above average". About 14 per cent expect "good - far above average" results, while about 4 per cent think their results will be "excellent - near the top of the class" for their studies during the first university year.

By comparing these expectations with those they report for their last year at school, students' prospects are made clear. Although not quite as good - percentage-wise that is - they nevertheless have high hopes and expectations of the outcomes of their studies during their first university year, but males more so than females.

12.3 Section B: description and discussion

The responses by the female and male student samples to all twenty three items in Section B of the questionnaire are described and discussed below. Five of the items in this section tested the attitudes developed amongst students and the frequencies of their responses to these items are shown

separately in Tables 12 (females) and 13 (males), below. Their responses to these five items are described and discussed below together with the remaining eighteen others in this section.

The sequence of description and discussion below is the same as that in chapter 6.1, where the responses of the whole sample to the items in this section were described, but with one difference: here the items are clustered to facilitate discussion. Clustered items, as before, are listed one below the other and then treated in the same order. Where appropriate, reference is made below to the whole and other samples.

Item 1

Item 12

Item 13

Item 21

Item 22 The responses to these five items by the female and male samples are set out in Tables 12 and 13, below. The frequency response of each sample was arranged from highest to lowest and then numbered. The highest total in each sample (signifying the greatest importance) was numbered 1. The list ended at 17, the number indicating the least importance in this rank.

At the foot of Tables 12 and 13, the rank order of the frequency response of each sample is shown, together with that of the whole sample. The similarity of response to these five items by the two samples is abundantly clear: they are almost replicas of one another. The response to

these five items was, as it were, merely divided into its respective male and female components.

A close examination of Tables 12 and 13 shows that in both cases the first - and hence the most important - factors are: an interest in Nature, an interest in Nature which was focussed by studies in biology at school and studies in biology at school afford students entry into courses in the biological sciences at university. If these three factors are included in the framework of students' attitudes, they would operate in the following manner: studies in biology at school built onto a quite natural inborn love and appreciation of Nature; further, and very importantly, they provided students with entry into university courses.

The factors occupying fourth to eighth places varied slightly, with female responses placing the information-centredness of their studies in biology in fourth place. As if to corroborate this priority, the percentages reported by the female sample for their studies in biology during the final year at school were higher than those reported by the male sample.

Overall, the fourth to eighth places were occupied by such factors as: a positive attitude to Nature which was developed during studies in biology at school, and this subject contained much useful information, although much information had to be learned during studies in this subject. By and large, these students thought that biology was a comparatively "easy" subject to study successfully but the subject was test and examination centred.

The ranking of factors re-emphasises a love and appreciation of Nature which permeated through to everyday existence, although the mechanics of studying this subject strongly centred on handling information and committing it to memory.

The ninth to fourteenth positions are as follows: studies in biology afforded students opportunities to demonstrate their ability for achievement, gave them opportunities to perform experiments, and attempt projects, either singly or in groups, express their creative ability by making models, designing posters etc. In addition, there was the improved communication between teacher and student and their career and employment prospects after graduation.

As shown above, science and career directed activities were accorded comparatively low frequencies and hence importance in the ranking of factors. Translated into priorities, which operate from within a framework of student attitudes, they indicate low priorities during the course of studies.

The last three places, fifteenth to seventeenth, are occupied by the factors representing persons such as teachers, parents and friends; all the student samples assigned least importance to them. No doubt all of them will agree that such a low rating is certainly not justified in view of the considerable time, effort and money expended on behalf of the students!

The ranking of factors above does not attempt to describe the attitudes so much as list the priorities of a number of identifiable factors during students' studies in the biological sciences. As mentioned above in chapter 12.1.1, above, the priorities developed at school will almost inevitably continue to operate during continued studies in the biological sciences. Their influence directs students' attempts to learn with the hope of the same degree of success that characterised their studies in biology at school. A glance at Tables 12 and 13 will make it abundantly clear that the attitudes of many female students in the sample were developed in such a manner that they are

very nearly indistinguishable from those developed by the males if they are based upon the priorities of their factors.

Based on such an outcome, the attitudes developed amongst the majority of students of both sexes are very nearly replicas of one another as well of course of the whole sample. If, as discussed in chapter 7, above, the attitudes prevailing amongst the majority of students in the whole sample are considered inappropriate to their continued studies in the sciences, then they are shared by both females and males.

These students might develop learning problems they cannot solve by themselves. This might lead even further: to their failing tests and examinations which they might reasonably expected to have passed. The high degree of success afforded them by their studies in science and biology at school might have persuaded many of them that they should study science at a university, whether they are really suited to it or not.

When the frequencies of the responses of the whole sample to the attitude-testing items were arranged from highest to lowest, irregular intervals were seen to exist between them, with the varying large and small intervals between them creating "clusters". A number of such "clusters" were seen and commented upon in chapter 6.2.

The response of the female and male samples also yielded "clusters" similar to those described above, but here the composition of the clusters was different. Those of the males differed from those of the females (combined, they naturally formed the overall "clusters" mentioned above). These differing "clusters" make one aware that although one might say, in the course of conversation that: "the same

attitudes were developed amongst males and females during the course of their studies in biology at school", this is not entirely accurate. These "clusters", which differ in composition for each sex, indicate that the most accurate interpretation takes heed of the composition of the clusters, all of which contribute to apparently identical attitudes being developed by the sexes.

Both samples have the same factors at the top of their list in the most important position: first was a general interest in Nature, followed in second and third places, respectively, by an interest in Nature was focussed by studying biology and studying biology at school provides entry into a university.

The females' top "cluster" of factors consisted of two, namely their interest in Nature together with their subject-focussed interest in Nature. Following below, the third factor is included together with the fourth in a "cluster" consisting of two factors: studying at a university and school biology is an information-centred subject.

Males, despite the very nearly identical sample size to that of females, generally responded less strongly than females did in assigning places to factors. Their top "cluster" consists of a single factor, namely a general interest in Nature. The following "cluster" consists of two factors, a subject-focussed interest in Nature together with prospects of study at a university. Although these "clusters" are interesting, even tantalising, very little could be gleaned from them in the course of analysis other than to speculate that - differing in composition for each sample - they might well correspond to personality attributes relating to the criteria used for selecting the samples.

Item 2

Item 3

Item 4

Item 5

Item 15

Item 14

Item 20 Roughly 45 per cent of both samples were taught biology through the medium of either Afrikaans or English alone, while the remaining 10 per cent were taught this subject through the medium of both languages at dual or parallel-medium schools.

About 97 per cent of the student samples of the two sexes studied biology on the Higher Grade, whilst only 1 per cent studied it on the Standard Grade. The remaining 2 per cent studied this subject with no Grade system in operation.

In general, biology was a popular subject amongst the students in the two samples, although somewhat less so amongst males than females. The popularity ratings for the top three options of this item (from "above-average" to "very popular") ranged between 65 and 76 per cent. That of males was lowest, at 65 per cent. This was another indication that sexual differences should be taken into account during teaching both at school and at university level.

As a result of their studies in biology, the interest in Nature of both females and males was noticeably influenced for the better. Nearly all (about 95 per cent) of the

students reported that their inborn love and appreciation of Nature was either unchanged or had undergone a change for the better; about 12 per cent had had their interest in Nature "very much increased". Very few, about 5 per cent in both cases, had had their interest in Nature diminished by their studies in biology at school.

Asked to choose from a list of descriptions those which fitted their biology teacher best, female students responded with higher percentages than males for all the seven options which were supplied. Female students gave the highest ratings to the following: "a teacher interested in his/her students", "a teacher interested in Nature", "a teacher who had a good knowledge of biology" and "a teacher whose students fared well during tests and examinations". The focus of female students on a wide range of attributes of their biology teacher was very similar to that of medical students. Comparatively, the male sample did not respond so strongly to this item, their percentages invariably being lower than those of the female sample.

The sample of female students gave higher ratings than the males to nearly all the sources of information in use at their schools. Three of these, however stood out: the use of the textbook, notes supplied by the teacher for use in the class and the showing of films and slides. Once again, high percentages were given by the female sample to these three sources of information and once again they closely resembled those reported by the medical students.

Below that occupied by the textbook, teachers' notes and films, the middle range of importance was accorded the use of additional textbooks, charts and diagrams and the use of a library. Still lower percentages - and hence importance - was accorded the use of television and video-tapes, periodicals and journals. The lowest percentages were

assigned to dictionaries and encyclopaedias, commercially available students' notes and help from subject specialists.

Female students give higher percentages than males to nearly all the options of item 15 (sources of information) and 14 (the attributes of the biology teacher). The studious nature of female science students is apparent here, and it helps to account for the high percentages they report for their studies in biology (See item B10, below).

When the students of either sex developed learning problems in the course of their studies in biology, they took their problems to their subject teacher, who helped solve them. Comparatively, their friends, even "special friends", were not considered as much as half as important in this context. Parents and other teachers on the school staff were, according to the students, of little resource value when it came to solving their learning problems in this subject.

Once again, comments volunteered by students made it clear that when they developed problems with learning this subject, they took them to their subject teacher. To judge from their volunteered responses, very few students had problems with learning this subject which remained unsolved at the end of their studies.

Students' comments on their biology teachers totalled only 5 per cent of the sample; of these the positive ones were almost cancelled out by the negative ones - except in the case of the male student sample, where it was exceeded. Positive comments included the following: an enthusiasm for Nature which was shared by students and teacher alike, an appreciation of up-to-date knowledge and the ability to explain away difficulties which arose during studies. Students' negative comments focussed mercilessly on teachers who were out of touch with Nature and their

students, and who showed a lack of background, training and hence command of their subject.

Item 17

Item 6

Item 7

Item 9

Item 8

Item 11

Item 10 Students of both sexes reported that they believed that they had developed comparatively few skills during practical sessions in laboratories, or the equivalent ones during field trips. About 60 per cent of the students of both sexes reported that the science skills they had learned were "below average"; the "above average" skills they developed totalled only 22 per cent. Nearly half the females responded to the "very little" option of this item, compared with about 40 per cent of the males; clearly, although both sexes were well aware of their lack of skills, females felt it more keenly than males.

Although the percentages the students reported for their participation in practical work were low, it is gratifying to note that at least the content material of the subject gave them food for thought. About 80 per cent of both these student samples were encouraged to think "somewhat", "quite a lot" and "a great deal" about what they had learned during their studies. Unfortunately, 19 per cent of the female sample and 15 per cent of the male sample were encouraged

"not at all" and "little" to reflect on what they had learned in this subject.

Nearly 40 per cent of the students in both samples reported that they had "now and then (i.e. twice a year)" gone on field trips into either the human or the natural environment. Roughly thirty per cent of the students in each of the two samples had gone on field trips and excursions oftener than that, but the balance, also roughly thirty per cent, had gone on field trips less often than twice per year. The lowest rating "never" ranged between 11 and 15 per cent. The highest percentage for this option, 15 per cent, was assigned by the sample of males. This could be interpreted to mean that they feel more restricted by being taught almost exclusively indoors than their female fellow-students. A valuable opportunity for learning out of doors might well have been lost here.

Item 9 enquired into the frequency of trips by the senior biology class-group to places such as museums, nature reserves, fertilizer factories, mines. These are not only of scientific interest to a group of students, but also provide employment for science graduates. In their response, about 75 per cent of each sample reported that they "never" and "seldom" went on such visits; only about 10 per cent of each sample reported going on such visits "from time to time" and "often". To judge from the overall picture, neither of the two samples benefitted more than the other, although males seem to have felt the lack of such visits slightly more.

About 70 per cent of the students in both samples were optimistic, having positive attitudes towards the outcomes of tests and examinations they wrote in biology at school. A total of about 10 per cent of them were, however, cautious about the outcome, or had negative feelings about testing

and were unsure of the outcomes. About 20 per cent of the students of both sexes found tests unpleasant but necessary and were "irritated" by them.

The students of these two samples, reporting on the personal satisfaction they gained during their studies in biology, expressed their satisfaction as follows: About 10 per cent gained "very little" and "little" satisfaction, whilst about 23 per cent expressed "moderate" satisfaction. Nearly 70 per cent reported that they had gained "above average" and "a great deal" of satisfaction from their studies in biology. As in the case of item B8 (enquiring into students' attitudes to testing in this subject) the percentages reported by these two and all the other samples - nine in all - are virtually replicas of one another, showing little variation in the percentages reported.

During their last year at school, the students of both sexes nearly always scored above 55 per cent for the tests and examinations they wrote in biology. About 80 per cent of both samples reported that they scored above 65 per cent in this subject, 54 per cent of the females reporting that they had scored above 75 per cent, compared with the 43 per cent of males who scored the same. These figures report the high percentages scored by many students and occur consistently in the results of all nine samples.

Item 19

Item 16

Item 18

Item 23 The samples of female and male students were "very rarely" (about 50 per cent) and "seldom" (about 30

per cent) affected by the rapid tempo at which biology was taught at school. About 20 per cent were affected "from time to time". Overall, the percentages reported by the two sexes follow that of other samples, yet the "very rarely" option of males was the lowest, at 45 per cent, of all the percentages reported for this option by all the samples: it was about 5 per cent lower than the more frequent percentage of (about) 50 per cent. It is possible that a sex-related difference is manifesting itself in this percentage; possibly the males would prefer more thorough teaching, or perhaps more time for discussion; it is difficult to be sure which of these two is the more accurate interpretation.

When asked whether biology, in their opinion, was studied in suitable detail at school, the overall response of both samples was almost identical. Half of each sample considered that the detail was "sufficient". About 12 per cent of both samples thought there was "too much detail", while about 30 per cent were of the opinion that the detail was "varied: sometimes too little, sometimes too much". A number of students are doubtless aware, in their response to item B16.4 ("varied: sometimes too little..."), that their interests and enquiries are of little importance when set against that of assimilating content and that "learning for learning's sake" conditions generally prevail during students' studies in this subject at school.

The overall response by these two samples was similar to that of the whole sample, and this response was replicated, with small variations, by most of the other samples.

About 50 per cent of the students in these two samples report that studies in biology at school relate to other subjects "very little" and "little". By comparison only about 18 per cent thought this subject related to others "quite a lot" and "a great deal". A response such as this

might lead one to consider whether or not the students' viewpoint was not strongly influenced by their teachers; that for example by concentrating on content-matter to the exclusion of much else, this might not have restricted the students' view of the subject. On transfer from school to university the change in teaching style and emphasis would come as a shock to those students who have been accustomed to having their teachers provide powerful leadership during teaching.

When asked to rate the usefulness of a sound knowledge of school biology to everyday life and living, the middle value "moderately useful" received a response of about 27 per cent from both sexes. The scale values above and below the middle value were the following: a total of about 65 per cent of the student samples thought the subject was of above-average usefulness, and a total of about 10 per cent thought it of below-average usefulness.

The high percentages these two samples reported for the usefulness of this subject when compared with the low frequency response they gave for employment and career priorities (B1.6 + 1.7) do not match well. Nor does the low incidence of visits to nature reserves, fertilizer factories, museums, etc. (B9.1) relate satisfactorily with the few skills they reported were developed during their sessions in the biology laboratory at school. As a result, these students might have developed a very hazy picture of the day-to-day work done to further knowledge and understanding in this field, or the types of work they would be qualified for after graduation.

Description and discussion of the items of Sections A and B of the questionnaire have once again emphasised the remarkable similarity of response which characterises all the samples. Although, as we have seen above, the samples of

the sexes largely replicate one another, there are nevertheless a number of differences. These indicate that, despite the fundamentally similar attitudes which were developed amongst the students in these two samples, the sex of the students results in a small but noticeable contribution to the attitudes developed by each of the two groups.

13 RECOMMENDATIONS

13.1 Introduction

Based on the description and discussion of the responses by the students included in the whole and other samples, the following recommendations are made with a view to modifying the attitudes prevailing amongst them. Some of the recommendations are of a general nature, whilst others are more specific. Their aim is to bring about a change in some of the more typical outcomes of school biology which, based on student responses, illustrate clearly that they developed attitudes during their biology studies at school which could easily create problems for them during later university studies in the biological sciences. These recommendations could be included in the teaching strategies of those persons who, at school or university, deliberately attempt to remedy those outcomes of school biology which in the past contributed to students failing, or performing badly in tests, examinations and courses which they might reasonably have been expected to have passed.

The suggestions put forward below should not be regarded as prescriptive but rather as guides for those who are interested in generating subject-related attitudes amongst their students, whether at school or university. The projects listed here cannot serve as substitutes for effective teaching and form a part of it.

The outcomes of this research suggest that unless some definite action is taken, either at school or at university (or at both) as a result of closer co-operation and co-ordination, typical problems such as, for example, under-achievement, inability to adapt to the university learning environment, the inability to select relevant facts from information provided, a casual attitude to practical in-

vestigations, and others, will, as in the past, continue to hamper students' efforts during their first year of university study.

The recommendations outlined in chapter 13.2, below, seldom refer by name to theorists or researchers in the field of attitudes whose work was discussed in some detail in chapter 2 (pp. 4 - 16), above. Their findings are combined with those of this investigation, however, so that the recommendations put forward for this sample are based upon both.

13.2 General recommendations

Teachers should teach with specific learning outcomes in mind. These learning outcomes, however, are not necessarily those which are concerned with explanation, clarification, transfer of information and students' achievement, although these are naturally important in their own right.

The results of this investigation make it clear that outcomes of study which are directed toward the processes of science - rather than study which is involved with scientific information should, in addition to the outcomes listed above, receive more attention during school biology teaching. In addition to the information and knowledge covered during science teaching, science-orientated attitudes should receive much more deliberate attention, as one of the outcomes of learning, during teaching. At the same time there should be more scope for inclusion of the many and varied experiences and backgrounds of the learners.

An increase in students' contributions to and participation in their biology studies as is suggested here would doubtless limit the time available for direct teaching - that is, instructing, clarifying and related activities.

This reduced "teaching time" has to be accepted if any positive changes are to be made. It is recommended that teachers teach less by direct teaching, but listen and share more.

Experience leads one to the conclusion that at present many biology teachers take on dominating roles as leaders during teaching, assuming almost full responsibility for their students' performance in this subject. The students, for their part, are all too often reduced to a very passive role: that of acceptance of this leadership; only those students who possess very individual attitudes and identities as learners can hope to avoid this complaisant, fact-absorbent role.

An old-fashioned "learning for learning's sake" atmosphere seems to prevail in all too many South African school biology classrooms. Admittedly, a background of biological information will undoubtedly benefit those students who continue their studies in similar fields at university, but when much of the information to be learned is linked with information-transfer approaches and over-strong leadership by the teacher, the students are frequently uncertain why they are learning biology or, more importantly, how best to learn it. This is all the more so when learning is not accompanied by appropriate practical investigations.

As a general comment on teaching biology at school, the following suggestion is made: less time should be spent on transferring the contents of school textbooks into students' memories and more on creating links between their environment and the content of the subject. Making use of the resources of the environment together with the theories and factual information contained in school textbooks should by this means hopefully generate interest in both areas of knowledge, and lead to the formation of attitudes enriched

by the knowledge and insights gained during a much wider range of learning experiences. The attitudes formed by this kind of learning will almost certainly serve the students better than the current attitudes do. Coming into contact with the reality of the environment in addition to textbook theory might also serve to deter students from attempting post-school studies, for which they are not well-suited, in the biological sciences.

If, as recommended above, the information-transfer aspects of biology receive less attention in the classroom, there would be more scope for students to select and contribute material relevant to their own interests and abilities, from their environment and their textbooks, as well as information from other sources. Teachers as well as their students would undoubtedly gain much more from the types of learning encounters suggested above: from the discussing, sharing and evaluating which are fundamental to this kind of learning. Needless to say, such an approach to teaching during the senior secondary phase at school necessitates a carefully structured approach on the part of the teacher.

This approach might be achieved, for example, during individual or group projects: more particularly if these projects are of an investigative rather than a descriptive nature, i.e. being open-ended, where students are actively involved in both the planning and execution of the project. All the students - and not only those who intend continuing their studies at university - should be involved, for all would undoubtedly benefit. Some suggestions for projects of this type are as follows:

- * How does the time and cost of keeping a canary for one year compare with that of keeping a hamster for the same period?

- * From which pet-shop would a prospective buyer get the best buy and after-sales service when setting up a tropical fish tank?
- * What is the cost per month, in terms of time and effort, of keeping a home swimming pool free from algae, apart from the cost of pool chemicals?
- * How do the local authorities respond to an offer by the biology class to select, plant and maintain for one year trees on a treeless pavement in front of the school?
- * Design a garden for your school, to include shade areas, play areas, a pond, etc. Include a list of plants, preferably indigenous ones.

These projects should be seen as examples of exercises in designing and executing, to the best of students' abilities, planned, scientific investigations.

If these projects either take longer than expected to complete or give inconclusive results, this should be considered as part of the learning process: an apprenticeship, as it were, in science.

Inconclusive results or failed experiments will hopefully make inroads into, or even break, the "closed circuit" of reinforcement of self-satisfaction which, as a result of successful textbook learning, all-too-easily characterizes the attitudes of many science students.

13.2.1 Co-operation and co-ordination between school and university

But who would have to complete these proposed projects, and should students participate on a voluntary or compulsory basis? There is no simple answer to this question. A number of problem areas common to students transferring from

school to university are outlined below; the importance to their students of one or more of these should enable teachers to decide on the best course of action in their particular case.

- 1 In recent years the necessity of student practical work during school science has repeatedly been stressed. However apparatus and equipment are not invariably available and replacing breakages is becoming increasingly expensive.
- 2 Certain skills such as, for example, the correct use of measuring cylinders, burettes and pipettes are comparatively easily learned; others, like experimental design, the necessity of a control experiment, or various science-orientated reasoning skills, need much more time and considerable practice to develop.
- 3 A "learning gap" undoubtedly exists between school and university. Unfortunately, it seems that in general only the most talented learners (not necessarily the highest achievers at school) can hope to bridge this gap successfully; the average learner has difficulty in achieving success equal to or better than school during university tests and examinations. Such a student might even fail tests which, despite a good effort on his or her part, he/she should have passed; this is at its most evident during the first year at university.
- 4 There is evidence (Van Zyl, 1982) to suggest that science reasoning skills can be developed by students at university. However one recent study, by Sanders and Fridjohn (1986), has shown that to develop these skills during the first year at university is difficult.

Those students who, during first-year studies, need remedial programmes most, are frequently those who are least interested in them and reluctant to participate therein.

- 5 Active co-operation and co-ordination between school and university is necessary to bridge the education gap which undoubtedly exists between the two in South Africa; jointly developing attitude tests for general use in life sciences, for example, would go a long way in achieving such a goal.

Co-ordination is needed to alter some of the more typical outcomes of school science and biology. One of the first objectives of such co-ordination would be to make prospective biological science students aware of the "education gap" which exists between school and university, and then to devise practical, cost-effective methods to involve them in science-orientated activities such as, for example, "a morning in the botany/zoology/physics/chemistry laboratory", where students are introduced to methods of scientific investigation during one or more open-ended practical sessions in university laboratories. Practical sessions in the laboratories are clearly to be preferred to merely visiting and viewing them, and could serve as an introduction to what is in store during university study. For practical reasons these visits would best take place during school and university vacations.

The compartmentalized, highly academic and frequently theoretical aspects of school biology need to be balanced by contact with reality. For example, a visit to the zoo by a senior biology class should, using the above approach, become a structured visit and not merely an outing. During such a visit the students should be able, besides viewing

the animals, to gain knowledge and insights into the cultural value of a zoo, the opportunities for the study of live specimens and opportunities for graduate employment, the relationship between a zoo, and tourism and nature conservation and the managerial skills needed to run such an institution successfully.

The practice gained by selecting, planning and (most particularly) organizing information from different sources should be seen as contributing to science education beyond the school years, hopefully creating a more balanced attitude to science than is evident from the responses of the current student sample.

The emphasis of the projects and investigations briefly outlined above should be on careful planning: collecting, sifting and integrating information and, finally, careful evaluation rather than a hastily composed account with superficial descriptions and sweeping generalizations - all of which are very much in evidence during the university first-year but not taught there!

Some of the proposed activities will hopefully reduce or even break the "closed circuit" of textbook learning and reinforcement which characterizes the student sample: the imbalances of their learning experiences have created corresponding imbalance in their attitudes.

13.3 Specific recommendations

13.3.1 Addressing the attitudes of students at school

The large, urban, Afrikaans and English-medium schools which supply the two universities studied with substantial numbers of biological sciences students are in key positions to place their students at an advantage by implementing the

recommendations outlined in chapters 13.2 and 13.2.1 above and described in more detail below.

In chapter 13.2 above, the development of a scientific approach to problems was outlined. The students should, in addition, be encouraged to problematize; that is, to develop organized approaches to understanding puzzling natural phenomena. As mentioned in chapter 13.2, the emphasis of students' attempts should be on problem-solving by reasoned, organized attempts, with the focus on their personal involvement and followed thereafter by an evaluation of what was learned during the problem-solving operation.

Students' attempts at problem solving should not, in their own interests, be allowed to "fizzle out", but instead should finish on as positive a note as possible, particularly if, for some reason, their investigations did not "work well".

A major attempt should be made to remedy the overall very low incidence of structured investigations and involvement with Nature revealed in this research. The investigations proposed here need not necessarily be performed by students in laboratories, but could equally well take the form of one or more field-trips, organized in collaboration with teachers, parents and other persons. As mentioned earlier, student participation is vital to the success of such operations.

Teachers at schools which lack adequate facilities and equipment for teaching the sciences might more seriously consider whether "a morning in the laboratory", with the students performing several simple experiments in local university laboratories, could be arranged during school or

university holidays. Students would without question benefit from such an experience.

An encounter with the university as a place of learning should not be allowed to degenerate into a mere sight-seeing trip. Instead, the university should be seen as a place of learning, sharing and discussion rather than as some form of Utopia.

While not attempting to prescribe in unnecessary detail, it is hopefully clear what is recommended here and the deficiencies these recommendations attempt to address: increased use of students' environments to increase their awareness as prospective biological science graduates; of salaries, jobs and careers in their home environments, as well as their employability in zoos, fertilizer companies, universities, research institutes, industry, etc. Field trips and visits to local factories or mines, as well as films or talks by representatives of the above-mentioned employers, would also contribute to widening the range of students' learning and experience, all having the same end in view: to create an awareness - and the equivalent balanced attitude - of the web of life and Nature, and how mankind either fits, or comes into conflict with it.

During a time when rapid advances in science are made on an almost daily basis, a student-centred approach should include a greater emphasis on the correctness and source of the factual material than is almost certainly the case at present. For example, is the information of a fifteen year old reference work still valid? Similarly, to what extent does a "Nature film" represent a narrow or biased view-point on the part of the maker?

With the teacher less in the foreground during every learning encounter, incorporating these suggestions in

schools will, it is hoped, permeate the students' consciousness and generate increased individual and peer-group thinking.

No curriculum development activity is ever free from problems, misjudgements and, on occasion, mistakes; these are, however, inevitable in any development process. If teachers and their students are encouraged to attempt, both inside and outside their classrooms, to explore some of the less traditional methods of learning, both will undoubtedly benefit: more so the students when, continuing their studies, they go from school to university, into the tutelage of others.

13.3.2 Addressing the attitudes of students at university

At a university there is, generally speaking, comparatively little time during undergraduate courses for the more leisurely, long-term development of attitudes; this is particularly so in the biological sciences, where attending lectures and practical sessions and completing assignments consumes much of a student's time; there is thus all too little time left for reflection on what was learned and integration of an "old" stock of information with the "new" gained during lectures and practical sessions.

In addition, many first-year students' attitudes are, on entry, characterized by self-satisfaction brought about by the "mastery learning" (that is, an approach to learning where the students have mastered all the content information required and are drilled and tested in it) of their final school years. As we have pointed out above such attitudes can easily create a "closed circuit" for further learning; this is a serious hindrance to successful and profitable study at a university.

In an attempt to balance such deficient attitudes, an attitude-testing session could be held shortly after commencement of classes to determine the range of students' attitudes. When this has been done, the necessary action can be taken. Essentially, this would consist of attempting to reduce large differences between the attitudes of the students as shown by the test and a set of "ideal" basic attitudes, as established by agreement and consultation amongst the teaching staff.

If, for example, the results of an attitude test show that serious deficiencies exist in many students' attitudes, and that such attitudes might seriously hamper their performance in a subject, the teaching programme might attempt to remedy this. By this method, the details of which are given below in this chapter, the development of balanced, appropriate attitudes is seen as an essential component of successful teaching.

Designing attitude tests for marking by computer would mean that the results of such tests would be available with a minimum of delay: this is of particular importance when the classes are large and serious deficiencies are suspected. A number of examples of attitude-testing items designed for marking by computer have been included in Appendix 3, below. By using a computer the results of these tests could be expressed as individual attitude scores or attitude profiles of the whole class. Records could easily be kept of scores and profiles (or both) and these compared with the results of traditional methods of testing: class tests, assessment of practical work and assignments.

The results of attitude tests could be particularly useful in cases where students are entering new fields of study, are returning to university after a long absence or are educationally disadvantaged. These results might also be

used to considerable advantage during student counselling and, where necessary, the students taken up in academic support programmes (ASP) for shorter or longer periods of time. Recent research in South Africa (Behr: 1985; Jackson and Young: 1987) on students in their first year at university foreshadow the increased use of tests such as attitude tests and greater reliance upon their results.

In the past, many students who developed problems during their laboratory practical sessions, in the author's experience, responded favourably to a system which avoided supplying them directly with answers to their questions, leading them by enquiry to discover the solution for themselves. This is not necessarily the best solution, as classes are often large, while frequently educationally disadvantaged students are too timid to ask for assistance. The following suggestion relates to those areas where students' attitudes are not seriously deficient:

Append open-ended, thought-provoking questions to the notes handed out to all the students during their lectures and practical sessions. "Answers" to selected questions might be given. During the first stage, all the students receive these questions and answers. Staff members, or graduate assistants, might be assigned to help students who have problems with either the questions or making sense of the suggested answers.

At a later stage, an attitude test - possibly in the form of an "enquiry" - is given to the students. Essentially, this would be the same test, but a different version. Those students whose responses show that their attitudes have not changed to fall in line with university expectations are then placed in discussion groups where both lecture content and the methods and problems of the practical sessions are discussed, together with a frank discussion of the problems

with learning which students experienced but were not able to solve. A film or video could be shown to such a group and after the viewing, be tested with respect to content, style and method of presentation in order to make students understand the essential difference between passive viewing and entertainment value on the one hand, and viewing in order to learn but also understand and to relate on the other.

At or near the end of the first-year course, the attitudes of all the students are once again tested. As mentioned in chapter 3.3 (p. 24), above, attitude tests have the advantage over tests of knowledge in that students do not have to study for them and they are comparatively free from stress. The outcome of this third test could be used to establish the degree of success of the remedial programme, students' progress in terms of attitudes which have (or have not) changed and the outcomes of the course besides the gain in knowledge. Using a computer programme to mark the attitude tests, record the results and show, in addition, how attitudes have - or have not - changed, the results of a large class' tests can be made available to teaching staff within a very short space of time.

In an attempt to avoid, as far as possible, the deficiencies such as those reported by Barnett et al (1983: see p. 7, above) the development of attitudes is best seen as an inseparable part of the teaching programme. The time and effort required to test separately for knowledge and attitudes will by this means be considerably reduced.

Implementing this suggestion would lead to testing students' knowledge and attitudes during the same test. Multiple-choice closed-ended questions similar to those used in the questionnaire would be inserted amongst those testing their knowledge. A computer would then be used to mark the

questions testing their attitudes and keep appropriate records. A number of suggestions for attitude-testing items are supplied in Appendix 3 (pp. 281-284), below.

Using this method, a number of reliable attitude-testing questions could be accumulated in the course of time. Students such as those having, for example, highly creative attitudes to research could be identified on the basis of their knowledge and understanding but also with respect their attitudes, whilst those best suited to teaching could be identified by the same means. Doubtless, as the attitude-testing questions become more reliable due to constant refining, fewer items will be required to test students' attitudes.

Although the success of the methods outlined above, attempting to modify students' attitudes cannot, at this stage, be guaranteed, they might serve to guide and support those students who, almost from the very beginning of their university studies, experience problems with learning, yet are at a loss to understand why this is so; those who are anxious to remedy learning problems, but often are too timid in asking for help because they cannot identify their own learning problems.

14 SUMMARY AND AFTERWORD

Current theories of attitudes postulate that the attitudes developed amongst students during their studies in, for example, science at school will persist and continue to operate during their subsequent studies at university. There they would, for example, influence students' efforts at studying with the same high degree of success that had characterised their studies during their last year at school.

Attitude theories also hold that well-developed attitudes are very tenacious and are therefore resistant to change. If this theory is applied to science education, it implies that the attitudes which develop amongst students during their studies in biology at school will also be characteristically tenacious and resistant to change. Thus attitudes formed during studies in biology at school would similarly undergo little change on moving from school to university, although naturally subject to the condition that no studies of this nature were undertaken in the period between leaving school and entering university. Accordingly, the attitudes developed during biology studies in school could be safely tested at university provided that these tests were completed before first year studies at university began to modify them.

During the period 20 March to 11 April 1986, a questionnaire was administered to first-year biological science students at the Universities of Cape Town and Stellenbosch; this was done under carefully controlled conditions. After administration the completed questionnaires were checked, numbered and the results processed by computer.

Eight hundred and ninety three completed questionnaires were processed; hence $N_T = 893$. This figure represents 84 per

cent of all the students enrolled for first-year courses in the biological sciences at the two universities in that year. The sample was finally reduced to 807, this figure representing only students who had studied biology at school - nearly always together with physical science - and who were therefore relevant to this research.

The questionnaire sought to establish the attitudes which had developed amongst the students during their studies in the sciences at school, i.e. during the time they had studied physical science and biology. This research focussed particularly on the attitudes students developed during their studies in biology.

During processing of the students' responses they were at first all combined into a single sample which was designated the "whole sample". During description and discussion of the whole sample, it became clear that the attitudes which had developed amongst the great majority of students during their school studies in science and biology were inappropriate. This held for the study of biological science, represented here by school biology, as much as it did for its continued study, at a university, in subjects such as botany, entomology, zoology etc, and, more generally, degree courses in the biological sciences.

One of the implications of this finding was that a substantial percentage of students in the sample would, as a result of their inappropriately developed attitudes, very probably develop learning problems during their first year of study at university. Comparatively few students could hope to avoid such problems, which would not necessarily develop as a result of a lack of reasonable levels of ability, or enthusiasm for study, but because of students' attitudes, chiefly developed during studies in science and biology at school. As a result, during their studies in the

university first year, they very probably would not be able to achieve the same high degree of success which they had enjoyed during their last year at school.

Typically, the attitudes developed in this sample of students emphasised a love and appreciation of Nature in preference to investigation by experiment and handling projects. The absorption of information and the achievement of excellent examination results were, in their view, perceived as being more important than the success of a subject such as biology in fostering communication between teacher and student. The students were of the opinion that the comparative ease with which this subject could be handled was more important than the influence of their parents, teachers and friends in supporting and encouraging them in their efforts to make a success of their science studies at school and proceeding from there to university.

The recommendations put forward for the whole sample were based upon information supplied by the students; their responses highlighted the importance of large, urban schools which offer a choice of both science subjects. Many students (about 60 per cent) had studied at such schools. Importantly, many of these schools are linked by long-standing tradition to one or the other of the two universities, having over the years provided them with large numbers of able students. The recommendations put forward to modify students' deficient attitudes would, certainly in the first instance, be most conveniently implemented at these schools, and at the universities they supply with so many students. It is believed that the suggestions put forward here should be implemented with as little delay as possible at school level, for if a major revision of South African school science curricula does not take place in the near future, a continued stream of students with similar,

haphazardly developed or neglected attitudes will continue to enter university from school.

The recommendations attempting to cope with the attitudes of the students in the sample suggest that studies in science and biology should bring them both frequently and deliberately into contact with the scientific method. If, during the learning process, the methods of science and the role of science in the community received the attention due to them, they would inevitably influence the attitudes the students developed while they were still at school. By this means, an increase in knowledge and understanding related to a subject - in this case biology - would be accompanied by the attitudes which were developed at the same time, i.e. develop attitudes reflecting a knowledge of science and its role in the community and environment to a greater degree than the case in the samples in this study.

The development of sound attitudes is seen as an inseparable part of the study of biology, and this would also be applicable to testing. In virtually all educational processes, knowledge and understanding of a subject are tested on a regular basis; the same conditions should apply to the attitudes developed in the course of learning. If this is accepted, then amongst the questions testing knowledge, items testing attitudes would also be included. (A number of suggestions for such items are included in Appendix 3, pp. 281-284). In this manner, progress in each of these areas i.e. knowledge and attitudes could be determined. The attitude profiles resulting from such regular tests might then be profitably used during student counselling.

In the early stages of this research a number of splits of the sample were planned. As only a limited amount of information concerning the students was available at that time, there was some uncertainty as to exactly how many splits

would finally be possible, but the following seemed obvious: by university, by their sex, by course - either science or medicine - and one which was later named the Cape Senior Certificate sample. This was named after the matriculation examination many students resident in the Cape Province write on leaving school. A good pass in this examination ensured substantial numbers of students entry to both universities. This last-named sample would be considered as a strict target group within the large, more diverse sample and would consist of students who had written the Cape Senior Certificate examination, had studied biology at school and in addition were planning at least two years of study in the biological sciences at university. The latter criterion would hopefully ensure students' high motivation for successful studies at university.

The whole sample was split a number of ways by making use of appropriate computer programmes. The Cape Senior Certificate sample was split once again into 'science' and 'medical' samples. Altogether there were nine samples: the whole sample and eight others.

Each of the samples resulting from a split of the whole sample was described and discussed. Each time, the original finding of this research - that the majority of students had developed attitudes inappropriate to further study in science and biology - was repeated.

Consecutive splits of the sample made it abundantly clear each time that, by and large, their studies in biology at school had very inadequately catered for individual learners, whether this was based on their sex, course of study, choice of university or the matriculation examination they wrote (although with respect to this latter factor here only the Cape Senior Certificate came under detailed scrutiny).

The responses by each of the nine samples to the attitude-testing items were astonishingly similar, using larger or smaller numbers of students. Each, however, emphasised another surprising result: the attitudes prevailing in the medical sample - representative of a very able and highly selected group of learners - were virtually indistinguishable from those of any of the other samples. Place of origin (Cape Province or elsewhere in South Africa or South West Africa/Namibia), sex or even course of study (science or medicine): none of these made anything but the slightest difference to the outcomes as far as attitudes was concerned. As a consequence of this remarkable similarity of response, the general recommendations for the whole sample were also considered appropriate for these samples.

Addressing the current system of science education in South Africa at school and university level, the following are strongly recommended:

- 1 Science teachers should continue to teach information and develop understanding in their subject as a means of attaining accepted, well-defined educational goals. However, one of the most important goals in science education also consists of the development in students of attitudes which are appropriate to the further study of science in the world in which they live, beginning with their immediate environment.

Progress in the knowledge and understanding of the subject - here, biology - ideally goes hand in hand with the development of appropriate attitudes. During class tests, the attitudes developed amongst the students should also be tested in a manner similar to the way in which knowledge and understanding are tested.

2 Much more attention has to be given to the individual learner than is at present the case. A widespread lack of practical experience during science studies at school could advantageously be countered by individual or group projects of the kind suggested in chapter 13.2 (pp. 200-201) in an attempt to remedy the defect. These projects would be completed in the students' own environment and would without doubt benefit all of them, although naturally all might not benefit equally. According to a number of well-known general educators and science educators, students in the top group of learners particularly need to encounter challenging situations during their studies in science, thereby developing highly individual attitudes during their studies. This may well not be readily accomplished in their home environment.

Co-operation and co-ordination between school and university might help bring about these challenges by, for example, the organization of visits by student groups to universities. School and university holidays suggest an ideal time for visits by such groups from high schools. Once there, they meet fellow science students from other schools, are conducted on tours to familiarise them with the campus, visit exhibitions, debate subjects of interest to them and participate in practical sessions in the university laboratories.

The outcome of increased participation in activities which centre on their studies, in this case biology, will undoubtedly benefit them whilst developing an increased sense of reality as regards their forthcoming studies in science and the careers they envisage, or are open to them, in that field. Students' learning experiences during such trips to the university will

almost certainly result in positive and healthy attitudes to science.

- 3 On entering university, students' attitudes should be tested, after which the relevant university teaching staff are made aware of the results of the tests. Widespread deficiencies and problem areas which have been identified, and which are likely to result in learning problems, could then be given the necessary attention. During lectures, practical sessions in laboratories, fieldwork and assignments, these problems could be addressed both directly and indirectly, in order to remediate them.

Where necessary, students who do not readily respond to the methods outlined above, could be referred to programmes such as the Academic Support Programme (ASP) which operates for students studying at the University of Cape Town.

Undoubtedly, both university teaching staff and their students would benefit from this positive approach. Each, being better informed on the need for developing appropriate, healthy attitudes, would be more enthusiastic about their shared commitment to this vital aspect of the study of science.

AFTERWORD

Although the methods outlined above might serve to bring the attitudes prevailing amongst students at school into a more favourable relationship with the study of biology than is evident from this research, they unfortunately address the symptom and not the disease of students' deficiently developed attitudes.

It would be very convenient to lay the blame on the components of the school science system, listing, amongst others, "the teachers", "the students", "lack of science facilities", "lack of equipment", etc.

This research has made it quite clear, however, that the deficient attitudes which were found to exist amongst the great majority of students in this sample resulted from the widespread use of traditional teaching methods during their studies in science and biology. Although many students and their teachers would not willingly have made use of these methods, they were almost compelled to do so, abandoning the more enlightened pursuits in science in the interests of meeting both the educational requirements of the syllabus and a university entrance pass. An enormous gain in factual knowledge - although unfortunately not always accompanied by a similar gain in understanding - resulting from their studies in biology was unfortunately not balanced by the development of appropriate attitudes. This lack of balance is almost certain to adversely affect the performance of those students who are, not unnaturally, unaware of the effect of attitudes in directing their efforts during continued study at university. It is indeed a great pity that this should be so.

APPENDIX 1

TABLE 1: TABLE OF SPECIFICATIONS FOR ITEMS IN SECTION A OF THE QUESTIONNAIRE

Item number	Item description
1	Name of university where student is registered
2	Date of completion of the questionnaire
3	Sex of the student
4	Academic status of the student: first year at any university?
5	Academic status of student: first year, returning or otherwise
6	The education authority for which the student wrote his/her school-leaving examination
7	Query: did the student write the Senior Certificate examination of the Cape Education Department?
8	Year in which student wrote his/her school-leaving examination
9	Age of the student at the time of completion of questionnaire
10	Name of last school attended by the student
11	Name of the country)
12	Name of the town or city) where the school
13	Name of residential area) attended by the
14	or suburb)
15	Type of school attended by the student: a "neighbourhood" school or a "selected" school?
16	Query: did the student study biology at school?
17	Query: what was the student's average percentage for all subjects during the final year at school?
18	Query: did the student study physical science at school?

Table 1 (continued)

Item number	Item description
18	Query: was physical science studied on the Higher or Standard Grade?
19	Query: how many years' duration are the student's studies at university?
20	Self-rating by the student: the degree of his/her interest in Nature and living things
21	Self-rating by the student: the degree of his/her purposeful activities involved with Nature and living things
22	Self-rating by the student: his/her expectations of outcomes of tests and examinations in biological sciences during the university first year

TABLE 2: TABLE OF SPECIFICATIONS FOR ITEMS IN SECTION B OF THE QUESTIONNAIRE

Item number	Item description
1	The student's choice of reasons (from a list of seven provided) why he/she chose to study biology at school
2	In which language was biology taught at school?
3	The level of the student's studies in biology at school; whether on the Higher or on the Standard Grade
4	The student's rating of the general popularity of biology at school
5	The student's rating of how studies in biology affected his/her general interest in Nature
6	The student's rating of the extent to which he/she was encouraged to think about Nature and natural processes during studies in biology at school
7	The student's rating of how frequently the environment was used during studies in biology at school
8	The student's choice of a description of the usual reaction (from a list of five provided) to announcements of forthcoming tests and examinations in biology
9	The student's rating of the frequency of visits by the senior biology class-group to places such as mines, nature reserves, fertilizer factories, etc.
10	Query: what was the student's average percentage for tests and examinations in biology during the final year at school?
11	The student's rating of the personal satisfaction resulting from studies in biology at school
12	The student's choice of descriptions (from a list of seven supplied) of what seemed important during studies in biology at school

Table 2 (continued)

Item number	Item description
13	The student's choice of reasons (from a list of seven supplied) why he/she would have liked to achieve good marks for biology at school
14	The student's listing of sources of information (from a list of eleven provided) used by the teacher during studies in biology at school
15	The student's choice of attributes (from a list of eight provided) describing his/her Senior Secondary biology teacher
16	The student's choice of a rating (from a list of four provided) to indicate the detail in which biology was studied at school
17	The student's rating of the skills developed during practical work in biology at school
18	The student's rating of the extent to which studies in biology at school related to other subjects
19	The student's choice of a description (from a list of five provided) to indicate how often problems developed due to the rapid tempo at which biology was taught at school
20	The student's choice of persons (from a list of six provided) to whom problems which developed during studies in biology were taken
21	The student's choice of alternatives (from a list of seven supplied) to complete a statement beginning: "Biology as a school subject has"
22	The student's choice of alternatives (from a list of seven provided) to indicate what, resulting from studies in biology at school, was most vivid in the memory
23	The student's rating of the usefulness to everyday life and living, of a sound knowledge of the content of school biology

TABLE 3: TABLE OF SPECIFICATIONS FOR THE FACTORS UNDER INVESTIGATION BY ITEMS 1, 12, 13, 21 AND 22 OF SECTION B OF THE QUESTIONNAIRE

	FACTOR UNDER INVESTIGATION	ITEM NUMBER				
		1	12	13	21	22
1	The <u>influence and interest of parents</u> , encouraged the student to study biology at school	X		X		
2	Interest in biology is <u>focussed on the nature of its content</u>	X		X		
3	Interest in biology is <u>focussed on the excellent teacher</u> in this subject	X		X		
4	<u>Friends</u> influenced the student to study biology at school	X		X		
5	The student is <u>interested in Nature</u>	X			X	
6.1	There are prospects of <u>reasonable salaries and an interesting career</u> following studies in biological sciences at university	X				
6.2	There are prospects of <u>top salaries</u> together with <u>excellent career</u> prospects following studies in biological sciences at university	X				
7	Biology is an <u>information-centred subject</u> : i.e. during studies in biology a great deal of information needs to be processed		X			X
8	Biology is <u>test-centred</u> : i.e. it is important to get good results for tests and examinations in this <u>subject</u>		X			X
9	The <u>information</u> contained in school biology is <u>useful</u> in the home and the environment		X		X	
10	<u>Attitudes</u> to Nature and Creation are developed during studies in biology at school		X			X
11	<u>Experiments</u> contribute to the study of biology at school		X		X	
12	<u>Projects</u> of various kinds contribute to the study of biology at school		X		X	
13	A <u>creative approach</u> , involving reading, research, thinking, model-making, etc contributes to the study of biology at school		X			X
14	A moderate effort at learning during studies in school biology brings good results: i.e. it is an <u>"easy" subject</u>			X	X	
15	Biology at school gives a student an opportunity to <u>demonstrate his/her ability to achieve success</u> during studies			X	X	
16	Studying biology at school serves to <u>improve the communication</u> between teacher and student				X	X
17	Good marks in school biology make an important contribution towards <u>being able to enter university</u>			X		X
		7	7	7	7	6*

*Plus one 'open' option where students are able to make a personal contribution

TABLE 4: TABLE OF FREQUENCY OF RESPONSES BY THE WHOLE SAMPLE OF STUDENTS (N_{TB} = 807) TO ITEMS 1, 12, 13, 21, 22 OF SECTION B

	FACTOR																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Parents' influence and interest	Subject-focussed interest	Teacher-focussed interest	Friends' influence	General interest in Nature	Reasonable/) Salary and career Excellent) prospects	Information-centred subject	Exam and test-centred subject	Info. useful in the home and environs	Attitude to Nature and Creation	Contribution of Experiments	Role of Projects	Creative approach to Learning	Perceived as an "easy" subject	Opportunity to demonstrate own ability	Improved communication between stu.+ t.	Study at university after leaving school
Item 1 ¹⁻⁷	37 ¹	324 ²	38 ³	12 ⁴	430 ⁵	142 ^{6.1} 34 ^{6.2}											
Item 12 ¹⁻⁷							310 ¹	411 ²	261 ³	380 ⁴	203 ⁵	104 ⁶	131 ⁷				
Item 13 ¹⁻⁷	29 ⁴	469 ²	30 ⁶	14 ⁵										244 ³	172 ¹		448 ⁷
Item 21 ¹⁻⁷					473 ⁶			391 ⁷			69 ²	61 ³		297 ¹	182 ⁴	58 ⁵	
Item 22 ¹⁻⁶						336 ¹	113 ²			268 ⁵			48 ⁶			181 ³	291 ⁴
TOTAL	66	793	68	26	903	176	646	524	652	648	272	165	179	541	354	238	739
FREQUENCY RANKING:																	
This sample, i.e. here the whole sample 16																	
	2	15	17	1	13	6	8	4	5	10	14	12	7	9	11	3	

NOTE: In the table above, a response such as 37¹ should be interpreted as 37 responses to option 1 of item 1 in Section B of the questionnaire.

TABLE 5: TABLE OF FREQUENCY OF RESPONSES BY THE UNIVERSITY OF CAPE TOWN SAMPLE ($N_B = 329$) TO ITEMS 1, 12, 13, 21 AND 22 OF SECTION B

	FACTOR																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
	Parents' influence and interest	Subject-focussed interest	Teacher-focussed interest	Friends' influence	General interest in Nature	Reasonable/) Salary and career Excellent) prospects	Information-centred subject	Exam and test-centred subject	Info. useful in the home and environs	Attitude to Nature and Creation	Contribution of Experiments	Role of Projects	Creative approach to Learning	Perceived as an "easy" subject	Opportunity to demonstrate own ability	Improved communication between stu. + t.	Study at university after leaving school	
Item 1 ¹⁻⁷	20 ¹	176 ²	23 ³	9 ⁴	158 ⁵	57 ^{6.1} 13 ^{6.27}												
Item 12 ¹⁻⁷							132 ¹	162 ²	140 ³	124 ⁴	83 ⁵	51 ⁶	66 ⁷					
Item 13 ¹⁻⁷	17 ⁴	188 ²	19 ⁶	12 ⁵									100 ³	80 ¹			187 ⁷	
Item 21 ¹⁻⁷			7		188	2	3	168	4	53	37		172	88	22			
Item 22 ¹⁻⁶							155 ¹	61 ²		85 ⁵			27 ⁶			86 ³	119 ⁴	
TOTAL	37	364	42	21	346	70	287	223	308	209	116	88	93	272	168	108	306	
FREQUENCY RANKING:																		
This sample	16	1	15	17	2	14	5	7	3	8	10	13	12	6	9	11	4	
Whole sample	16	2	15	17	1	13	6	8	4	5	10	14	12	7	9	11	3	

NOTE: In the table above, a response such as 20¹ should be interpreted as 20 responses to option 1 of item 1 in Section B of the questionnaire.

TABLE 6: TABLE OF FREQUENCY OF RESPONSES BY THE UNIVERSITY OF STELLENBOSCH SAMPLE ($N_B = 478$) TO ITEMS 1, 12, 13, 21 AND 22 OF SECTION B

	FACTOR																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																		Study at university after leaving school
																		Improved communication between stu.+ t.
																		Opportunity to demonstrate own ability
																		Perceived as an "easy" subject
																		Creative approach to learning
																		Role of Projects
																		Contribution of Experiments
																		Attitude to Nature and Creation
																		Info. useful in the home and environs
																		Exam and test-centred subject
																		Information-centred subject
																		Reasonable/) Salary and career Excellent) prospects
																		General interest in Nature
																		Friends' influence
																		Teacher-focussed interest
																		Subject-focussed interest
																		Parents' influence and interest
Item 1 ¹⁻⁷	17 ¹	148 ¹	15 ³	2 ⁴	21 ⁵	85 ^{6.1} 21 ^{6.2}												
Item 12 ¹⁻⁷							178 ¹	249 ²	121 ³	256 ⁴	120 ⁵	53 ⁶	65 ⁷					
Item 13 ¹⁻⁷	12 ⁴	281 ²	11 ⁶	2 ⁵										144 ³	92 ¹			261 ⁷
Item 21 ¹⁻⁷					285 ⁶				223 ⁷		36 ²	24 ³		125 ¹	94 ⁴	36 ⁵		
Item 22 ¹⁻⁶							181 ¹	52 ²		183 ⁵				21 ⁶			95 ³	172 ⁴
TOTAL	29	429	26	5	557	106	359	301	344	439	156	77	86	269	186	131	433	
FREQUENCY RANKING:																		
This sample	15	4	16	17	1	12	5	7	6	2	10	14	13	8	9	11	3	
Whole sample	16	2	15	17	1	13	6	8	4	5	10	14	12	7	9	11	3	

NOTE: In the table above, a response such as 17¹ should be interpreted as 17 responses to option 1 of item 1 in Section B of the questionnaire.

TABLE 7: TABLE OF FREQUENCY OF RESPONSES BY THE MEDICAL SAMPLE (N_R = 260) TO ITEMS 1, 12, 13, 21 AND 22 OF SECTION B

	FACTOR																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Parents' influence and interest	Subject-focussed interest	Teacher-focussed interest	Friends' influence	General interest in Nature	Reasonable/) Salary and career Excellent) prospects	Information-centred subject	Exam and test-centred subject	Info. useful in the home and environs	Attitude to Nature and Creation	Contribution of Experiments	Role of Projects	Creative approach to learning	Perceived as an "easy" subject	Opportunity to demonstrate own ability	Improved communication between stu.+ t.	Study at university after leaving school
Item 1 ¹⁻⁷	17 ¹	110 ²	10 ³	7 ⁴	130 ⁵	39 ^{6.1} 23 ^{6.2}											
Item 12 ¹⁻⁷							100 ¹	134 ²	83 ³	123 ⁴	59 ⁵	24 ⁶	44 ⁷				
Item 13 ¹⁻⁷	9 ⁴	144 ²	8 ⁶	4 ⁵										81 ³	94 ¹		153 ⁷
Item 21 ¹⁻⁷					140 ⁶				131 ⁷		20 ²	19 ³		105 ¹	69 ⁴	25 ⁵	
Item 22 ¹⁻⁶							105 ¹	43 ²		88 ⁵			10 ⁶			62 ³	104 ⁴
TOTAL	26	254	18	11	270	62	205	177	214	211	79	43	54	186	163	87	257
FREQUENCY RANKING:																	
This sample	15	3	16	17	1	12	6	8	4	5	11	14	13	7	9	10	2
Whole sample	16	2	15	17	1	13	6	8	4	5	10	14	12	7	9	11	3

NOTE: In the table above, a response such as 17¹ should be interpreted as 17 responses to option 1 of item 1 in Section B of the questionnaire.

TABLE 8: CRITERIA FOR CREATING STRICT TARGET GROUPS WITHIN THE SAMPLE

TABLE 8.1 CRITERIA FOR A COMBINED SCIENCE AND MEDICAL SAMPLE

SECTION	ITEM	ITEM DESCRIPTION	RELEVANT OPTION
A	4	"... first year at any university?": the response: Yes	2
	5	"Which of the following...?": the appropriate response: First year at <u>any</u> university	1
	6	"Your school-leaving examination..." the response: Cape Province	1
	7	"Did you write the Senior Certificate examination of the Cape Education Department?" the response: Yes	2
	8	"When did you write your school-leaving examination?" the response: 1981-1984 and 1985 and thereafter	3+4
	15	"Did you have biology as a subject for your school-leaving examination?" the response: Yes	2
	19	"How many years do you intend studying biological sciences at university?" the response: 3 years, 4 years, and more than four years	3+4+5
B		(the whole of Section B is included for each student in the sample)	

Additional criteria to select two samples within the combined sample are the following:

TABLE 8.2 SCIENCE SAMPLE
QUESTIONNAIRES: 0001-0173 + 0526-0640

TABLE 8.3 MEDICAL SAMPLE
QUESTIONNAIRES: 0174-0525 + 0641-0893

TABLE 10: TABLE OF FREQUENCY OF RESPONSES BY THE SCIENCE SAMPLE (N_B = 248), WITHIN THE CAPE SENIOR CERTIFICATE SAMPLE, TO ITEMS 1, 12, 13, 21 AND 22 OF SECTION B

	FACTOR																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Parents' influence and interest	Subject-focussed interest	Teacher-focussed interest	Friends' influence	General interest in Nature	Reasonable/) Salary and career Excellent) prospects	Information-centred subject	Exam and test-centred subject	Info. useful in the home and environs	Attitude to Nature and Creation	Contribution of Experiments	Role of Projects	Creative approach to learning	Perceived as an "easy" subject	Opportunity to demonstrate own ability	Improved communication between stu.+ t.	Study at university after leaving school
Item 1 ¹⁻⁷	6 ¹	85 ²	13 ³	3 ⁴	147 ⁵	48 ^{6.1} 36 ^{6.2}											
Item 12 ¹⁻⁷							102 ¹	129 ²	72 ³	130 ⁴	55 ⁵	38 ⁶	39 ⁷				
Item 13 ¹⁻⁷	11 ⁴	162 ²	11 ⁶	5 ⁵										81 ³	36 ¹		12
Item 21 ¹⁻⁷					162 ⁶			112 ⁷			17 ²	16 ³		84 ¹	57 ⁴	15 ⁵	
Item 22 ¹⁻⁶							102 ¹	25 ²		88 ⁵			12 ⁶			61 ³	9
TOTAL	17	247	24	8	309	51	204	154	184	218	72	54	51	165	93	76	22
FREQUENCY RANKING:																	
This sample	16	2	15	17	1	13	5	8	6	4	11	12	13	7	9	10	
Whole sample	16	2	15	17	1	13	6	8	4	5	10	14	12	7	9	11	

NOTE: In the table above, a response such as 6¹ should be interpreted as 6 responses to option 1 of item in Section B of the questionnaire.

TABLE 11: TABLE OF FREQUENCY OF RESPONSES BY THE MEDICAL SAMPLE ($N_B = 134$), WITHIN THE CAPE SENIOR CERTIFICATE SAMPLE, TO ITEMS 1, 12, 13, 21 AND 22 OF SECTION B

	FACTOR																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
						Reasonable/ Excellent) Salary and career prospects	Information-centred subject	Exam and test-centred subject	Info. useful in the home and environs	Attitude to Nature and Creation	Contribution of Experiments	Role of Projects	Creative approach to learning	Perceived as an "easy" subject	Opportunity to demonstrate own ability	Improved communication between stu. + t.	Study at university after leaving school
Item 1 ¹⁻⁷	6 ¹	50 ²	2 ³	3 ⁴	63 ⁵	22 ^{6.1} 11 ^{6.2}											
Item 12 ¹⁻⁷							51 ¹	72 ²	43 ³	70 ⁴	33 ⁵	10 ⁶	22 ⁷				
Item 13 ¹⁻⁷	3 ⁴	77 ²	4 ⁶	1 ⁵										47 ³	47 ¹		81 ⁷
Item 21 ¹⁻⁷					71 ⁶				71 ⁷		10 ²	9 ³		47 ¹	33 ⁴	11 ⁵	
Item 22 ¹⁻⁶							54 ¹	21 ²		48 ⁵			6 ⁶			30 ³	55
TOTAL	9	127	6	4	134	33	105	93	114	118	43	19	28	94	80	41	136
FREQUENCY RANKING:																	
This sample	15	3	16	17	2	12	6	8	5	4	10	14	13	7	9	11	1
Whole sample	16	2	15	17	1	13	6	8	4	5	10	14	12	7	9	11	3

NOTE: In the table above, a response such as 6¹ should be interpreted as 6 responses to option 1 of item in Section B of the questionnaire.

TABLE 13: TABLE OF FREQUENCY OF RESPONSES BY MALES ($N_R = 402$) TO ITEMS 1, 12, 13, 21 AND 22 OF SECTION B

	FACTOR																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Parents' influence and interest	Subject-focussed interest	Teacher-focussed interest	Friends' influence	General interest in Nature	Reasonable/) Salary and career Excellent) prospects	Information-centred subject	Exam and test-centred subject	Info. useful in the home and environs	Attitude to Nature and Creation	Contribution of Experiments	Role of Projects	Creative approach to learning	Perceived as an "easy" subject	Opportunity to demonstrate own ability	Improved communication between stu. + t.	Study at university after leaving school
Item 1 ¹⁻⁷	17 ¹	152 ²	12 ³	4 ⁴	211 ⁵	62 ^{6.1} 17 ^{6.2}											
Item 12 ¹⁻⁷							118 ¹	196 ²	124 ³	173 ⁴	105 ⁵	47 ⁶	62 ⁷				
Item 13 ¹⁻⁷	16 ⁴	200 ²	14 ⁶	9 ⁵									97 ³	78 ¹			214 ⁷
Item 21 ¹⁻⁷					221 ⁶			167 ⁷		40 ²	28 ³		117 ¹	87 ⁴		31 ⁵	
Item 22 ¹⁻⁶							145 ¹	51 ²		131 ⁵			24 ⁶			83 ³	128
TOTAL	33	352	26	13	432	79	263	247	291	304	145	75	86	214	165	114	342
FREQUENCY RANKING:																	
This sample	15	2	16	17	1	13	6	7	5	4	10	14	12	8	9	11	3
Whole sample	13	2	15	17	1	13	6	8	4	5	10	14	12	7	9	11	3

NOTE: In the table above, a response such as 17¹ should be interpreted as 17 responses to option 1 of item 1 in Section B of the questionnaire.

TABLE 14: SUMMARY TABLE OF TOTALS OF FREQUENCY OF RESPONSES BY ALL SAMPLES TO ITEMS 1, 12, 13, 21 AND 22 OF SECTION B

SAMPLE	FACTOR																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
																		Study at university after leaving school
																		Improved communication between stu. + t.
																		Opportunity to demonstrate own ability
																		Perceived as an "easy" subject
																		Creative approach to learning
																		Role of Projects
																		Contribution of Experiments
																		Attitude to Nature and Creation
																		Info. useful in the home and environs
																		Exam. and test-centred subject
																		Information-centred subject
																		Reasonable) 1 Salary and Excellent) 2 career prospects
																		General interest in Nature
																		Friends' influence
																		Teacher-focussed interest
																		Subject-focussed interest
																		Parents' influence and interest
																		Sample size expressed as a per- centage (N = 807)
1 Whole (i.e. intact)	100	66	793	68	26	903	176	646	524	652	648	272	165	179	541	354	238	739
2 University of Cape Town	41	37	364	42	21	346	70	287	223	308	209	116	88	93	272	168	108	306
3 University of Stellenbosch	59	29	429	26	5	557	106	359	301	344	439	156	77	86	269	186	131	433
4 Medical	32	26	254	18	11	270	62	205	177	214	211	79	43	54	186	163	87	257
5 Cape Senior Certificate	48	26	374	30	12	443	84	309	247	298	336	115	73	79	259	173	117	361
6 Cape Senior Certificate - Science	31	17	247	24	8	309	51	204	154	184	218	72	54	51	165	93	76	225
7 - Medical	17	9	127	6	4	134	33	105	93	114	118	43	19	28	94	80	41	136
8 Females	50	33	440	41	12	471	96	383	277	360	344	127	89	93	327	189	124	396
9 Males	50	33	352	26	13	432	79	263	247	291	304	145	75	86	214	165	114	342

TABLE 15: SUMMARY TABLE OF RESPONSES BY ALL SAMPLES TO ITEMS IN SECTION A

(NOTE: In the table below, less than 1 per cent is shown as: *1)

Item Number	Item description	SAMPLE								
		Whole	UCT	US	Med (UCT + US)	CED	CED (Sci)	CED (Med)	Female	Male
1	<u>Query: Name of university where the student is registered?</u>		368	525						
2	<u>Date of completion of questio.</u> (This item is not reported)									
3	<u>Sex of student</u>									
	Female	49	52	47	40	53	60	40	100	
	Male	51	48	54	60	47	40	60		100
4	<u>Query: Is this the student's first year of registration at a university, the response: "Yes"</u>	88	84	91	88	100	100	100	89	88
5	<u>Academic status of student</u>									
	1 First year	87	83	90	88	100	100	100	87	86
	2 Returning	9	12	8	12				9	10
	3 Other than above	4	5	3	*1				4	4
6	<u>School leaving examination written by student</u>									
	1 Cape Province	60	37	76	61	100	100	100	62	58
	2 Natal	5	8	3	8				6	4
	3 Orange Free State	2	2	2	2				2	2
	4 Transvaal	8	7	9	7				8	8
	5 Joint Matriculation Board	6	13	1	7				6	6
	6 Dept. Education and Culture	12	18	8	7				11	14
	7 Dept. Education and Training	2	5		1				1	3
	8 Outside education authority e.g. America, Europe	1	2		1				1	1
	9 National States	1	*1		*1					*1
	10 Zimbabwe	1	3		1				1	1
	11 National Senior Certificate	3	6	1	3				3	4
7	<u>Query: Did the student write the Cape Senior Certificate Examination?</u>									
	1 No	35	52	23	37				31	38
	2 Yes	65	48	78	63	100	100	100	69	62
8	<u>Query: When did the student write his/her school-leaving examination?</u>									
	1 before 1977	1	1	1	1				1	1
	2 1977 - 1980	2	2	2	1				1	3
	3 1981 - 1984	22	26	20	20	10	11	8	17	27
	4 1985 and after	75	71	78	78	90	89	92	82	69
9	<u>Age of the student at the time of completing the questionnaire</u>									
	17	3	6	*1	4	1	*1	2	4	2
	18	46	48	44	47	57	58	57	51	40
	19	34	28	39	37	35	35	35	37	32
	20	8	10	7	6	3	3	3	5	11
	21	4	3	4	2	3	4	2	*1	7
	22	2	2	2	2	1	1	1	1	3
10	<u>Name of the last school attended by the student</u> (This item is not reported)									
11	<u>Country in which student's last school is situated</u>									
	Republic of South Africa	94	91	96	93	97	96	98	95	94
	South West Africa/Namibia	3	3	4	3	3	4	2	2	3
	Zimbabwe	1	1		1				1	1
	National States	2	4	2					1	2
	Other, e.g. Europe, America	*1	2		1				1	1
12)	The outcome of the analysis of									
)	these items is discussed in chap-									
13)	ters 6.1 and 8.2									
14	<u>School type attended by student</u>									
	1 "Neighbourhood"	60	49	68	60	66	66	66	65	56
	2 "Selected"	40	51	32	40	34	34	34	35	44

TABLE 15 (CONT.)

Item Number	Item description	SAMPLE								
		Whole	UCT	US	Med (UCT + US)	CED	CED (Sci)	CED (Med)	Female	Male
15	<u>Query: Biology as subject for the matriculation exam.?</u>									
	1 No	9	10	9	9				7	12
	2 Yes	91	90	91	91	100	100	100	93	88
16	<u>Query: Student's average percentage for all subjects during final year at school?</u>									
	1, 2, 3: no response									
	4 31-35	*1		*1						*1
	5 36-40	*1		*1						*1
	6 41-45	*1		*1		*1	*1		*1	
	7 46-50	1	*1	2		1	2		*1	2
	8 51-55	3	1	4		2	4		1	5
	9 56-60	8	7	8	2	6	8	3	6	9
	10 61-65	14	12	16	5	13	18	5	13	16
	11 66-70	19	16	21	11	19	23	11	18	20
	12 71-75	19	22	17	17	18	18	16	19	18
	13 76-80	18	19	16	27	18	14	26	19	16
	14 81 and above	18	24	15	37	23	14	39	23	14
17	<u>Query: Physical Science as subject for the matriculation examination?</u>									
	1 No	7	9	5	2	5	7	1	9	5
	2 Yes	93	91	95	98	95	92	99	92	95
18	<u>Query: Grade level of school Physical Science study?</u>									
	1 Did not study this subject	6	9	5	1	5	7	1	8	5
	2 No grade system in use	1	2	1	1				1	2
	3 Higher	83	85	82	97	85	77	99	83	83
	4 Standard	9	5	13	1	10	15	1	8	11
19	<u>Query: Number of years' intended study at university?</u>									
	1 1 year	11	16	8	2				12	11
	2 2 years	3	5	1	*1				4	2
	3 3 years	16	19	14	1	16	25		19	14
	4 4 years	26	17	34	8	35	47	12	33	21
	5 more than 4 years	43	43	43	89	49	28	88	33	52
20	<u>Self-rating by student of his/her interest in Nature</u>									
	1 very little	*1	*1	*1	*1					*1
	2 slight	*1	1		*1				*1	*1
	3 below average	1	1	1	1	1		2	1	1
	4 average	15	13	16	12	10	10	10	13	16
	5 above average	26	29	25	29	24	23	28	27	26
	6 well established	31	32	30	30	34	35	32	29	32
	7 a great deal	27	24	30	27	31	32	28	30	24
21	<u>Self-rating by student of his/her purposeful Nature-centred activities</u>									
	1 very little	13	18	9	13	9	8	12	14	12
	2 slight	9	6	11	9	9	10	8	7	10
	3 below average	12	14	11	14	13	13	14	13	12
	4 average	37	34	39	36	38	37	38	41	33
	5 above average	14	13	15	18	15	13	18	13	16
	6 considerable	10	9	11	7	11	14	5	8	11
	7 a great deal	5	5	5	4	5	5	5	4	7
22	<u>Self-rating by student of his/her test marks during first year at university</u>									
	1 awful	*1	*1							*1
	2 poor	*1		*1		1	1		*1	*1
	3 below average	2	2	2	1	2	2	1	1	3
	4 average	37	27	45	34	37	38	35	40	34
	5 above average	43	49	38	44	44	43	48	43	43
	6 good	14	19	11	16	13	13	13	13	16
	7 excellent	4	4	3	5	3	3	3	3	4

TABLE 16: SUMMARY TABLE OF RESPONSES BY ALL SAMPLES TO ITEMS 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 19, 20 AND 23 IN SECTION B

NOTE: In the table below, less than 1 per cent is shown as: *1)

Item number	Item description	SAMPLE								
		Whole	UCT	US	Med (UCT + US)	CED	CED (Sci)	CED (Med)	Female	Male
2	<u>Language in which biology was taught at school</u>									
1	Afrikaans	46	6	73	47	58	56	61	42	50
2	Afrikaans and English	9	6	12	10	13	14	12	10	9
3	English	45	88	16	43	29	30	27	49	42
4	Other than above									
3	<u>Level of student's studies in biology at school</u>									
1	Higher	98	96	99	98	99	99	99	98	97
2	Standard	1	1	1	*1	1	1	1	1	1
3	No grade system in use	2	3	*1	2				2	2
4	<u>Student's rating of popularity of biology at school</u>									
1	very popular	34	32	35	32	38	38	39	42	26
2	.....	20	18	21	25	20	17	25	19	21
3	.....	16	19	15	14	17	17	15	15	18
4	Neither popular nor unpopular	22	22	22	20	19	21	14	19	26
5	.....	5	5	5	5	5	6	2	4	6
6	.....	2	2	2	2	1	1	2	2	1
7	very unpopular	1	1	1	1	1	1	2	*1	2
5	<u>Student's rating of how his/her interest in Nature was affected by school biology</u>									
1	very much decreased	1	1		*1	*1	*1		1	1
2	much decreased	1	1	*1	1	1	*1	2	1	1
3	slightly decreased	2	2	3	3	3	2	3	2	3
4	unchanged	14	13	15	15	12	11	14	15	13
5	slightly increased	29	27	31	29	32	32	33	27	31
6	much increased	40	42	39	40	40	40	40	39	41
7	very much increased	13	14	13	12	12	14	8	15	11
6	<u>Student's rating of the extent to which school biology encouraged him/her to think about Nature</u>									
1	encouraged not at all	4	3	4	4	4	4	5	3	4
2	encouraged a little	13	13	14	12	14	15	14	16	11
3	encouraged somewhat	28	23	31	26	29	31	27	26	29
4	encouraged quite a lot	39	43	36	39	38	37	40	39	39
5	encouraged a great deal	17	18	15	19	15	14	16	16	17
7	<u>Student's rating of the frequency of use of the environment during biology at school</u>									
1	i.e. never	13	14	13	11	9	9	10	11	15
2	.....	10	13	9	10	10	9	11	11	9
3	.....	9	6	10	10	9	8	10	7	11
4	now and then (e.g. twice a year)	36	35	37	38	37	39	34	36	36
5	.....	17	14	18	15	21	22	20	18	15
6	.....	9	12	7	7	7	7	8	9	9
7	i.e. very often	7	6	7	9	7	7	7	7	7
8	<u>Student's description of the usual reaction when tests in school biology were announced</u>									
1	Negative	2	2	1	2	1	*1	1	1	2
2	Cautious	11	7	14	9	12	13	10	14	9
3	Irritated	18	17	18	17	19	20	17	17	19
4	Optimistic	50	51	49	53	52	50	58	48	52
5	Positive	20	23	17	20	17	17	15	20	19
9	<u>Student's rating of the frequency of visits to places such as museums, nature reserves, etc.</u>									
1	i.e. never	52	47	56	51	53	49	61	50	55
2	.....	22	24	21	22	24	26	21	24	21
3	.....	15	18	13	15	12	15	8	15	15
4	.....	5	6	5	7	5	4	7	6	4
5	i.e. often	6	5	6	5	5	6	4	5	6

TABLE 16 (CONT.)

Item Number	Item description	SAMPLE								
		Whole	UCT	US	Med (UCT + US)	CED	CED (Sci)	CED (Med)	Fe-male	Male
10	<u>Student's report of his/her average percentage scored in biology during the last year at school</u>									
	1, 2, 3, 4: No response									
	5 36-40	*1		*1					*1	
	6 41-45	*1		*1		*1	*1			
	7 46-50	1	*1	1	*1	1	*1	1	*1	1
	8 51-55	2	1	3		2	2		1	1
	9 56-60	6	3	8	3	6	7	2	4	5
	10 61-65	8	6	10	4	8	11	5	8	8
	11 66-70	18	16	19	12	16	19	10	16	20
	12 71-75	17	20	15	15	13	14	12	17	17
	13 76-80	19	19	20	22	21	20	22	23	16
	14 81 and above	29	35	25	46	33	25	49	31	27
11	<u>Student's rating of personal satisfaction resulting from studies in biology at school</u>									
	1 i.e. very little	4	5	3	3	3	2	3	4	4
	2	5	2	7	4	7	9	4	5	5
	3 i.e. moderate	23	23	23	22	22	21	24	22	24
	4	32	30	33	30	34	34	36	30	33
	5 i.e. a great deal	36	42	33	41	34	34	34	39	34
14	<u>Student's listing of sources of information in use during studies in biology at school</u>									
	1 a textbook	61	55	65	60	68	66	73	65	57
	2 more than one text book	46	53	42	47	41	46	34	46	47
	3 teacher's notes	66	76	60	70	63	60	67	68	64
	4 dictionaries	16	17	15	17	17	17	18	18	13
	5 periodicals, journals	25	21	27	28	30	28	33	28	22
	6 films, slides	61	63	60	62	67	67	67	67	55
	7 charts, diagrams	47	58	40	48	43	43	43	51	43
	8 help from subj. specialists	5	8	3	6	5	5	4	5	5
	9 comm. available notes	6	6	6	7	6	5	8	6	6
	10 television, videos	22	29	17	23	20	20	19	21	22
	11 library: school or public	37	39	35	39	39	40	37	40	33
15	<u>Student's choice of attributes of his/her biology teacher</u>									
	1 interested in students	64	66	62	70	65	64	69	67	60
	2 interested in Nature	53	60	47	57	54	53	57	59	46
	3 interested in student performing well in tests	53	62	48	58	51	47	59	57	50
	4 popular and friendly	40	47	36	45	42	41	43	45	36
	5 knowledgeable	54	42	63	60	61	58	66	58	50
	6 an intellectual	29	24	32	33	30	28	35	30	28
	7 clarify work, solve problems	46	46	46	45	46	46	46	51	40
	8 none of the above relevant* (*The option has been included where the item is discussed in the text.)									
16	<u>Student's choice of a rating indicating depth-of-study of biology at school</u>									
	1 too little	11	12	10	14	12	9	16	10	13
	2 sufficient	50	56	46	47	46	48	41	51	50
	3 too much	5	5	4	3	4	5	3	4	6
	4 varied: too little or too much	34	26	39	37	39	38	40	36	31
17	<u>Student's rating of skills developed during practical work in school biology</u>									
	1 i.e. learned very little	42	50	37	36	38	40	34	45	39
	2	15	12	18	14	19	19	19	13	17
	3	20	16	24	21	23	24	22	21	20
	4	15	17	15	19	15	13	19	16	15
	5 i.e. learned a great deal	7	6	8	11	6	4	8	4	9
18	<u>Student's rating of the extent to which biology related to other school subjects</u>									
	1 very little	13	15	12	14	14	13	15	13	13
	2 little	30	27	32	28	30	33	25	38	35
	3 moderately	40	38	41	38	41	42	39	45	34
	4 quite a lot	14	17	12	17	12	11	16	14	14
	5 a great deal	3	3	3	3	2	1	5	3	4

TABLE 16 (CONT.)

Item Number	Item description	SAMPLE								
		Whole	UCT	US	Med (UCT + US)	CED	CED (Sci)	CED (Med)	Fe- male	Male
19	<u>Student's choice of description of how often problems resulted from the rapid tempo at which biology is taught at school</u>									
	1 very rarely	49	52	47	56	52	49	57	54	45
	2 seldom	29	30	29	28	28	30	25	27	31
	3 from time to time	19	16	22	14	18	19	16	17	22
	4 frequently	2	2	2	2	1	1	2	2	2
	5 very often	1	1	*1		1	1		*1	1
20	<u>Student's choice of resource persons, to whom learning problems related to school biology were taken</u>									
	1 biology teacher	65	68	59	64	59	60	57	60	65
	2 another teacher	3	3	3	3	2	2	3	2	4
	3 friends	22	26	20	20	20	19	22	23	21
	4 one or two special friends	23	25	22	25	23	21	25	24	21
	5 parents, relatives	7	7	7	8	8	7	8	7	6
	6 no problems/another person not on the list* (*This option is included where the item is discussed in the text.)									
23	<u>Student's rating of the usefulness, to daily life and living, of a sound knowledge of school biology</u>									
	1 i.e. almost useless	2	4	2	3	1	1	2	3	2
	2	3	3	2	3	2	2	2	2	3
	3	5	5	5	5	5	4	6	4	5
	4 i.e. moderately useful	27	31	25	29	26	24	30	24	30
	5	19	22	17	17	20	21	17	18	21
	6	17	16	17	16	19	20	17	18	16
	7 i.e. extremely useful	28	21	33	28	27	28	27	31	24

APPENDIX 2

This questionnaire attempts to discover your interest and attitude to the study of biological sciences at university. By 'biological sciences' is meant the study of plants, animals, humans, nature in general as well as systems of living things. If, for example, you are studying to be a medical doctor, you are studying biological sciences. If you want to be a teacher of biology or a physiotherapist, biochemist or veterinary scientist, you will also have to study biological sciences.

Please complete all the items.

To complete an item do the following:

Read through the entire item and choose your response. Then make a cross in the square next to the response (i.e. answer) you have chosen.

Read through the item below as an example.

EXAMPLE - COMPLETING AN ITEM

12 When would you most like to attend a biological science lecture at university?

First period on a Monday morning	<input type="checkbox"/>	1
First period on a Wednesday morning	<input type="checkbox"/>	2
Last period on a Friday morning	<input type="checkbox"/>	3
I am undecided about the best time	<input type="checkbox"/>	4

Suppose you want to respond: "Last period on a Friday morning." Make a cross in the square next to the block numbered 3. Your response will then look like this:

12 When would you most like to attend a biological science lecture?

- | | | |
|-------------------------------------|-------------------------------------|---|
| First period on a Monday morning | <input type="checkbox"/> | 1 |
| First period on a Wednesday morning | <input type="checkbox"/> | 2 |
| Last period on a Friday morning | <input checked="" type="checkbox"/> | 3 |
| I am undecided about the best time | <input type="checkbox"/> | 4 |

EXAMPLE - MAKING A CHANGE TO AN ITEM

Suppose you change your mind about the response you have made. Do the following:

Cross out the number next to the square you have crossed. Make a cross in the square you have now chosen. Your response will now look like this:

12 When would you most like to attend a biological science lecture?

- | | | |
|-------------------------------------|-------------------------------------|--------------|
| First period on a Monday morning | <input type="checkbox"/> | 1 |
| First period on a Wednesday morning | <input type="checkbox"/> | 2 |
| Last period on a Friday morning | <input checked="" type="checkbox"/> | 3 |
| I am unsure about the best time | <input checked="" type="checkbox"/> | 4 |

Your response is now: "I am unsure about the best time".

Remember to complete ALL the items of this questionnaire. Please do not leave any out! If you are unsure about a response, choose the best response from those supplied.

SECTION A

246

1 At which university are you registered?
Read the list below to answer this question.

- University of Cape Town 1
- University of Stellenbosch 2
- Neither of the universities listed above 3

2 Today's date:

----- day ----- month ----- year

1

3 You are:

- Female 1
- Male 2

4 This is your first year at any university:

No 1

Yes 2

5 Which of the following are you? Read the list below and choose.

First year student at any university 1

First year student, but have been a student at this or another university on a previous occasion 2

I am neither of the above* 3

(*Please specify: -----

-----)

6 Your school-leaving examination was written for the Examination Board of:

- Cape Province 1
- Natal 2
- Orange Free State 3
- Transvaal 4
- Joint Matriculation Board 5
- Department of Education and Culture 6
- Department of Education and Training 7
- Any other education authority in or outside South Africa* 8

(*Please specify: _____
_____)

7 Did you write the Senior Certificate examination (i.e. matric exam) of the Cape Education Department?

- No 1
- Yes 2

8 When did you write your school-leaving exam? (Supplementary exams you might have written in the following year should be ignored).

- Before 1977 1
- 1977 - 1980 2
- 1981 - 1984 3
- 1985 and after 4

9 Your age, in years, on the last day of this month. See below for examples:

EXAMPLES

19 years 4 months is 19 years
18 years 7 months is 19 years

Complete: My age is years

Write your age in the square alongside

10 Write down the name of the school where your three final years of schooling took place. If you changed schools during this time then write down the name of the last school.

11--13 Where is the school you spent your last three years situated? Be as complete as you can when you write the details in the spaces below.

11 Name of the country or state: -----

12 Name of the town or city: -----

13 Name of the residential area or suburb: -----

14 Which description fits the senior secondary school you attended in your last years at school?

Choose between the two descriptions below.

A neighbourhood school: the most suitable school, closest to my living-place

1

A selected school: it might even be in another town, city or suburb

2

15 Did you have Biology as a subject for your school-leaving examination?

No

1

Yes

2

Note: If you have Botany or Zoology or any other mainly biological subject for your school-leaving exam you may respond Yes to this question.

16 Think back to the average percentage you scored for an exam you wrote during your final year at school. Then read the example below and show your score by choosing from the range of percentages supplied.

EXAMPLE

"My September exam percentage was about 64%"

Response: 64% is in the 61 - 65 range.

Make a cross in the square next to 61 - 65.

20 and below	<input type="checkbox"/>	1
21 - 25	<input type="checkbox"/>	2
26 - 30	<input type="checkbox"/>	3
31 - 35	<input type="checkbox"/>	4
36 - 40	<input type="checkbox"/>	5
41 - 45	<input type="checkbox"/>	6
46 - 50	<input type="checkbox"/>	7
51 - 55	<input type="checkbox"/>	8
56 - 60	<input type="checkbox"/>	9
61 - 65	<input type="checkbox"/>	10
66 - 70	<input type="checkbox"/>	11
71 - 75	<input type="checkbox"/>	12
76 - 80	<input type="checkbox"/>	13
81 and above	<input type="checkbox"/>	14

Note: If you did not write exams during the year give the most accurate percentage you would have scored.

17 Did you take Physical Science as a subject for your school-leaving examination?

No	<input type="checkbox"/>	1
Yes	<input type="checkbox"/>	2

18 If you studied Physical Science as a subject for your school-leaving examination, did you study the subject on the Higher Grade or Standard Grade?

Read the list below and choose a response to this question.

- I did not study Physical Science at school 1
- A Grade System was not in use 2
- Higher Grade 3
- Standard Grade 4

19 How many years do you intend studying biological sciences at university?*

- 1 year 1
- 2 years 2
- 3 years 3
- 4 years 4
- more than 4 years 5

*If you plan to do post-graduate courses you may include them in your total.

Courses lasting less than 1 year are included as "1 year".

20 From the list below, choose the rating that best describes your interests in nature in general, living things, systems of living things.

- 1 very little 1
- 2 slight 2
- 3 below average 3
- 4 average 4
- 5 above average 5
- 6 well-established 6
- 7 a great deal 7

21 From the list below, choose the rating that best describes your activities involved with living things and nature in general. Examples: being a member of an outdoor club, anti-litter projects, entering competitions concerning nature, poster-making, attending or giving talks etc.

- | | | | |
|---|---------------|--------------------------|---|
| 1 | very little | <input type="checkbox"/> | 1 |
| 2 | slight | <input type="checkbox"/> | 2 |
| 3 | below average | <input type="checkbox"/> | 3 |
| 4 | average | <input type="checkbox"/> | 4 |
| 5 | above average | <input type="checkbox"/> | 5 |
| 6 | considerable | <input type="checkbox"/> | 6 |
| 7 | a great deal | <input type="checkbox"/> | 7 |

22 Give yourself a rating on what you expect your test and exam marks to be in the biological sciences you are planning to study at university. Be honest in your estimation!

- | | | |
|---------------------------------------|--------------------------|---|
| awful - near the bottom of the class | <input type="checkbox"/> | 1 |
| poor - far below average | <input type="checkbox"/> | 2 |
| below average | <input type="checkbox"/> | 3 |
| average, middling | <input type="checkbox"/> | 4 |
| above average | <input type="checkbox"/> | 5 |
| good - far above average | <input type="checkbox"/> | 6 |
| excellent - near the top of the class | <input type="checkbox"/> | 7 |

SECTION B

Complete this section ONLY IF you had Biology as a subject for your school-leaving exam.

Note: If you studied Botany, Zoology or any other mainly biological subject for your school-leaving exam, please complete this section. The word Biology will be used in this section for your subject.

1 Why did you choose to study Biology at school? Read through the list below and then choose ANY reasons which apply to you.

- parents approved and were interested in your study of this subject 1
- an interesting subject for study while at school 2
- good teacher in this subject 3
- friends taking same subject 4
- own interest in nature was stimulated by studying this subject 5
- reasonable pay and interesting careers in this field after further studies 6
- excellent jobs and top salaries in this field after further studies 7

2 In which of the following languages were you taught Biology at school?

- Afrikaans 1
- Afrikaans and English 2
- English 3
- A language other than Afrikaans or English* 4

(*Please specify -----
-----)

3 Did you study Biology at school on the Higher Grade or Standard Grade? Read the list below and choose a response to this question.

- Higher Grade 1
- Standard Grade 2
- A Grade System was not in use 3

4 Generally, what was the popularity of Biology at your school? Choose ANY number from those supplied that will show how popular this subject was.

- 1 i.e. very popular 1
- 2 ----- 2
- 3 ----- 3
- 4 i.e. neither popular nor unpopular 4
- 5 ----- 5
- 6 ----- 6
- 7 i.e. very unpopular 7

5 How was your general interest in nature affected by your Biology course at school? Choose from the list below and make a response.

- 1 interest very much decreased 1
- 2 interest much decreased 2
- 3 interest slightly decreased 3
- 4 interest unchanged 4
- 5 interest slightly increased 5
- 6 interest much increased 6
- 7 interest very much increased 7

6 Did school Biology encourage you to think about nature and natural processes? Choose a number from the list supplied below that will make this clear.

- 1 encouraged not at all 1
- 2 encouraged a little 2
- 3 encouraged somewhat 3
- 4 encouraged quite a lot 4
- 5 encouraged a great deal 5

7 To complete investigations in school subjects information may be needed from the human and the natural environment. Such information might be found in the school, near the school or might only be available at some kilometres' distances from the school. How often was the environment used during Senior Secondary Biology studies at your school? Choose ANY number from the list below that will show use of the environment.

- 1 i.e. never 1
- 2 ----- 2
- 3 ----- 3
- 4 now and then (e.g. twice per year) 4
- 5 ----- 5
- 6 ----- 6
- 7 i.e. very often 7

8 When exams and tests were announced in Biology at school, what was your usual reaction? Choose ANY from the list below.

- Negative: fear and hatred of tests and exams 1
- Cautious: unsure of outcome but willing to try 2
- Irritated: tests are unpleasant but necessary 3
- Optimistic: fairly sure of a reasonable outcome 4
- Positive: used and welcomed the opportunity of showing knowledge and understanding 5

9 Did you, as a member of the Senior Biology class-group, visit places such as mines, nature reserves, fertilizer factories, zoos and similar places? Choose ONE number from the list below to indicate how frequent these visits were.

- 1 i.e. never 1
- 2 ----- 2
- 3 ----- 3
- 4 ----- 4
- 5 i.e. often 5

10 What was your usual percentage for tests and exams in Biology during your final year at school? Read the example and then choose from the range below.

EXAMPLE

"My average for Biology during the year was 64%"

Response: 64% is in the 61 - 65 range.

Make a cross in the square next to 61 - 65.

- 20 and below 1
- 21 - 25 2
- 26 - 30 3
- 31 - 35 4
- 36 - 40 5
- 41 - 45 6
- 46 - 50 7
- 51 - 55 8
- 56 - 60 9
- 61 - 65 10
- 66 - 70 11
- 71 - 75 12
- 76 - 80 13
- 81 and above 14

11 Choose a number from the list below that will show how much personal satisfaction you achieved studying Biology in the last three years at school.

- 1 i.e. very little satisfaction 1
- 2 ----- 2
- 3 i.e. moderate satisfaction 3
- 4 ----- 4
- 5 i.e. a great deal of satisfaction 5

12 Which, from the list below, seemed important when you studied Biology at school? Choose as many responses as apply in your case.

- facts concerning animals and plans which had to be learned 1
- getting good test and examination results 2
- usefulness of what was learned at school in the home, in nature, in the environment 3
- attitude, like a respect for Creation, a love of plants, animals, nature in general 4
- experiments investigating natural processes and products of plants and animals 5
- projects, done singly, possibly also group-projects involving reading, field work and related research activities 6
- creativity involving reading, research, thinking, making models and designing experiments 7

13 Why would you have liked to get good marks in tests and exams in Biology at school? Read the list below and then choose ANY reasons that apply to you.

- I got good marks in all my school subjects 1
- because this particular school subject interested me 2
- it was easy for me to get good marks in this subject 3
- to impress my parents and family 4
- to impress my school friends 5
- to impress my Biology teacher 6
- because good marks are important to ensure entry to university for further studies 7

14 Listed below are sources of information for use during the study of Biology. Read through the list and show ANY sources that were used in your school for studying Biology.

- a textbook 1
- more than one textbook 2
- notes made by the teacher for use in class 3
- dictionaries and encyclopaedias 4
- periodicals, journals, popular magazines, magazine articles 5
- films and slides 6
- charts and diagrams 7
- help from specialists in certain fields e.g. university staff members 8
- commercially available students' notes 9
- TV, videos, self-made video-tapes 10
- a library e.g. school library, public library 11

15 Which of the following are true of your Senior Secondary Biology teacher at school? Choose ANY descriptions from those supplied in the list below.

- the teacher was interested in his students 1
- the teacher was interested in nature 2
- the teacher was interested in getting students to do well in exams and tests 3
- the teacher was a popular and friendly person 4
- the teacher knew a lot 5
- the teacher was an intellectual, a thinker 6
- the teacher could explain well and solve students' learning problems 7
- none of the above are relevant* 8

(*Please specify: _____

_____)

16 Do you think that the animals, plants and natural processes were studied in suitable detail during the Biology course at school? Give your opinion by choosing ONE from the list below.

- too little detail 1
- sufficient detail 2
- too much detail 3
- varied: sometimes too little, sometimes too much detail 4

17 Did you learn how to use laboratory equipment e.g. a microscope and/. or skills in field work during high school Biology? Choose ONE number from the list below to illustrate.

- 1 i.e. learned very little 1
- 2 ----- 2
- 3 ----- 3
- 4 ----- 4
- 5 i.e. learned a great deal 5

18 How much did Biology relate to your other school subjects? Read through the list below and choose ONE which most accurately describes this relationship.

- very little 1
- little 2
- moderately 3
- quite a lot 4
- a great deal 5

19 The rapid tempo at which Biology is taught at school might cause problems for the learners. How often did you have this problem? Choose ONE from the list below.

- very rarely, almost never 1
- seldom 2
- from time to time 3
- frequently 4
- very often, nearly all the time 5

20 When you had learning problems during your studies of Biology at school, to which persons did you take these problems? Choose ANY persons from the list below.

- the teacher of Biology 1
- another teacher or teachers 2
- your friends or classmates 3
- one or maybe two particular friends in your class 4
- your parents, relatives 5
- a person or persons not in the list above. Possibly you could not solve your problems or you had no problems? * 6

(*Please specify: -----

 -----)

21 Choose ANY alternatives from the list below which will complete the statement:

"Biology as a school subject has ...

- been a reasonably easy subject for me to study 1
- enabled me to do experiments to investigate nature 2
- enabled me to do projects, either by myself or as a member of a group, to investigate nature 3
- been a subject in which I can show what I am able to achieve 4
- improved communication between the teacher of biology and the students 5
- encouraged my greater interest in plants, animals and nature 6
- provided me with information which is useful for everyday living, based on studies of examples from nature." 7

22 What is most vivid in your memory of Biology at school?
Choose ANY responses from the list below.

- information, i.e. facts of this subject that had to be learned 1
- the tests and exams you wrote in this subject 2
- the communication between teacher and students in this subject 3
- the usefulness of this subject for further studies after leaving school 4
- a special attitude to nature created by studies at school 5
- opportunities to be creative by making models, drawing, etc. involved with the studies of this subject 6
- something not in the list above* 7

(*Please specify: -----

-----)

23 How would you rate the usefulness of a sound knowledge of content of school Biology to everyday life and living? Choose ONE option from the list below to express your opinion.

- 1 i.e. almost useless 1
- 2 ----- 2
- 3 ----- 3
- 4 i.e. moderately useful 4
- 5 ----- 5
- 6 ----- 6
- 7 i.e. extremely useful 7

THANK YOU FOR YOUR CO-OPERATION

Please check whether you have responded to all the items in this questionnaire.

Met hierdie vraelys word daar probeer om meer besonderhede te verkry in verband met jou belangstelling en gesindheid vir studies in die biologiese wetenskappe aan 'n universiteit. Met 'biologiese wetenskappe' word bedoel die bestudering van plante, diere, mense, die natuur in die algemeen en sisteme van lewende wesens. As, byvoorbeeld, jy studeer om 'n mediese dokter te word, studeer jy biologiese wetenskappe. Indien jy 'n biologie-onderwyser, biochemikus of veearts wil word, sal jy ook biologiese wetenskappe moet studeer.

Voltooi asseblief al die items.

Om 'n item te voltooi, doen die volgende:

Lees die hele item deur en kies jou respons.

Dan trek jy 'n kruisie in die blokkie langs die respons (d.w.s. antwoord) wat jy gekies het.

Lees die item hieronder. Die sal as voorbeeld dien.

VOORBEELD - HOE OM 'N ITEM TE VOLTOOI

12 Wanneer sou jy die meeste daar van hou om 'n lesing in die biologiese wetenskap aan 'n universiteit te woon?

- | | | |
|--------------------------------------|--------------------------|---|
| eerste periode op 'n Maandag oggend | <input type="checkbox"/> | 1 |
| eerste periode op 'n Woensdag oggend | <input type="checkbox"/> | 2 |
| laaste periode op 'n Vrydag oggend | <input type="checkbox"/> | 3 |
| ek is onseker van die beste tyd | <input type="checkbox"/> | 4 |

Veronderstel jy wil respondeer: "laaste periode op 'n Vrydag oggend". Trek 'n kruisie in die blokkie langs die nommer 3. Jou antwoord sal dan so lyk:

12 Wanneer sou jy die meeste daar van hou om 'n lesing in die biologiese wetenskap aan 'n universiteit by te woon?

- | | | |
|--------------------------------------|-------------------------------------|---|
| eerste period op 'n Maandag oggend | <input type="checkbox"/> | 1 |
| eerste periode op 'n Woensdag oggend | <input type="checkbox"/> | 2 |
| laaste periode op 'n Vrydag oggend | <input checked="" type="checkbox"/> | 3 |
| ek is onseker van die beste tyd | <input type="checkbox"/> | 4 |

VOORBEELD - HOE OM 'N VERANDERING TE MAAK

Veronderstel dat jy 'n respons wat jy gemaak het, wil verander. Doen dan die volgende:

Trek die nommer langs die blokkie met die kruisie dood.

Trek 'n kruisie in die blokkie van jou keuse.

Jou respons sal nou so lyk:

12 Wanneer sou jy die meeste daar van hou om 'n lesing in die biologiese wetenskap aan 'n universiteit by te woon?

- | | | |
|--------------------------------------|-------------------------------------|--------------|
| eerste periode op 'n Maandag oggend | <input type="checkbox"/> | 1 |
| eerste periode op 'n Woensdag oggend | <input type="checkbox"/> | 2 |
| laaste periode op 'n Vrydag oggend | <input checked="" type="checkbox"/> | 3 |
| ek is onseker van die beste tyd | <input checked="" type="checkbox"/> | 4 |

Jou respons is nou: "Ek is onseker van die beste tyd."

Onthou om AL die items in hierdie vraelys te voltooi.

Asseblief, moenie items oorslaan nie! Indien jy onseker is van 'n respons, kies die beste respons van die wat verstrek word.

1 Aan watter universiteit is jy geregistreer? Lees die lysie hieronder om die vraag te beantwoord.

- Universiteit van Kaapstad 1
- Universiteit van Stellenbosch 2
- geen een van die bostaande universiteite nie 3

2 Vandag se datum:

----- dag ----- maand ----- jaar

3 Jou geslag:

- Vroulik 1
- Manlik 2

4 Hierdie is jou eerste jaar aan enige universiteit.

- Nee 1
- Ja 2

5 Watter van die volgende is jy? Lees die onderstaande lys en kies.

- eerstejaarstudent aan enige universiteit 1
- eerstejaarstudent maar was 'n student aan hierdie of 'n ander universiteit by 'n vorige geleentheid 2
- ek is geen een van die bostaande* 3

(*Gee besonderhede asseblief: _____

_____)

6 Jou skool eindeksamen was vir die Eksamenraad van:

- Kaapprovinsie 1
- Natal 2
- Oranje Vrystaat 3
- Transvaal 4
- Gemeenskaplike Matriekraad 5
- Departement van Onderwys en Kultuur 6
- Departement van Onderwys en Opleiding 7
- Enige ander onderwys-departement binne of buite Suid -Afrika* 8

(*Gee besonderhede asseblief: _____

 _____)

7 Het jy die Senior Sertifikaat eksamen (d.w.s. matriek-eksamen) van die Kaapse Onderwysdepartement geskryf?

- Nee 1
- Ja 2

8 Wanneer het jy jou skool eindeksamen geskryf? (Supplementêre eksamens wat jy in die daaropvolgende jaar afgele het, kan geïgnoreer word).

- voor 1977 1
- 1977 - 1980 2
- 1981 - 1984 3
- 1985 en daarna 4

9 Jou ouderdom, in jare, op die laaste dag van hierdie maand. Kyk onder vir voorbeelde.

VOORBEELDE

19 jaar 4 maande is 19 jaar
 18 jaar 7 maande is 19 jaar

Voltooi: My ouderdom is _____ jaar

Skryf jou ouderdom in die blokkie langs

10 Skryf die naam van die skool waar jy jou laaste skooljare deurgebring het, hieronder neer. Indien jy gedurende hierdie tydperk van skool verwissel het. Skryf dan die naam van die laaste skool neer.

11-13 Waar is die skool waar jy jou laaste drie skooljare deurgebring het, geleë? Wees so volledig moontlik wanneer jy die besonderhede in die ruimtes hieronder inskryf.

11 naam van land of staat: -----

12 naam van die dorp of stad: -----

13 naam van die woonbuurt of voorstad: -----

14 Watter beskrywing is van toepassing op die senior sekondêre skool wat jy in jou laaste skooljare bygewoon het? Kies tussen die twee hieronder.

'n buurtskool: die geskikste skool, naaste aan my woonplek 1

'n uitgesoekte skool: dit mag selfs in 'n ander dorp, stad of voorstad wees 2

15 Het jy Biologie as vak vir jou skool eindeksamen aangebied?

Nee 1

Ja 2

Let wel: Indien jy Plantkunde, Dierkunde of enige ander oorheersend biologiese vak vir jou skool eindeksamen aangebied het, mag jou respons hierbo JA wees.

16 Dink terug aan die gemiddelde persentasie wat jy behaal het vir 'n eksamen wat jy gedurende jou laaste skooljaar geskryf het. Lees daarna die voorbeelde hieronder en dui jou persentasie aan deur 'n keuse te maak uit die reeks persentasies wat voorsien word.

VOORBEELD

"My September-eksamen persentasie was ongeveer 64%"

Respons: 64% is in die 61 - 65 reeks.
Trek 'n kruisie in die blokkie langs 61 - 65.

20 en minder	<input type="checkbox"/>	1
21 - 25	<input type="checkbox"/>	2
26 - 30	<input type="checkbox"/>	3
31 - 35	<input type="checkbox"/>	4
36 - 40	<input type="checkbox"/>	5
41 - 45	<input type="checkbox"/>	6
46 - 50	<input type="checkbox"/>	7
51 - 55	<input type="checkbox"/>	8
56 - 60	<input type="checkbox"/>	9
61 - 65	<input type="checkbox"/>	10
66 - 70	<input type="checkbox"/>	11
71 - 75	<input type="checkbox"/>	12
76 - 80	<input type="checkbox"/>	13
81 en meer	<input type="checkbox"/>	14

Let wel: Indien jy nie gedurende die jaar eksamens skryf het nie, gee die mees akkurate persentasie wat jy sou behaal het.

17 Het jy Skei- en Natuurkunde as vak vir jou skool eindeksamen aangebied?

Nee	<input type="checkbox"/>	1
Ja	<input type="checkbox"/>	2

18 Indien jy Skei- en Natuurkunde as vak vir jou skool eindeksamen gehad het, het jy die vak op die Hoër Graad of Standaard Graad studeer? Lees die onderstaande lys om hierdie vraag te beantwoord.

- ek het nie Skei- en Natuurkunde as skoolvak gehad nie 1
- 'n Graad stelsel was nie in gebruik nie 2
- Hoër Graad 3
- Standaard Graad 4

19 Vir hoeveel jare is jy van plan om biologiese wetenskappe aan 'n universiteit te studeer?*

- 1 jaar 1
- 2 jare 2
- 3 jare 3
- 4 jare 4
- meer as 4 jare 5

*Indien jy van plan is om nagraadse kursusse te studeer mag jy die aantal jare in jou getal insluit.

Kursusse wat nie 'n volle jaar duur nie mag as "1 jaar" beskou word.

20 Uit die lys hieronder, kies die nommer wat jou belangstelling in die natuur, lewende wesens en sisteme van lewende wesens op sy beste weergee.

- 1 baie min 1
- 2 'n bietjie 2
- 3 onder gemiddeld 3
- 4 gemiddeld 4
- 5 bo gemiddeld 5
- 6 goed gevestig 6
- 7 baie groot 7

21 Kies, uit die lys hieronder, 'n nommer wat jou aktiwiteite met lewende wesens en die natuur as geheel sal aandui. Voorbeelde: deur lid van 'n buitelug-klub te wees, projekte wat op voorkoming van rommelstrooi gemik is, inskryf vir natuurbewaringskompetisies, plakkate teken, natuurpraatjies lewer of bywoon, ens.

- | | | | |
|---|-----------------|--------------------------|---|
| 1 | baie min | <input type="checkbox"/> | 1 |
| 2 | min | <input type="checkbox"/> | 2 |
| 3 | onder gemiddeld | <input type="checkbox"/> | 3 |
| 4 | gemiddeld | <input type="checkbox"/> | 4 |
| 5 | bo gemiddeld | <input type="checkbox"/> | 5 |
| 6 | heelwat | <input type="checkbox"/> | 6 |
| 7 | baie | <input type="checkbox"/> | 7 |

22 Watter verwagtings het jy van die toets- en eksamenpunte in die biologiese wetenskappe wat jy van plan is om aan 'n universiteit te studeer? Wees eerlik in jou skatting!

- | | | |
|--|--------------------------|---|
| treurig - van die laagste in die klas | <input type="checkbox"/> | 1 |
| swak - ver onder gemiddeld | <input type="checkbox"/> | 2 |
| onder gemiddeld | <input type="checkbox"/> | 3 |
| gemiddeld | <input type="checkbox"/> | 4 |
| bo gemiddeld | <input type="checkbox"/> | 5 |
| goed - ver bo gemiddeld | <input type="checkbox"/> | 6 |
| uitstekend - van die hoogste in die klas | <input type="checkbox"/> | 7 |

AFDELING B

Voltooi hierdie afdeling SLEGS as jy Biologie as vak vir jou skool eindeksamen aangebied het.

Let wel: Indien jy Plantkunde , Dierkunde of enige ander oorheersend biologiese vak vir jou skool eindeksamen aangebied het, voltooi dan asseblief hierdie afdeling. Die woord Biologie sal vir jou vak gebruik word.

1 Hoekom het jy op skool Biologie as vakkeuse gehad? Lees die onderstaande lys en kies aan ENIGE redes wat op jou van toepassing is.

- ouers se goedkeuring en belangstelling in jou studies van hierdie vak 1
- 'n interessante vakkeuse vir studie gedurende die skoolloopbaan 2
- goeie vakonderwyser 3
- vriende wat hierdie vak as keuse gehad het 4
- 'n eie belangstelling in die natuur wat gestimuleer was terwyl jy die vak studeer het 5
- redelike betaling en interessante loopbane in hierdie rigting na verdere studies 6
- uitstekende werkgeleenthede en top-salarisse in hierdie rigting na verdere studies 7

2 Watter van die volgende was voertaal vir Biologie toe jy nog op skool was?

- Afrikaans 1
- Afrikaans en Engels 2
- Engels 3
- 'n taal wat nie of Afrikaans of Engels is nie* 4

(*Gee asseblief besonderhede: _____
_____)

3 Het jy Biologie op skool op die Hoër of op die Standaard Graad studeer? Lees die onderstaande lys om hierdie vraag te beantwoord.

- Hoër Graad 1
- Standaard Graad 2
- 'n Graad stelsel was nie in gebruik nie 3

4 In die algemeen, hoe populêr was Biologie in jou skool?
Kies ENIGE nommer uit die onderstaande om aan te dui
hoe populêr hierdie vak was.

- | | | | |
|---|----------------------------------|--------------------------|---|
| 1 | m.a.w. baie populêr | <input type="checkbox"/> | 1 |
| 2 | ----- | <input type="checkbox"/> | 2 |
| 3 | ----- | <input type="checkbox"/> | 3 |
| 4 | m.a.w. nóg populêr nóg onpopulêr | <input type="checkbox"/> | 4 |
| 5 | ----- | <input type="checkbox"/> | 5 |
| 6 | ----- | <input type="checkbox"/> | 6 |
| 7 | m.a.w. baie onpopulêr | <input type="checkbox"/> | 7 |

5 Hoe was jou algemene belangstelling in die natuur beïnvloed
deur die skool Biologie-kursus? Kies uit die onderstaande
lys en maak 'n respons.

- | | | | |
|---|-----------------------------------|--------------------------|---|
| 1 | belangstelling baie verminder | <input type="checkbox"/> | 1 |
| 2 | belangstelling heelwat verminder | <input type="checkbox"/> | 2 |
| 3 | belangstelling effens verminder | <input type="checkbox"/> | 3 |
| 4 | belangstelling onveranderd | <input type="checkbox"/> | 4 |
| 5 | belangstelling effens vermeerder | <input type="checkbox"/> | 5 |
| 6 | belangstelling heelwat vermeerder | <input type="checkbox"/> | 6 |
| 7 | belangstelling baie vermeerder | <input type="checkbox"/> | 7 |

6 Het skoolbiologie jou aangemoedig om na te dink oor die
natuur en natuurprosesse? Kies 'n nommer uit die
onderstaande lys om te verduidelik.

- | | | | |
|---|--------------------------|--------------------------|---|
| 1 | glad nie aangemoedig nie | <input type="checkbox"/> | 1 |
| 2 | effens aangemoedig | <input type="checkbox"/> | 2 |
| 3 | redelik aangemoedig | <input type="checkbox"/> | 3 |
| 4 | heelwat aangemoedig | <input type="checkbox"/> | 4 |
| 5 | baie aangemoedig | <input type="checkbox"/> | 5 |

7 Om skoolvakke soos Biologie goed te verstaan is praktiese werk in die natuurlike of mensgemaakte natuur belangrik. Die omgewing kan naby die klas-kamer wees (bv. die skooltuin of sypaadjie) of ver weg. (bv. 'n natuurreservaat). Hoe dikwels was die omgewing tydens Senior Sekondêre Biologie studies op skool gebruik? Kies enige nommer uit die onderstaande lys om benutting van die omgewing aan te dui.

- 1 m.a.w. nooit 1
- 2 ----- 2
- 3 ----- 3
- 4 nou en dan (bv. tweekeer per jaar) 4
- 5 ----- 5
- 6 ----- 6
- 7 m.a.w. baie dikwels 7

8 Toe eksamens en toetse in Biologie aangekondig was, wat was gewoonlik jou reaksie? Kies ENIGE uit die onderstaande lys.

- negatief: vrees en afkeer van toetse en eksamens 1
- versigtig: onseker van resultate maar gewillig om te probeer 2
- irritasie: toetse is onaangenaam maar is tog nodig 3
- optimisties: taamlik seker van redelike resultate 4
- positief: gebruik en verwelkom die geleentheid om kennis en begrip van die vak aan te dui 5

9 Het jy, as lid van die Senior Biologie-klasgroep plekke soos myne, natuurreservate, kunsmisfabrieke, dieretuine en dergelike plekke besoek? Kies EEN nommer uit die onderstaande lys om aan te dui hoe dikwels hierdie besoeke was.

- 1 m.a.w. nooit 1
- 2 ----- 2
- 3 ----- 3
- 4 ----- 4
- 5 m.a.w. dikwels 5

10 Gedurende jou laaste skooljaar, watter persentasie het jy gewoonlik behaal vir toetse en eksamens in Biologie? Lees die voorbeelde en kies dan uit die onderstaande reeks.

VOORBEELDE

"My gemiddelde vir Biologie vir die jaar was 64%"

Respons: 64% is in die 61 - 65 reeks.
Trek 'n kruisie in die blokkie langs 61 - 65.

20 en minder	<input type="checkbox"/>	1
21 - 25	<input type="checkbox"/>	2
26 - 30	<input type="checkbox"/>	3
31 - 35	<input type="checkbox"/>	4
36 - 40	<input type="checkbox"/>	5
41 - 45	<input type="checkbox"/>	6
46 - 50	<input type="checkbox"/>	7
51 - 55	<input type="checkbox"/>	8
56 - 60	<input type="checkbox"/>	9
61 - 65	<input type="checkbox"/>	10
66 - 70	<input type="checkbox"/>	11
71 - 75	<input type="checkbox"/>	12
76 - 80	<input type="checkbox"/>	13
81 en meer	<input type="checkbox"/>	14

11 Kies uit die onderstaande lys 'n nommer om aan te dui hoeveel persoonlike bevrediging jy ondervind het tydens jou laaste drie jare van Biologie op skool.

1	m.a.w. baie min bevrediging	<input type="checkbox"/>	1
2	-----	<input type="checkbox"/>	2
3	-----	<input type="checkbox"/>	3
4	-----	<input type="checkbox"/>	4
5	m.a.w. baie bevrediging	<input type="checkbox"/>	5

12 Watter, uit die onderstaande lys, het tydens jou skool-biologieskursus as belangrik voorgekom? Kies soveel response as wat op jou van toepassing is.

- feite wat verband jou met diere en plante wat geleer moes word 1
- om goeie toets- en eksamenpunte te behaal 2
- die nut van wat op skool geleer was in jou woonplek, in die natuur, in die omgewing 3
- gesindheid soos 'n respek vir die Skepping, 'n aanvoeling vir plante, diere, natuur in die geheel 4
- eksperimente wat natuurprosesse en produkte van plante en diere ondersoek het 5
- projekte, eiehandig aangepak, moontlik groep-projekte wat lees, veldwerk en verwante navorsingsaktiwiteite ingehou het 6
- kreatiewe aktiwiteite wat navorsing, denke, modelle maak en eksperimente ontwerp ingehou het 7

13 Hoekom sou jy op skool in Biologie goeie punte vir toetse en eksamens wou behaal? Lees die onderstaande lys en kies dan ENIGE redes wat op jou van toepassing is.

- ek het goeie punte in al my skoolvakke behaal 1
- omdat hierdie besondere skoolvak my interesseer het 2
- dit was my redelik maklik om goeie punte in hierdie vak te behaal 3
- om my ouers en familie te beïndruk 4
- om my skoolvriende te beïndruk 5
- om my Biologie-onderwyser te beïndruk 6
- omdat goeie punte belangrik is om toelating tot 'n universiteit vir verdere studies te verkry 7

14 In die lys hieronder is inligtingsbronne vir gebruik tydens studies van Biologie. Lees die lys deur en duit aan ENIGE bronne wat in jou skool vir Biologie gebruik was.

- 'n handboek 1
- meer as een handboek 2
- aantekeninge deur die onderwyser voorberei vir klasgebruik 3
- woordeboeke en ensiklopedieë 4
- tydskrifte, joernale, populêre tydskrifte, tydskrifartikels 5
- films en skyfies 6
- kaarte en diagramme 7
- hulp van spesialiste op sekere gebiede bv. universiteitspersoneel 8
- student-aantekeninge deur die handel verkrygbaar 9
- TV, video's, tuisgemaakte video's 10
- 'n biblioteek bv. skoolbiblioteek, openbare biblioteek 11

15 Watter eienskappe sou jou Senior Sekondêre Biologie-onderwyser beskryf? Kies ENIGE beskrywings uit die lys wat voorsien word.

- die onderwyser het in sy studente belang gestel 1
- die onderwyser het in die natuur belang gestel 2
- die onderwyser het belang gestel in die goeie eksamen- en toetspunte van sy studente 3
- die onderwyser was gewild en vriendelik 4
- die onderwyser het goeie vakkennis gehad 5
- die onderwyser was intellektueel ontwikkel, 'n denkende persoon 6
- die onderwyser kon goed verduidelik en studente se leerprobleme oplos 7
- geeneen van die bostaande is van toepassing* 8

(*Gee asseblief besonderhede: _____

_____)

16 Dink jy dat in die skoolbiologieskursus die diere, plante en natuurprosesse in gepaste detail bestudeer was? Gee jou mening deur EEN uit die onderstaande lys te kies.

- te min detail 1
- voldoende detail 2
- te noukeurige detail 3
- wisselend: somtyds te min, somtyds te veel detail 4

17 Het jy in die hoërskool in die Biologie-klas geleer hoe om laboratoriumapparaat bv. 'n mikroskoop, te gebruik en/of hoe om veldwerk te doen? Kies EEN nommer uit die onderstaande lys om te illustreer.

- 1 m.a.w. baie min geleer 1
- 2 ----- 2
- 3 ----- 3
- 4 ----- 4
- 5 m.a.w. baie geleer 5

18 Hoeveel het Biologie op skool met ander vakke verband gehad? Lees die onderstaande lys en kies EEN wat hierdie verbandhouding die akkuraatste beskryf.

- baie min 1
- min 2
- redelik 3
- heelwat 4
- baie 5

19 Die vinnige tempo van Biologie-onderwys op skool mag probleme skep vir die studente. Hoe dikwels het jy hierdie probleem ondervind? Kies EEN uit die onderstaande lys.

- baie selde, amper nooit 1
- selde 2
- van tyd tot tyd 3
- dikwels 4
- baie dikwels, amper deurentyd 5

20 Toe jy leerprobleme tydens skoolbiologie ondervind het, na watter persone het jy jou probleme geneem? Kies ENIGE persone uit die onderstaande lys.

- die vakonderwyser 1
- 'n ander onderwyser of onderwysers 2
- jou vriende en klasmaats 3
- een of moontlik twee van jou klasmaats in besonder 4
- jou ouers, familie lede 5
- 'n persoon of persone wat nie in die lys hierbo verskyn nie. Moontlik kon jy nie jou probleme oplos of het jy geen probleme ondervind nie? * 6

(*Gee asseblief besonderhede: _____

_____)

21 Kies ENIGE alternatiewe uit die onderstaande lys wat die volgende stelling sal voltooi:

"As skoolvak het Biologie ...

- vir my 'n redelik maklike studie geblyk te wees 1
- my in staat gestel om eksperimente uit te voer om die natuur te ondersoek 2
- my in staat gestel om projekte eiehandig of as lid van 'n groep, aan te pak tydens ondersoeke van die natuur 3
- 'n vak geblyk waarin ek bewys kon lewer waartoe ek in staat is 4
- die kommunikasie tussen Biologie-onderwyser en die studente verbeter 5
- 'n groter belangstelling in plante, diere en die natuur in my aangewakker 6
- my van inligting voorsien wat nuttig is vir die alledaagse bestaan, gebaseer op voorbeelde uit die natuur." 7

22 Wat het skoolbiologie die helderste in jou geheue afgeprent?
Kies ENIGE response uit die onderstaande lys.

- inligting m.a.w. die feite van hierdie vak wat geleer moes word 1
- die toetse en eksamens wat jy in hierdie vak afgelê het 2
- die gedagtewisseling tussen onderwyser en studente in hierdie vak 3
- die nuttigheid van hierdie vak vir naskoolse studie 4
- 'n besondere gesindheid teenoor die natuur wat tydens skoolstudies na vore gekom het 5
- geleenthede om kreatief te wees deur modelle maak, teken, ens. tydens studie van hierdie vak 6
- iets wat nie hierbo in die lys verskyn nie* 7

(*Gee asseblief besonderhede: _____
_____)

23 Hoe sou jy die nut van 'n deeglike kennis van skoolbiologie vir die alledaagse lewe beskryf? Kies EEN nommer uit die onderstaande lys sodat jou mening duidelik is.

- 1 m.a.w. amper nutteloos 1
- 2 _____ 2
- 3 _____ 3
- 4 m.a.w. redelik nuttig 4
- 5 _____ 5
- 6 _____ 6
- 7 m.a.w. besonder nuttig 7

DANKIE VIR JOU SAMEWERKING

Kyk net asseblief weer of jy al die items in hierdie vraelys voltooi het.

APPENDIX 3

A number of suggestions for attitude-testing items for use at school and university are provided. Their design and layout serve as examples of a test designed for marking by computer.

All the test-items included here are concerned with a single factor namely, the role of projects. Other factors such as the influence of parents, the contributions made by experimentation, creativity, etc., are not included here.

Please complete ALL the items below - do not leave any out!

If you are in doubt about your response (i.e. your answer) choose the best response from those supplied.

1 What contribution should be made by projects during your course in biology? Read through the list below, choose your response and make a cross in the square alongside it.

1	projects 0% and lectures/teaching 100%	<input type="checkbox"/>	1
2	projects 25% and lectures/teaching 75%	<input type="checkbox"/>	2
3	projects 50% and lectures/teaching 50%	<input type="checkbox"/>	3
4	projects 75% and lectures/teaching 25%	<input type="checkbox"/>	4
5	projects 100% and lectures/teaching 0%	<input type="checkbox"/>	5

2 "Getting high marks for a project is important to me."

To make your point of view clear, choose a response from the list provided and make a cross in the square next to it.

1	agree	<input type="checkbox"/>	6
2	mostly agree	<input type="checkbox"/>	7
3	neither agree nor disagree	<input type="checkbox"/>	8
4	mostly disagree	<input type="checkbox"/>	9
5	disagree	<input type="checkbox"/>	10

3 "The last project I completed investigated areas of importance to me."

From the list provided below, choose a response that will complete the above statement. Make a cross in the square next to it.

- | | | | |
|---|---------------|--------------------------|----|
| 1 | great | <input type="checkbox"/> | 11 |
| 2 | considerable | <input type="checkbox"/> | 12 |
| 3 | moderate | <input type="checkbox"/> | 13 |
| 4 | rather little | <input type="checkbox"/> | 14 |
| 5 | little | <input type="checkbox"/> | 15 |

4 Do you suppose that the approaches you developed while you were completing your last project have prepared you in some way for the next one?

To answer this question, choose a response from the list supplied and then make a cross in the square next to it.

- | | | | |
|---|--------|--------------------------|----|
| 1 | no | <input type="checkbox"/> | 16 |
| 2 | unsure | <input type="checkbox"/> | 17 |
| 3 | yes | <input type="checkbox"/> | 18 |

5 Choose a response from the list below that expresses your honest opinion of the following statement:

"Completing a project has enabled me to study/learn independently."

- | | | | |
|---|----------------------------|--------------------------|----|
| 1 | entirely disagree | <input type="checkbox"/> | 19 |
| 2 | mostly disagree | <input type="checkbox"/> | 20 |
| 3 | neither disagree nor agree | <input type="checkbox"/> | 21 |
| 4 | mostly agree | <input type="checkbox"/> | 22 |
| 5 | entirely agree | <input type="checkbox"/> | 23 |

6 Read the following statement and thereafter give your opinion by choosing an answer from those supplied. Make a cross in the block next to it:

"Projects are able to successfully relate their content material to the everyday world in which I live."

- | | | | |
|---|----------------------------|--------------------------|----|
| 1 | entirely disagree | <input type="checkbox"/> | 24 |
| 2 | mostly disagree | <input type="checkbox"/> | 25 |
| 3 | neither disagree nor agree | <input type="checkbox"/> | 26 |
| 4 | mostly agree | <input type="checkbox"/> | 27 |
| 5 | entirely agree | <input type="checkbox"/> | 28 |

7 "Getting personal satisfaction from project work is important to me."

Choose the best response from the list below and make a cross in the square next to it.

- | | | | |
|---|----------------------------|--------------------------|----|
| 1 | disagree | <input type="checkbox"/> | 29 |
| 2 | mostly disagree | <input type="checkbox"/> | 30 |
| 3 | neither disagree nor agree | <input type="checkbox"/> | 31 |
| 4 | mostly agree | <input type="checkbox"/> | 32 |
| 5 | agree | <input type="checkbox"/> | 33 |

PLEASE CHECK: did you complete ALL the items?

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