# A STUDY OF STUDENT ATTITUDES TO TEACHING STRATEGIES AIMED AT ENCOURAGING AUTONOMOUS LEARNING IN UNIVERSITY LEVEL BIOLOGY

BY

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# DEDICATION

**THIS WORK IS DEDICATED TO GOD THE *FATHER*, GOD THE *SON* AND GOD THE *HOLY SPIRIT* - THE TRIUNE GOD ALMIGHTY; WITHOUT WHOSE PROVIDENCE THIS WORK WOULD HAVE NOT BEEN COMPLETED. TO HIM BE GLORY, HONOUR, DOMINION, POWER AND MAJESTY FOR EVER AND EVER AMEN.**

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# ABSTRACT

This thesis examines the attitudes of students to teaching strategies that are aimed at encouraging autonomous learning in university level biology.

Attitudes determine the learning which occurs within a student as he/she selects from the environment what he/she learns according to his ideas, values and feelings as well as his concepts. Attitudes may indeed lead to a rejection or acceptance of new ideas. Hence there is the need to inculcate the right attitudes in the students..

Favourable attitudes to a subject could be promoted by the use of appropriate teaching strategies.

University teaching combines training for professional life with the development of the student's mind - the ability to think for ones self ( that is, autonomous learning). A student who has become autonomous will be able to exercise freedom of choice after rational reflection and conduct his life without having his mind made up by others. This skill is important to the student future life in the society in which he plays a part.

Hence there is the need to provide learning environments that will offer the learner the freedom and the right attitude to practice the skill.

The study assessed whether the change in biology level 1 course, aimed at helping students to become autonomous in their learning, has achieved that aim.

The population included all students of the level one biology of the University of Glasgow, for the 1994/95 and 1995/96 sessions. 1994/95 was when the old course was still being implemented while 1995/96 was when changes were made to the old course. A sample of 500 students from each of the sessions was used.

The Perry Model of Intellectual Development was used to describe how students develop from a simplistic stance on the nature of knowledge to one which is more pluralistic and contextual. It provides an insight into how students perceive their education and approach

their classroom. The characteristics of the maturity end goal of this model, that is, relativism, are indicative of an autonomous learner. therefore the model was used as an observational tool to identify the changes in the ways which students think or behave.

Questionnaires were administered to the students and data was analysed using the Chi square ($X^2$) statistic.

The result indicated that : -

(1) The students were encouraged to become autonomous in their learning and this position was more evident when the changes were made to the course in 1995/96 session.

(2) The laboratory method with its many activities which serve to ensure that each student has an opportunity to participate effectively also indicated that the students were encouraged to think for themselves.

(3) The tutorial method which had become more varied and frequent encouraged the students to become more free in airing their views thereby enabling them to become more independent.

(4) The project method enhanced the students' ability to carry out their studies independently.

(5) The organisation of the course, especially the new course, was considered very good as it facilitated their moving towards autonomy.

(6) The Perry model confirmed that the changes made in the course did make a difference in students' attitudes to their learning producing a shift towards a higher degree of autonomy.

The findings have shown that students were undergoing changes in their perception and approach to their study while at university.

# CHAPTER 1

# BACKGROUND TO THE STUDY

## 1.1 INTRODUCTION

The desire to know who one is and how one has come to be so , is a fundamental mental human impulse which drives the search for all knowledge and it is one of the few desires which does not diminish with increasing age. It sharpens the taste for speculating on the future ( Macleod, 1981).

Science has always been characterised by the desire to know. And this is the attribute that has led scientists to probe into the nature of things and events and thereby generating scientific knowledge. Science is defined both as a process and a product. It is operational and dynamic. It asks questions like how, what, when, and why about nature and man - caused events.

Science has made large advances in our understanding of the natural world. And modern society throughout the world is highly dependent on the application of scientific knowledge and on continuing programmes of scientific research. Therefore, science education is a vital part of an educational system. This is so because of :- (1) the need to produce new generations of scientists and (2) the need for all members of the public to have some understanding of science.

In the last few years the British Government has encouraged an increase in the participation rate in Higher Education to around 30% of school leavers. One effect of this has been to increase the diversity of university entrants - in addition to an increase in numbers. This change in population, in addition to other factors ( for example, reduced funding, re - thinking the purposes of higher education ) has led many university teachers into a re - consideration of their teaching strategies. An example which has involved a single very large Department is Glasgow University's IBLS.

### 1.2 INSTITUTE OF BIOMEDICAL AND LIFE SCIENCES (IBLS)

Glasgow University is the largest science - based University in the United Kingdom outside London. Its internationally recognised bioscientists are now enjoying new vigour and a fresh commitment to research excellence through the merger in 1994 of eleven specialist departments into a focal point for research, technology and teaching in a diversity of bio - related disciplines, the Institute of Biomedical and Life Sciences, (IBLS).The eleven departments were :- (1) Anatomy, (2) Botany, (3) Biochemistry, (4) Cell Biology, (5) Genetics, (6) Biotechnology, (7) Microbiology, (8) Pharmacology, (9) Physical Education and Sports Sciences, (10) Virology and (11) Zoology. These departments have been grouped into a set of divisions. There are six research divisions that reflect IBLS strengths in important research areas, and they are :- (1) Biochemistry and Molecular Biology, (2) Neuroscience and Biomedical systems, (3) Environmental and Evolutionary Biology. (4) Infection and Immunity (5) Molecular Genetics and (6) Virology. In addition to the research divisions, the Undergraduate Teaching Unit (UTU) manages the Institute's undergraduate teaching using its own staff and staff from the research divisions, and the Graduate School manages the Institute's postgraduate teaching.

The emergence of this integrated unit is in response to the need to preserve and strengthen the teaching and research excellence for which the University has been known. This has created an environment in which cross fertilisation of ideas and research collaborations can thrive and where increasing integrated student training can be developed (IBLS brochure,1997).

The establishment of IBLS is supposed to promote a thorough review of the curriculum in biological sciences, a new system of teaching management and new developments in the teaching philosophy. Increasing student numbers, including students studying medicine, veterinary medicine, dentistry and nursing are also supposed to benefit from rationalisation of courses and improved funding allocation options which offer a better quality of education.

One of the stated objectives for establishing the IBLS was excellence in research, teaching efficiency and effectiveness. Hence its educational mission is to provide the best learning opportunities for all students, to care for each student as a unique individual and to ensure that each can achieve a personal best in terms of academic progress, development of learning, understanding and transferable skills, in obtaining a challenging and rewarding education and in preparing for further training and employment (IBLS brochure, 1997).

## 1.3 THE UNDERGRADUATE TEACHING UNIT (UTU)

The Undergraduate Teaching Unit is responsible for all the IBLS undergraduate courses. However, it currently devolves responsibility for honours courses to Course Co-ordinating committees located in the research divisions. The UTU organises and manages educational provision in levels one and two, which are its prime responsibility. In other course areas, for example, Dentistry, Veterinary medicine, Medicine and nursing, the IBLS acts as a service - but it is also heavily involved in course innovation, for example, the new medical curriculum. In science, part of the programme of change has been to modularise courses in levels one and two.

## 1.4 THE FIRST YEAR BIOLOGY COURSE

This is an introductory and a foundation course available to students in science, arts and social sciences. The course originated in the 1970s ; the content of the course has been continuously revised, but the overall structure remained intact ( J. R. Downie, personal communication). This course was one of IBLS 'first targets for extensive revision. The students come into the course with a variety of backgrounds, for example, Scottish Higher, Sixth year studies, English GCE Advanced level, or Higher National Certificate (or Diploma), General Certificate of Secondary Education, General National Vocational

Qualification, Scottish Vocational Qualification, Open University, Standard grades, Access, Nursing and so on. About twenty percent of the students come into the course with no previous biological knowledge.

### 1.5 WHAT WERE THE CHANGES?

In October 1995, IBLS introduced a new course for first year students in biology at the University of Glasgow. The new course consisted of four Modules and a Special Study Project. The modules are :- (1) Module A - Plants and Microbes, (2) Module B - Molecules, Genes and Cells, (3) Module C - How Animals Function, (4) Module D - Ecology and Evolution. Each Module represents 100 hours of learning time and includes 20 lectures, practicals, assessed classwork (essays and practical notebooks) and independent study ( set reading, questions, revision). The Special Study Project - on AIDS, involves working in teams, debates, written work, tutorials, independent study, problem solving and computing.

The Course Information Document for 1995/96 session stated the overall aims of the course as :- (a) To provide a broad - based understanding of modern biology in those areas selected for study. (b) To provide the knowledge appropriate for continuing studies in Biological subjects. (c) To encourage the acquisition of general scientific skills relating to the systematic assembly, critical analysis, interpretation and discussion of factual information and data. According to the Deputy co-ordinator of the course, an additional aim of the course would be to offer students, with no intention of further biological study, a good general educational experience of the subject.

A feature of the new course has been to expose students to a variety of learning and teaching techniques. The department believed that if they invested in and showed students how to learn at the start of their careers, they would gain much more from their later years in education.

Although the four modules stand alone and can be studied independently, students intending to continue with biology into later years are required to study all four modules and the special study project. With regards to assessment, Modules A and B are examined after 12 weeks of the session in late January and Modules C and D after 12 weeks of the session in June.

## 1.6 WHY WERE THE CHANGES NECESSARY?

The new course was developed to expose students to developments in biology, to introduce and to make biology a truly enjoyable and challenging subject.

During a discussion with Dr. J. R. Downie, he stated that the 'old ' first year biology course had been designed as an integrated, broad - based course in 1970. Over the years since, the Course Management Committee ( based on the group of the old subject - based departments) had undertaken several reviews of the course, some minor and some major. However the course had become very heavy in terms of numbers of lectures, compared to other first year science courses. The student intake had also changed, becoming much more variable in their previous educational background. Overall, it was felt that the course was too demanding with an unacceptably high failure rate. He continued that the new course was developed to use resources more effectively, to make the course more manageable for students and to shift the emphasis from teaching to learning.

## 1.7 PREPARATIONS FOR THE CHANGE

The Department developed a clear and agreed plan after various meetings.The new course underwent many versions over several months before an agreement was eventually reached on the basic structure and content. The agreed plan included lecture titles, laboratories, tutorials, study projects and so on. The plan was approved by the University authorities, for example the Senate,and the Faculty of Science. External examiners for the course were also appointed.

## 1.8 ENSURING THE EFFECTIVENESS OF CHANGE

The Course Management Committee takes evidence from staff, students, external examiner and examination results in order to discuss and implement necessary changes in the course.

## 1.9 OBSERVATION OF THE OLD AND NEW FIRST YEAR BIOLOGY COURSES FOR 1994/95 AND 1995/96 SESSIONS

The research on the first year biology course in this thesis is based on observations on the 'old ' course in its final session (1994/95) compared to the first session of the new course (1995/96). Aspects observed included the lectures, laboratories, tutorials, staff student meetings, learning resources, library facilities, student feedback and assessment, demonstrators' meetings and evaluation of teaching. My particular interest was to investigate the effectiveness of teaching strategies relating to autonomous learning.

## 1.10 ATTITUDES AND INSTRUCTIONAL STRATEGIES

Attitudes may influence or even determine the way students learn. Considering the definition of attitudes, Reid (1978) explained that different psychology writers tend to define attitudes in different ways. Each definition tends to reflect the psychological background of the writers - latent constructs, cognitive processes or behavioural aspects all being used as bases for definitions. However most agreed that attitudes have three components as proposed by Krech *et al.* (1962) :- a cognitive or ***knowledge*** component such as beliefs about an object, a person or a situation; an affective or ***feeling*** component and a ***response*** component. All believed that these three components are interrelated. The most widely accepted definition is that of Allport (1935), who defined an attitude as 'a mental and neutral state of readiness to respond, organised through experience, exerting a directive and/or dynamic influence on behaviour'.

According to Dunham (1974), the learner is not merely a cognitive entity, on the contrary, he exhibits affective or emotional states in his motivations, attitudes, personality, anxieties, intentions and beliefs, all of which influence his learning in both direct and indirect ways. These cognitive and non - cognitive variables interact with each other, for example, motivational factors have been known to energise the learning process by promoting attention and effort. He added that attitudes therefore have an important place in an interactionist perspective of teaching and learning which proposes that a pupil selects from and processes the information in his environment according to his ideas, values and feelings as well as his concepts. He continued that social psychologists have argued that attitudes are learned and evidence has shown that the experience and response of the student on a first year university course, suggested that consistent ways of perceiving, believing, feeling and behaving may be learned by being associated with important experiences charged with emotion. Affective or emotional states therefore, he concluded, may influence or even determine the learning which occurs in the classroom.

Katz (1960) explained that attitudes may function in a protective way leading to rejection of new ideas; on the other hand, they may facilitate the acceptance of new ideas, particularly if learning increases personal growth.

Teachers, therefore, should be cautious in the methods they use in attempting to change their pupils' attitudes.

Favourable attitudes to biology have been promoted by :- (1) considering the pupils needs (Maslow, 1954). (2) avoiding aversive conditions of learning and using investigative methods in learning (Falk, 1971). Falk argued that the investigative methods do stimulate more positive approaches towards biology because of their empirical characteristics. He also claimed that they can encourage the development of values which are necessary for scientific enquiry. He added that this method will stimulate curiosity, exploration and involvement by encouraging learner skills and interest in learning.

However, he warned that these claims are not yet supported by evidence. He explained that it is not yet known if optimum learning for students occurs by methods where they are made to ask their own questions and creatively devise their own methods of solutions or whether they learn better when teacher - directed methods are used.

Caution against the uncritical acceptance and propagation of investigative methods and rejection of directed methods has also been counselled by Ausubel and Robinson (1969). They are critical of enthusiasts for discovery methods such as Bruner who seems "to perceive learning by discovery as a unique and unexcelled generator of self - confidence, intellectual excitement and motivation for sustained problem solving and creative thinking". They argued that the skilful exposition of ideas by a competent teacher "can also generate considerable intellectual excitement and motivation for genuine inquiry".

According to Dunham (1974), after Ausubel and Robinson had completed their appraisal of the relevant studies they reported that "actual examination of research literature allegedly supporting learning by discovery reveals that valid evidence of this nature is virtually non-existent".

There is, however, some evidence from research studies which have investigated the learning of university students. Dunham (1973) explained that "with some learners discovery methods are inappropriate, in that they resulted in confusion, apathy or antagonism and failure. These studies indicate that students, who have a strong need for direction and organisation, perform best in structured and formal learning situations".

Falk (1971), however, emphasised that a well planned laboratory situation can offer a wide variety of activities so that students of differing abilities can have the opportunities to participate, with success, in various aspects of the experimental situation. Another important aspect of the laboratory is that the student can encounter the unexpected and try to explain it.

In tutorials, Falk (1971) again stated that "inquiry oriented questions can be directed by the teacher towards the development of scientific attitudes. The teacher guides the discussion, by the kind of questions he formulates and the order in which he asks them".

In the project method, Nathenson (1980) quoted Kilpatrick as saying that " each student is given some responsibility for choosing his own area of study, planning his own work, obtaining the necessary material and synthesising it. This often leads to the provision of an appropriate environment in which each student can be helped to make sense of the world in his own way". There is the need therefore, for teachers to select and use appropriate strategies that will encourage and ensure the development of positive attitudes by the students in their learning of science.

Dunham (1974) stated that "more research is needed into the learning processes which occur in the classroom, in order to examine the interaction between teaching methods and the pupils concepts and attitudes." He explained that it should not be assumed that investigative methods are appropriate for all pupils, and so it is important that teachers develop realistic attitudes concerning the advantages of discovery approaches to learning. He emphasised that it is important and urgent to carry out research in the classroom which attempts to show how the effectiveness of methods of teaching varies with the cognitive and affective characteristics of pupils.

## 1.11 THE PROBLEM

Introductory biology courses are organised to offer basic biological concepts to students and to give them a view of biology as a science and also to allow them to experience the scientific process. The most common processes for the transmission of this information are lectures and laboratory exercises. UNESCO (1987) noted that small group discussions, simulations and games are currently being introduced.

UNESCO (1987) pointed out that since the 1960s, biology teaching has undergone many changes, first at the secondary level, then at the tertiary level. Most of these changes came about as a result of an explosive aspiration to knowledge and the impact of science in modern life. Biology teaching methods have been called in question and have been criticised.

According to Teather (1979), "Higher Education institutions in many parts of the world are under challenge. There is now more than ever before, pressure on University administrators to examine their institutions critically - their objectives and processes and to effect changes where these are deemed necessary. There is a pressure on teachers to improve their courses of studies, to develop effective ways of facilitating students learning. The present concern is in response to conditions which challenge the Universities everywhere and one of such conditions is the increase in number and diversity of students". With regards to this condition, Clarke (1997) remarked that "almost one in three young people now go on to Universities compared to one in eight in 1979".

Hogg (1977) also pointed out that, "one of the difficulties of first year students in the University is the increase in number and diverse qualifications of these entrants". He explained that it is often not easy to cater adequately for this heterogeneous group by a single method. The least able and the most able students will not have a satisfying learning situation and poor learning habits can develop almost unnoticed and the testing of student performance can become too infrequent. Falk (1971) added that this wide variation in the composition of student population of a class can have a direct bearing on teacher - student interaction.

UNESCO (1987) noted that teachers involved with the teaching of first year biology in the universities have discovered that these students differ in aptitude, motivation, speed in the acquisition of knowledge and modes of structuring knowledge. Therefore for a truly effective instruction, the instructor must be aware of and respond to these personal differences in the learner, because failure to recognise these differences can force the learner into adopting undesirable ways of processing information.

Another problem with introductory biology courses is the lack of time and overloading of syllabuses. This lessens teaching and learning effectiveness. Morris (1958) states that "science teachers were struggling to cover 15 to 20 percent more ground than their classes could take". Raven (1974) added that "most science teachers have found that their students are in difficulties because too much is required of them in too short a period". Pont (1976), cited "pressure of work" as a factor operating against the choice of further science education by students.

UNESCO (1987) noted that the search for teaching strategies that can take into account individual differences in personality, interest and previous knowledge, so that students can work at their own pace during their course, is a constant in biology course planning. The large number of enrolments and the need to innovate in methodology and instructional materials have played a key role in dissemination of this idea.

UNESCO (1987) again pointed out that because of this need , the teaching of biology in most institutions of Higher learning has changed and is now oriented towards a style of teaching that is both individualised and independent, leaving pupil or small groups of pupils free to proceed at their own pace and to take such steps as are appropriate to that pupil or group. The student is no longer pursuing a linear programme centred on the mere acquisition of factual knowledge but launching forth from precise biological knowledge problems which he himself may set and which he himself attempts to solve.

A well planned laboratory situation can offer a wide variety of activities, so that students of differing abilities have opportunity to participate with success in various aspects of the experimental situation. Hence the introduction of active methods in the teaching of biology could imply a more effective participation by the pupils in class activities.

Kormondy (1971) suggested the introduction of a modular system of courses which take into consideration individual interests by allowing for independent study, avoidance of needless content repetition for students who have already studied a given subject and also allows for greater course flexibility permitting any number of differing module combinations.

Reid *et al.* (1974) suggested that independent learning is a suitable approach for heterogeneous classes. Cornwall (1981) defined an independent or autonomous learner as one who has attained the ability to use a wide variety of ways of learning.

Cornwall (1981) went on to emphasise that "there is the need to introduce small components of independence into the courses that are not purely designed for independent learning, thereby leading the student into a greater autonomy and responsibility". He explained that the skills and attitudes appropriate for independent study are likely to be the best promoted by allowing the student to experience some autonomy as early as possible during a course of study. The attitudes and expectations of students about what is expected of them and what are the usual methods of teaching and learning seem to be firmly established quite soon after they enter the new and unfamiliar world of university. If part of that normal pattern of activity includes elements of autonomy, the later introduction of real independence in things like their final year projects is likely to be much easier.

Travers (1970) emphasised that poor teaching methods do foster learning difficulties and consequently affect learning performance.

Shelton (1981) concluded that students learn best similar things from different sources, by different methods, at different rates and in different sequences. Students learn most from those things in which they see a purpose and which they enjoy doing.

The Undergraduate Teaching Unit of the IBLS at Glasgow has introduced a modular course system and also provided a great variety of the teaching and learning techniques for its students. This is an attempt to ensure that learning becomes meaningful to each student.

The attainment of any scientific learning goal depends on the competency of the teaching and learning force. From the facts already presented it will seem that large scale teacher incompetence is not the major factor but the fault may lie with the curriculum and the teaching and learning strategies. Hence this research views all aspects of the course but with particular reference to the teaching strategies so as to consider any possible difficulties the pupils might experience with the instructional strategies used by their teachers. There is the possibility that the instructional strategies used by their teachers do not promote an adequate understanding of the scientific principles in their students. The research will attempt, therefore, to find out the views held by the students with regards to the old course and the new course as it affects their learning.

Osborne (1993) has shown that poor methodology has been known to have adverse effects on student learning of science. Hence there is the need to explore ways to make scientific knowledge more meaningful to the learner.

Some research work is directed at student attitudes to strategies in the teaching of science, but they hardly indicate how these strategies encourage students to become autonomous in their learning. Poor performance of students could stem from the way that science material is presented to them. If a suitable method of scientific presentation could be found then a better understanding and application of science could be attained by the students and they would experience a sense of increasing mastery in the course. Hence the need exists for empirically based information on the effects of the teaching strategies that encourage autonomous learning in students.

The study therefore sets out to examine to what extent first year biology students have become autonomous in their learning and to answer the following questions.

1. Has the change in teaching strategies made any difference in students attitudes to the way they learn?

2. Is there any significant difference between the attitudes of male and female students in the way they learn?

3. Is there any significant difference between the attitudes of older and younger students in the way they learn?

4. Is there any significant difference between the attitudes of students who intend to continue with biological studies and those who do not intend to continue in the way they learn?

5. Is there a significant difference between the attitudes of students with higher qualifications and those with lower qualifications, in the way they learn?

6. Is there a significant difference in the student's stage of intellectual development before coming to the university and after one year at the university?

In an attempt to answer these questions the following null hypotheses have been formulated.

1. There is no significant difference in the attitudes of students with higher entrance qualifications and those with lower entrance qualifications in the way they learn.

2. There is no significant difference in attitudes of the male and female students in the way they learn.

3. There is no significant difference in attitudes of the older and younger students in the way they learn.

4. There is no significant difference in the attitudes of students who intend to continue with biological studies and those who do not intend to continue in the way they learn.

5. There is no significant difference in students position of their intellectual development before and after one year at the university.

## 1.12 SIGNIFICANCE OF THE STUDY

According to Cornwall (1981), the introduction of some degree of autonomy for the students in a course is essential because the promotion of independent thinking is central to the whole enterprise of Higher Education. The intellectual powers which it seeks to foster cannot be exercised except in an independent mode. Critical thinking, judgement, creativeness, initiative, interpretative skills, hypotheses formulation and problem solving capacities can only be developed in learning environments which offer the learner freedom to practice these skills.

One of the essential reasons for changing an educational method or course is that it should benefit the student.

The significance of the present study is its assessment of whether a change in course organisation - aimed at helping students to become autonomous in their learning - has actually achieved that aim.

Chapter 2 examines what autonomous learning is ; aspects of the laboratory, tutorials and project methods that encourage the students to become autonomous in their learning and finally looks at the relationship between autonomous learning and the Perry model of how students learn.

# CHAPTER 2

## 2.1 AUTONOMOUS OR INDEPENDENT LEARNING IN STUDENTS

### 2.1.1 INTRODUCTION

According to Boud (1981), " the notion of autonomy in learning is the subject of much debate amongst philosophers of education. Independently of this debate and unaware of many of the subtleties of the arguments, many practitioners throughout the world are trying to establish ways in which they can assist students to become less dependent upon them as teachers and to design courses which involve students more deeply in learning and in making decisions".

Autonomous learning can be traced as far back as 1852 when Newman argued that "any type of independent learning is better than any method of teaching." In other words, learners should not be provided with knowledge without being given the chance to work it out for themselves. They will not be able to think for themselves.

Mahfuth (1991) pointed out that this idea brought about a revolution in the seventies where the centrality of the learner features the system of education and consequent changes of teachers' roles in the learning process. Hence, the wide practice of independent learning in schools, colleges and universities took shape.

Autonomous learning, according to Jackins (1965), " implies a responsiveness to one's environment and the ability to make creative and unique responses to situations as they arise rather than patterned and stereotypical responses from one's past."

An autonomous learner, according to Cornwall (1981), "is one that has attained an ability to use a wide variety of ways of learning."

Knowles (1970) emphasised that education should be perceived as a life long process so that students should not be taught what they ought to know but rather how to keep finding out.

This is important because it has been found that many graduates of our higher institutions of learning are ill prepared to face the challenges of life. As Thompson (1984) rightly observed, these graduates acquire knowledge but they are not equipped to use the knowledge in ways which are relevant to the world outside the educational system.

Chickering (1988) emphasised that if the universities can create conditions where issues of humanitarian concern, interpersonal relationships and interdependence are confronted then they will be helping the students to move towards principled autonomy, integrity and personal commitment and therefore enhancing their ability to cope with life cycle issues.

Hill (1976) stated that " one of the aims of a university education is to help a student to learn not only while he is engaged in courses of higher education but also to help him to continue to learn throughout life."

Cornwall (1981) added that in order to achieve this aim, independent learning in higher education attempts to remove or at least reduce the mediation of the teacher between the learner and the real world of unformulated problems, non - pre-digested information, personal decision making and valued judgements.

Even though there is the need to promote independent learning in students, Cornwall (1981) pointed out that there is no blueprint for promoting it because of the large number of varieties of educational environments and the degrees of independence. He, however, emphasised that there is the need for careful preparation and induction of both students and teachers and also careful quality control or evaluation of the process and the outcome of the course.

According to Powell (1981), "constant intrusions into the learning space by the traditional teaching methods inhibit growth towards independence." Potts (1981) also argued that "students need a protected private space to think for themselves."

Teachers should therefore be willing to make fewer choices, decisions, plans, judgements and assessment in order to create opportunities for students to make more of the choices, decisions, plans, judgements and assessments themselves.

Powell (1981) stated that "lack of confidence, inability to respond constructively to criticism from others, and unrealistic appraisals of their own abilities and intellectual products often combine to lock students into endless fealty to their teachers." He added that students need to be progressively encouraged to move forward as they gain an increasing trust in their own judgements and abilities. He stressed that there is the need to introduce teaching and assessment practices that seek to foster autonomy.

Powell also stressed that because an independent learner is subject to unending further development and refinement, the teacher's work is guided by the fact that he has to share his intellectual interest and skills and encourage the student to develop these further so that they eventually transcend contemporary academic achievement.

Independent learning is important to the society in which the student plays a part, because as Powell rightly observed, "a society is valued in which people are able to think and act independently, to exercise freedom of choice after rational reflection and can conduct their own lives without having their own minds made up by others." He therefore stressed that independent learning must be viewed as part of a much broader social movement which respects the values of both individuality and community.

He quoted Voltaire as saying that, "without our own distinctive individual contributions there will be nothing worthwhile to share."

Despite the apparent need for independent learning, many higher institutions display only a weak commitment to this. Much of the teaching is not designed to promote independence of mind. Some students from these institutions after graduation are often ill - prepared to operate beyond the familiar confines of textbooks and laboratory manuals.

### 2.1.2 ARGUMENTS AGAINST INDEPENDENT OR AUTONOMOUS LEARNING

Cornwall (1981) presented eight arguments against independent learning based on actual conversations and discussions, and also gave their counter arguments. They are :-

(1) ***Left to themselves students will work at a low level and the standard will fall.*** The response to this statement is that there is much evidence to suggest that the level and standard of work is more often higher in independent study than we would expect from students on conventional courses at comparable stages. The outcome of independent learning is judged at least as much in terms of the acquisition of skills and abilities as of acquisition of factual knowledge.The ability to reproduce a given content area might decline but this is compensated for by an improvement in other abilities of a much longer term: for example, the ability to plan and manage one's own learning. The student is not left alone, as the teacher acts as a resource and counsellor who helps the student towards reaching his goal in his own way.

(2) ***Students are not capable of working independently.*** The response to this is that to expect students to have the skills to operate successfully in the very early stages of independent learning is unrealistic. They will need to be encouraged into it and others restrained from rushing headlong. All will need help in developing their skills over time. Students of an overprotective teacher will not learn to be independent learners.

(3) ***It is more efficient and much quicker to use teacher directed learning than to allow students to find out things for themselves***. The response is that if the formulation of problems, the development of approaches to learning and of research techniques, and several other intellectual skills are considered to be at least as important as the acquisition of a body of knowledge, then it will not be time wasted. Also as the student uses a wide

range of media, he is likely to explore well beyond the scope of what any individual teacher might reasonably be expected to offer.

( 4) ***In a highly structured subject it is essential that students be given a firm foundation of basic facts on which they can build.*** The response is that the students have acquired some basic materials through their school courses and therefore it is expected that they have reached a point where they might become independent learners. As with the research student, where the hierarchical and lateral connections become apparent through his research activity, so that the relevant map of knowledge is brought vividly to his attention, so it is with the learner at any other level of higher education. There is no uniquely definable predetermined body of knowledge which is necessarily a prerequisite for any independent study. It is possible to add pieces in almost any order as long as they interconnect in some way, and form a pattern which makes sense to the learner. There is support for this model from the works of Piaget and Bruner (1996), Norman (1973), Lindsay and Norman (1977) and Rumelhart (1977).

(5) ***Students don't know what they ought to study.*** The response is that a student does not have to have a superior knowledge of a subject before he/she can see what knowledge is appropriate for him/her to acquire at each stage.

(6) ***Most students prefer to be taught.*** Preference implies choice and choice is only real when,firstly, one is aware and has some experience of the alternatives and, secondly, when the opportunity to choose is actually offered.

(7) ***You can't properly assess flexibility, adaptability and other such qualities***. This does not prevent the structuring of courses in such a way as to develop other skills and abilities that are considered important for higher education because there are approaches where these skills can effectively be promoted more than others.The other skills can be taken care of with time.

(8) ***The teacher's knowledge and expertise would not be properly used. Most teachers would not be able to work in this way.*** The independent learner is likely to recognise and value highly the expert guidance which the teacher can provide in helping him with his learning difficulties. Instead of the teacher being an expert interpreter and dispenser of specialist knowledge, the teacher becomes a guide to resources, and a consultant. Instead of being an overseer of the progress of students through a prescribed syllabus, he becomes a guide and an adviser on their learning problems as they develop an increasing degree of self direction. The provision of advice, guidance and frequently direct assistance is crucial to the development of autonomy in learning. Staff retraining and development, learning on the job, are some of the ways in which teachers can possess the skills appropriate for this non - didactic role.

Boud (1981) noted that one of the difficulties in discussing the field of autonomy in learning is the relative lack of conceptual and empirical research. Wedemey (1971) pointed out that "the literature describing independent study is almost uniformly parochial. And compared to other literature on classroom research and educational testings, the area is almost completely neglected."

### 2.1.3 TYPES OF AUTONOMOUS OR INDEPENDENT LEARNING

The different types of independent learning include : - (1) **Contract learning** - According to Buzzell *et al.* (1981), this is a document drawn up by the student and his instructor or advisor which specifies what the student will learn and how this will be accomplished, within what period of time and what the criteria of evaluation would be. She went on to stress that both the student and the teacher see each other as learners valuing each other's knowledge and experience. The student determines the nature, content and scheduling of meetings; the teacher acts as a resource person and learning facilitator.

(2) **Resource Based learning** - Noble (1980) defines this as a type of learning where the information needed by the students is put into learning materials and then organised access to knowledge stored in visuals, writing or in recorded sound is available. Noble added that in this type of learning the students are given direct access to stored knowledge. Teachers take the role more as consultants and tutors.

(3) **Individualised learning** - Bruner (1971) has argued in favour of an individual approach to learning. To him, "learning is an individual thing, no matter how many pupils there are to a teacher." Abdullahi (1982) defines individualised learning as "one in which the learning materials are selected or determined only by the learner. Abdullahi explained that the learning programmes are essentially information presented in carefully structured steps and the pace of learning or steps depend on the individual student and the nature of the material to be learned". The learner's progress is consistently guided through the evidence of his performance. Immediate knowledge of results is generally acknowledged as an important factor in efficient instruction, thus making the learner take an active part in learning .

(4) **Problem-based learning** - According to the British Medical Council's publication "Tomorrow's Doctors" (1995), problem based learning is aimed at optimising learning by helping students to activate relevant prior knowledge, providing a context that resembles the future professional context as closely as possible and stimulates students to elaborate on their knowledge.

According to Camp (1996), problem-based learning is most widely used in many universities all over the world, especially in their Medical Schools.

### 2.1.4 THE CHARACTERISTICS OF PROBLEM - BASED LEARNING

Walton *et al.* (1989) enumerated the characteristics of problem based-learning to include:-

(1) The curricular organisation is structured around problems rather than disciplines. The

curriculum is an integrated one rather than one that is separated into different units. (2) Conditions which facilitate problem based learning include; small group tutorial instruction, student centred instruction, active learning, independent study, simulation and focusing on relevant and high priority community oriented issues.

(3) Outcomes which are facilitated by problem based learning include : - (a) Enhancing functional knowledge, development of self directed skills and motivation required for a capacity for continued learning and the development of self assessment. With regards to motivation, Camp (1996) pointed out that "the students find the environment more stimulating and humane". (b) Walton *et al.* (1989) state that "problem based learning brings real improvements in student perception and values and establishes excellence in patterns of professional behaviour and speeding up the acquisition of good judgement".

(c) According to Bligh (1996), the preliminary discussion in small groups, the contextual learning integration of knowledge and an emphasis on problems have several cognitive effects, on learning : for example, increased retention of knowledge and enhancement of integration of basic science concepts.

(d) Camp (1996) stated that "the success of problem based learning in settings sufficiently different from each other have given some confidence that it could be applied universally."

(e) Camp (1996) again stated that "problem based learning fits the tenets of adult theory, that is, increasing student autonomy by being able to build on previous knowledge and experiences and being able to apply the knowledge learned." She continued that this strategy enabled the students to make appropriate use of what they have learned. From the publication of "Tomorrow's Doctors" (1995) it was stated that, in the medical field, the students taught by traditional methods are unable to perform various standard practical procedure despite detailed knowledge. Camp (1996) also noted that problem based learning students are better able to transfer concepts to new problems.

(f) Camp (1996) explained that problem based learning harnesses the reality of learning; that is, finding knowledge for oneself, contrasting one's understanding of that knowledge, with other understanding and refining or structuring as more relevant experience is gained.

(g) Walton *et al.* (1989) concluded that main advantage of problem based learning is the creation of a pattern of life - long learning without which there is no possibility of keeping in step with current knowledge and good practice. He added that it is the only known method for preparing future professionals to be able to adapt to change, learning how to reason critically, for enabling a holistic approach to any profession,and also for attaining integrated cumulative learning.

### 2.1.5 EMPIRICAL EVIDENCE

Rolfe *et al.* (1995) assessed the clinical competence of medical graduates one year after qualification in a study based in New South Wales - Australia, using a clinical supervisor's form addressing 13 competencies.

The data from 485 interns (which gave a 97.2 % return), showed that graduates from 'problem based' medical schools, for example, Newcastle in Australia, were rated better than their peers with respect to their interpersonal relationships, reliability and self directed learning. Interns from one of the two 'traditional' New South Wales medical schools had higher ratings on teaching diagnostic skills and understanding of basic mechanisms.

Rolfe *et al.* (1995) noted that the rating scales could be subject to problems of leniency bias, whereby examiners tended to inflate the rating. Or the scales could be subject to geographical rater bias where the supervisors from a university rate students from their university more highly than others. Rolfe *et al.* however noted that the consistency of the findings with earlier data on Newcastle interns was impressive.

## 2.2 AUTONOMOUS LEARNING AND TEACHING STRATEGIES

### 2.2.1 INTRODUCTION

Autonomy as described by Holec (1981) "is the ability to take charge of one's learning". Benson (1997) stated that autonomy could also be referred to as a "set of skills which can be learned and applied in self directing learning; the exercise of learner's responsibility for their own learning and also the right of the learners to determine their own learning".

The greatest hope of autonomous learning is that it might lead students to greater independence. According to Bridge (1977), this "involves individual study in various ways in which students are given freedom to study and corresponding responsibility for their learning".

It is crucial in this type of learning that the students feel that they have studied in their own way.

Frazer *et al.* (1979) explained that learning is at maximum when the individual is actively involved in the learning process and emphasised that a condition necessary for becoming so involved is freedom - freedom to choose how to learn, freedom from the fear of failing to learn and to some extent freedom to choose what to learn.

Universities attempt to provide this freedom : as Hale *et al.* (1964) rightly observed, the function of a university education is not simply to equip the student with expert knowledge but also and even more importantly, to teach him to think for himself, to work on his own, and thus achieve a decisive stage on his journey to maturity.

Hale stressed that for the undergraduate student, it is not the latest development or the acquisition of a corpus of knowledge that is most valuable, but the development of a mind that is important. He concluded that undergraduate teaching should be student - centred.

Natheson (1980) recognised that every individual learner is different in his needs and abilities and he can therefore learn more effectively as an individual than in a group. He quoted Bruner as saying that there is the need to develop in students the ability to use intelligently the wide range of knowledge sources available.

Students entering science courses vary considerably in both their motivation and approach to study (Partlett 1970; Entwistle and Wilson 1977) and these differences are reflected in the way in which they learn within the instructional context.

Researchers (e.g. Marton and Saljo, 1976; Biggs, 1982) have investigated ways in which students can be encouraged to engage in more meaningful learning and focused on how student approaches influence the quality of their learning. Some students set out to understand any new material which they then actively relate to their previous knowledge and experience ( the *transformational* approach ), while others do not make the same effort to understand any new material and simply comply with the course requirement in a fairly routine way ( the *reproductive* approach). The latter results in information remaining disjointed and unrelated. Marton and Saljo (1976) identified these approaches as 'deep'and 'surface' respectively.

Research into the constancy of student approaches has produced contradictory results. Some students are always transformational (Svensson, 1977) while others adopt an approach according to the demands of the learning situation : for example, some students used the reproductive approach when preparing for objective type tests and more of a transformational approach when preparing for an essay test (Ramsden, 1984; Laurillard, 1987).

Students will also adopt the reproductive approach to their learning if an instructional method is perceived as being threatening, uninteresting, irrelevant, or if their workload is perceived as being too high or they are unsure of what is expected of them, in for example, an assessment procedure (Broadbent, 1975; Ramsden, 1984; Saljo, 1982 ).

If students are to undertake an active and meaningful approach to their learning then they should be provided with both an appropriate environment and adequate support in order that they might be encouraged to undertake that type of learning (Rogers, 1979; Biggs, 1982; Finster, 1991).

The level of active involvement by students in their learning affects the level of thinking they attain and the way any new material is stored and its subsequent retrieval (Bligh, 1986; Tobin *et al.* 1988).

A student might not become actively involved in his/her learning and may not become an autonomous learner if his lecturer seems unapproachable or distant (Boud, 1988; Powell, 1988).

It has been shown that many students entering universities are deficient in some of the skills required for engaging in autonomous study (Thomas *et al.* 1991). A supportive learning environment would appear to be of even greater importance if the students are to be expected to undertake any form of independent learning.

A number of teaching methods have been identified which encourage students to develop more meaningful approaches to their learning. Those relevant to this study include the tutorial, laboratory and project methods.

The way in which a course is taught is influential in determining the level of approach adopted by a student (Biggs, 1982; Constable and Long, 1992). However, whatever strategy is used, students will be more likely to adopt a transformational approach to their learning if they are interested in the subject area, perceive the work as relevant ( Johnstone *et al.* 1981), or feel stimulated by the content (Biggs, 1982).

The responsibility is often placed on the lecturer to encourage students to develop their own independent understanding of a subject. Even though it is possible to evoke transformational approaches in students in a traditional approaches lecture format

(Hodgson, 1984), many innovative methods of teaching involve lecturers taking up a new role, such as that of a facilitator of learning within the instructional context. Entwistle and Ramsden (1983 ) have shown that students greatly value freedom given in learning and 'good teaching'.

How then could the laboratory, tutorial and project methods of teaching encourage the student to become autonomous in his/ her learning?

### 2.2.2 THE LABORATORY METHOD

The laboratory method is an activity carried out by an individual or a group for the purpose of making personal observations of processes, products or events (Abdullahi, 1982).

The aims of the laboratory, according to Boud *et al.* (1986) include the development of skills : for example, manipulative, observational and mental. Laboratories also improve students' understanding of concepts : that is, they give ideas a certain reality, thereby leading to better retention of information. Finally, they aid student understanding of the processes of scientific inquiry : that is, learning how to inquire (Black, 1979).

Laboratories foster understanding and development of a scientific attitude : for example, creativity, honesty, open - mindedness and so on. They also foster a sense of success and motivation.

Laboratories have considerable potential for innovation by the students because they provide an opportunity for the students to devise their own experiments.

Boud (1986) explained that laboratory activity can be classified into three main types depending on their purpose and the degree of detailed control exercised by the staff. These are :

(a) Controlled Exercises - These are activities which are wholly devised by the staff and can be completed by the students in one or two laboratory periods these involve students carrying out an activity and writing out a report. One advantage of this exercise is that students can concentrate on one specific aspect rather than undertake a more complex experiment where the concepts can be obscured by detailed or confusing overlap. These exercises can be conducted in a short period of time and several may be carried out in a single three - hour laboratory period . These encourage the development of fundamental skills and techniques.

(b) Experimental investigations - they are for longer activities which include an element of choice of procedure and methods of data analysis by the students. They can extend over several periods. They are well suited to the development of investigative skills.

(c) Research projects - these are significant pieces of work that may occupy the practical sessions for a term, semester or even longer. A problem is defined by staff or a research group. It is selected by the students. Manual and inquiry skills are integrated.

Abdullahi (1982) gave general guidelines for use of the laboratory methods and included : (1) The procedure for any investigation should be clear and simple. (2) The student should be able to complete his work within the time allotted. (3) The materials and equipment needed by the students should be familiar to them. (4) Laboratory exercises should be based on the students' background, availability of materials and equipment needed for successful completion of the exercise. (5) Since one of the objectives of laboratories is to give the students an opportunity to learn for themselves, the teachers' role should be that of clarifying procedure, giving encouragement and straightening out ambiguous instructions.

For the development of autonomy in the students, the laboratories should encourage students to find out things for themselves, think for themselves and also see themselves as scientists. The tasks given to the students should not be too trivial or overwhelming.

The problems of laboratories include the difficulties of designing and conducting good practical in the time available and with limited resources.

Although laboratory work can encourage autonomous learning, poorly designed laboratory work can have serious deficiencies : for example, the development of problem - solving skills as compared to manipulative skills ( Osborne, 1976; Boud, 1980); lack of clarity of purpose in the laboratories (Moriera, 1980).

### 2.2.3 THE TUTORIAL METHOD

The tutorial method is a process where problems may be eased, where confusion can be turned into understanding, so that learning becomes satisfying. (Ogborn, 1977).

Ogborn (1977) pointed out that the aims of the tutorial include helping students in dealing with difficulties from lectures, talking through important ideas, working on particular skills including those involved in studying effectively. Hence tutorials could have a special role in discussing essays, examination answers and practicals.

Eckstein (1979) explained that tutorials are suitable for accompanying a course of lectures to give an opportunity for students to clarify uncomprehended points left over from the lectures.

Dealing with special problems and difficulties is the main and often the only acknowledged purpose of the tutorials (Ogborn, 1977). A tutorial is a student centred activity. Hence the lecturer acts as a facilitator. His total involvement, knowledge and skills are important in increasing the independence and self instruction of the learner.

Students arrive at a greater maturity and independence by being able to work out how they are progressing. This is possible because they become clear about their own qualities, standing and wishes.

Much science teaching is aimed at ensuring that all students become independent learners. Tutorials serve the same end by clearing up difficulties that they might have during lectures.

They also serve as an opportunity to develop individual interests and strengths, for example, essay writing.

Student feedback from a tutorial, according to Ogborn (1977), comes during or soon after the tutorial session : for example, feedback in the form of information the students actually ask for, or feedback on points the students had not realised the need for if left to themselves: for example, points on which they were subtly confused without knowing it.

Problems of tutorials include the problem of finding the right focus for discussion because the students may not have put their minds to the particular topic of discussion by the time of the tutorial. There is also the problem of finding a consistent level of discussion, for example getting the shy students to talk and preventing the discussion from being monopolised by the more talkative students.

Parker (1974) pointed out another problem of tutorials and that is that during tutorial sessions, discussions may be transformed either into lectures delivered to small groups or into unorganised talks without structure and without any definite direction. He emphasised that such classes defeat their own purpose and end up exactly where they started.

McNally (1979) also pointed out that students especially in the first year of university are shy about speaking out in large group tutorials. He explained further that sometimes they are shy and finds the lecturer quite a remote person and the student is not sure how to interest the lecturer in him. It is therefore left to the lecturer to build bridges but it is up to the students to cross them.

McNally (1979) explained that at times students are not willing to expose their weakness readily even in a small group; they worry that the difficulties they find may appear to be criticism of the lecturer concerned.

Hale (1964) further explained that it is often said that first year students are too ignorant of their subject to take any effective part in discussion and hence they are unresponsive. He emphasised that because they are being unresponsive does not mean that they do not need tutorials: rather it is a sign that they do indeed need them. As to ignorance, he recognised that no student should come to a tutorial session unprepared. The student may fail to benefit unless he knows something about the topic to be discussed.

A tutorial, therefore, is not a teacher dominated activity but is rather a conversation in which the students air their ideas freely and openly. It should not be a series of teacher questions and student answers. During the tutorial session, the teacher leads and guides by an occasional remark or a redirecting question.

### 2.2.4 THE PROJECT METHOD

According to Adderley (1975), a project is a practical unit of activity having educational value and aimed at one or more definite goals of understanding; it involves investigation and solution of problems and frequently the use and manipulation of physical materials.

Dowdeswell (1979) explained that a project is a student oriented activity that involves initiative and decision making by the student. He added that a project calls for certain behavioural attributes in students such as creativity, enterprise, persistence and dedication. Therefore it is a means of generating certain attitudes and of acquiring and practising new skills.

Adderley (1975) also notes that a project makes the student become responsible for his learning and enables him to combine knowledge from different disciplinary traditions. Projects also enable the student to look deep into a field of knowledge and offer considerable flexibility by enabling the student to recognise his interest and personal motivation.

Dowdeswell (1979) explained that in a project, the students are able to exploit and develop their own strengths while becoming aware of their own limitations; they become better equipped to face the challenges of professional life; because as the student assumes a greater responsibility for his learning, he can feel the maximum of involvement.

The teacher's role therefore is stimulatory and advisory and setting learning situations in which the learner can teach himself. Adderley (1975) stated that " a project grants a higher degree of autonomy to the learner than many traditional methods, a responsibility which the adult learner seems well equipped to carry".

Hence the demand for a higher degree of student autonomy in the choice of learning method and even the course content is uniquely answered by the project method.

Adderley quoted Meller (1962) as saying that "as passive recipient of lectures, the student may never think his way through the organising principles of his subject and as such a student may never be able to apply the result of his study in meaningful circumstances". In a project, however, the task of critical selection and evaluation of material is tackled by the student himself.

The degree of success in a project depends on the experience of the students, the nature of the topic, the time and the facilities available, the cost and the knowledge of the supervisor.

The main problems of projects are the conflicting requirements of assessment: an unanswered question has always been whether a project should be regarded primarily as a contribution to student assessment or as a means of teaching and learning, or as a mixture of both (Dowdeswell, 1979).

With respect to assessment, Dowdeswell (1979) explained that to him, the essence of any good assessment scheme is that it should be seen to be just by both students and staff alike; it should be closely related to the course objectives, provide appropriate incentives and be sufficiently sensitive to discern the differences in attainment between one student and another.

## 2.3 AUTONOMY AND THE PERRY MODEL

### 2.3.1 INTRODUCTION

A substantial increase in the amount of attention given to teaching and learning in Higher Education has been seen in the last decade. There have been many accounts of innovations in teaching and a smaller, but growing number of reports on student learning and how it can be facilitated (Boud, 1981).

Boud (1981) explained that "the approaches of the behaviourist psychologists are no longer in vogue as it has become legitimate to look at teacher and student intentions as well as the ways in which their reactions can be observed by others".

Boud (1981) noted that autonomy, in common with many educational concepts, is not always immediately apparent and has to be inferred from reports from individuals and analyses of their actions.

There is research work that now offers insights which are of direct relevance to teachers who wish to plan courses which pursue autonomous learning. This work has identified various developmental stages which learners must pass through from childhood to maturity and on the smaller scale from ignorance to expertise in a particular area of learning. This progression can also be seen as being from an absolute or simplistic stance on the nature of knowledge (that is, where the student believes that only right and wrong answers exist and that all knowledge is known), to one which is more pluralistic and contextual ( that is, where the student believes that all knowledge is complex and right and wrong answers exist only within specified context) ( Boud, 1981; Harvey, 1994 ).

If teachers want to develop autonomy in their students, a logical starting point is to examine how students develop through the college years.

### 2.3.2 THE PERRY MODEL

Perry ( 1970 ) and his colleagues undertook a major study of forms of Intellectual and Ethical Development in the college years.

From a series of intensive interviews with undergraduate students at Harvard University he identified a sequence he termed 'positions' which represent ways in which students view themselves and their learning, or, according to Harvey ( 1994 ), they revealed a continuum of developmental stages characterised by different ways of thinking and behavioural patterns.

According to Knefelkamp ( 1980 ), the original scheme reveals a series of nine stages through which a student passes while at college. These are : -

**Position 1** : The world is seen in dualistic terms of good or bad, right or wrong exist to every problem in the absolute. It is the authority's role to teach the 'right answers' to students. 'Rightness' in exams is assessed by quantitative measures.

**Position 2** : The student perceives diversity of opinion and uncertainty and accounts for them as unwarranted confusion created by poorly qualified authorities who set exercises so students can learn to find the answers for themselves.

**Position 3** : The student accepts diversity and uncertainty as legitimate but still temporary in areas where authority 'hasn't found the answer yet'. He remain puzzled by the assessment standards.

**Position 4a** : The student perceives diversity and uncertainty to be extensive but considered legitimate; everyone has the right to one's own opinion - but authority still operates in a right / wrong system.

**Position 4b** : The student recognises qualitative contextual relativistic reasoning but as a requirement of Authority to give them 'what they want' and to 'think how they want'.

**Position 5** : The student perceives all knowledge and values as contextual and relativistic, however a right/wrong value system can still operate within certain contexts.

**Position 6** : The necessity for making some form of commitment within a relativistic world is recognised .

**Position 7** : Some form of commitment is made in an area.

**Position 8** : The implications of commitment and issues of responsibility are felt.

**Position 9** : The student experiences the affirmation of identity among multiple responsibilities and commitment is recognised as an ongoing activity through which he expresses his life style.

The first five stages are related to epistemological and intellectual development and the last four are related to ethical and moral issues (Harvey, 1994).

Perry (1970), Finster (1989) and Knefelkamp (1980) have grouped these nine stages into four for descriptive purposes.

| | | | |
|---|---|---|---|
| (a) | Dualism | - | Position 1 and 2 |
| (b) | Multiplism | - | Position 3 and 4 |
| (c) | Relativism | - | Position 5 and 6 |
| (d) | Commitment in Relativism | - | Position 7 to 9 |

Baxter - Margolda and Porterfield (1985) combined the dualism and multiplism together and describe the scheme in total as three stages, which are : - (a) Dualism, (b) Relativism and (c) Commitment in Relativism. These differences might be related to the anticipated usage of the scheme.

These transitions do not reflect a smooth uninterrupted path from simplicity to sophistication. Perry (1970) described three transitional stages.

(a) Temporising (delay) - This is when the student delays in some position for a year exploring its implication or explicitly hesitating to take the next step.

(b) Escape (deflection) - This is between multiplism and relativism when a student avoids making a commitment in relativism and abandons responsibilities.

(c) Retreat (regression) - This is between dualism and multiplism, by the student regressing back to dualism.

Harvey (1994) explained that changes to another stage occur gradually with individuals starting to exhibit behaviour which is characteristic of the next stage. They do not operate at the full potential of that stage, rather they exhibit some of the characteristic behaviour only. Perry (1970) and others have noted that an individual may function at one position in one academic area but at a different position in another academic area. Finster (1991) also noted that a student can function at a higher level in one context and eventually use that framework for other contexts.

According to Finster (1991), first year students are usually dualistic in thinking and are at position 2 - 3 while final year students at position 4 and above. Their lecturers are at position 6 - 9. Hence productive teaching will occur at positions 3 and 4 coupled with the appropriate support system.

Finster (1991) also described how science students respond to different aspects of the learning environment during different developmental stages, for example, the dualistic students tend to adopt passive roles in their learning, feeling that it is the responsibility of the lecturer to give them all the facts, the multiplist students look with uncertainty to the lecturers for direction towards the right answers and the relativist students tend to be more autonomous learners.

Saidla (1990) also explained that, in group exercises, dualistic students feel threatened by another students' leadership of a group and multiplist students oppose or adhere to a leader's authority, while a relativist will be more likely to look for meaning from the group experience.

Boud (1981) pointed out that these positions as described in the Perry model are manifest in the students' approach to individual subjects or topics and they also reflect a general approach to knowledge and the world. He stressed that a teacher should always have in mind that within that same class there will be students with radically different outlooks on what is taking place.

The characteristics of an autonomous learner are similar to those of a relativistic thinker of the Perry model, and these include : - (1) Wondering and asking questions with a sense of a right to ask. (2) Refusing agreement or compliance with what others put to him when this seems critically unacceptable. (3) Defining what he really wants. (4) Conceiving of goals, policies and plans of his own, independently of any pressure to do so from others. (5) Choosing amongst alternatives in ways which could exhibit that choice as a deliberate outcome of his own ideas. (6) Forming his own opinion on a variety of topics that interest him. (7) Governing his actions and attitudes in the light of the previous activities. Hence, an autonomous learner or a relativistic thinker of the Perry model has a mind of his own and acts according to it (Dearden, 1975).

### 2.3.3 THE STRENGTH OF THE MODEL

According to Knefelkamp (1980), the strength of the model lies in the fact that there are different ways that the student views knowledge and the roles of the teacher and of students. The positions are organised in such a way that each position is a necessary building block for the position to come and each one contains the qualities of the previous one. This means that students do not understand the thinking and reasoning processes of the positions above them on the hierarchy but they do understand the thinking and reasoning process that they have already gone through. Hence students thinking dualistically cannot comprehend when addressed relativistically and 'panic', while students thinking relativistically comprehend very well when addressed dualistically and get bored.

Widdick, Knefelkamp and Parker (1975) have demonstrated that teachers can differentially design the instructional process to better 'match' the students capacity to make meaning.

### 2.3.4 TRANSITIONS WITHIN THE PERRY SCHEME

Developmental growth is best fostered by an environment that couples challenges which stimulate the student to confront new ideas in new ways, to a support system that enables the student to meet the appropriate challenge. This same principle applies to movement along the Perry scheme positions (Finster,1991).

Finster emphasised that it is important to encourage the students to make transitions between the four stages. He added that the best teaching strategy for cognitive growth encourages thinking at the positions of the student and just beyond. Some students would not be challenged and others would be overwhelmed, he concluded. Harvey (1994) stated that " the causes for this cognitive disequilibration or personal decentrings can be used in some way to stimulate students changes or to speed up the progress through the scheme towards a more relativistic thinking".

Perry (1981) explained that the progression through the scheme is an innate response but requires both an interaction and support within the academic environment if a relativistic way of thinking is to be achieved and that not all students make the transition to relativism while at university. This might indicate that either students do not have 'the state of mind' that appears to accompany the transitional stages of development, or that they are not stimulated or challenged to make such a change or there is not the requirement for them to change as relativism is not rewarded.

### 2.3.5 IDENTIFYING STUDENTS' STAGES IN PERRY SCHEME

Harvey (1994) enumerated a number of methods that have been devised to be used for the identification of student stages on the Perry developmental scheme. These are :- (1) Interviews (Perry 1970; Meyer,1977; Kitchener and King, 1990; Moore, 1982 - Measure of intellectual Development [MID]; Baxter - Margolda and Porterfield, 1985), (2) Item scale ratings and descriptive score (Haffernan,1975), (3) Sentence systems and essays - KneWI scheme (Widdick, 1974; Knefelkamp, 1974), (4) Justification statements (Gibbs and Widaman, 1982), (5) Measures of text comprehension ( Ryan, 1984), (6) Defining issues test DIT (Rest, 1973), (7) Short statements in questionnaires (Kurfiss, 1977), a 119 statement scale of Intellectual Development [SID] - Erwin, 1983; Measures of epistemological Reflection [MER] - Taylor, 1983). (8) and sentence items in a questionnaire (Harvey, Hunt and Shroder,1961).

A variety of disciplines have used different measures of Perry stages on students: for example, English literature - Knefelkamp (1974) and Widdick (1977); Maths - Copes (1974); Engineering - Culver and Hackos (1981); Science - Blake (1976); Information for curriculum design.- Kovacs (1977); Student career development - Knefelkamp and Slepitza (1976).

Baxter - Margolda and Porterfield (1985) have pointed out the importance of developing a measure that would allow for a more extensive usage of the Perry scheme in practice and could therefore provide educational environments appropriate for particular classes and which in turn could promote intellectual growth.

### 2.3.6 THE RELIABILITY OF MEASURES OF INTELLECTUAL DEVELOPMENT

Harvey (1994) stated that results from a number of the above mentioned methods of measuring on the Perry scheme have been compared with degrees of validity. However, a cross validation of all the methods has not been made.

King (1978) noted that "problems have arisen in categorising students exhibiting a range of behaviours particularly when researchers are trying to discriminate between behaviours from nine different developmental positions". King added that evidence does however exist from the many studies carried out which supported the theory that, developmental changes are occurring while students are at university and these are not due to maturational changes.

Entwistle and Hounsell (1975) and Entwistle and Marton (1984) have found that ambiguities in the identification of students stages of development have led to criticisms of the Perry scheme with the argument that students will naturally adopt different strategies according to their perception and the context of the learning task rather than because of their developmental stages.

Belenkey *et al.* (1986) have criticized the model as being a description of male changes of development as the original interviews were carried out with predominantly male students. As a result Belenkey *et al.* put forward a scheme relating to women's experiences at university and others have supported their descriptions, for example, Crawford (1989) and Tedesco (1991).

Laurillard (1978) and Wilson (1981) have drawn similarities between stages in Perry schemes and domains of student development. Saljo (1982) has compared relativism and some deep approaches to students learning. Marton and Saljo (1976) have described students capabilities of handling of abstractions and level of outcome.

### 2.3.7 OTHER RESEARCHES AND PERRY

There are other developmental models which can provide similar insights, but they are not related to students as directly as Perry: for example, stages of moral development (Kohlberg, 1972); stages of ego development (Loevinger, 1976); Head and Shayer, 1980). Loevinger in particular focuses on a stage she labels as 'autonomous'. Brundage and Mackeracher (1980) have produced a synthesis of various stage models which focus more clearly on learning activities. This can be applied directly to specific courses and learning projects.

There are a number of researches that have used the Perry model as a basis for identifying and explaining various strategies which students adopt at college (Harvey, 1994). Examples of these researches are :- Baxter - Margolda and Porterfield (1985); Kitchener and King (1990); Tedesco (1991). Other theorists have developed similar cognitive models describing differing stages of epistemological development: for example, the reflective judgmental model of Kitchener and King (1990); a theory of cognitive development by Fischer (1980); stages of cue awareness by Miller and Partlett (1974); levels of didactic, multilevels modes of thinking by Riegal (1973); a non - stage model of cognitive development by Heath (1964). Finster (1991) has developed Perry's original suggestions (1970, 1981) into ideas as to how science students might be both supported within their stages of development and how they might be challenged to move to the next stage.

Widdick and Simpson (1978) and Parker and Lawson (1978) have experimented with different teaching methods. Stephenson and Hunt (1977) have carried out intervention programmes in order to encourage students to progress through the Perry scheme towards a more relativistic approach. These are studies which have investigated ways in which the different instructional methods might influence changes in student stages of intellectual development.

### 2.3.8 THE PERRY MODEL AND THIS STUDY

The Perry model provides an insight into how students perceive their education and approach their classrooms. The model identifies the ways in which students view themselves and their learning. It can therefore be used as an observational tool to identify the ways in which students think or behave.

In this study, the model will be used to measure the extent to which the student have become autonomous in their learning, and, in particular, to compare their attitudes to the 'new' and the 'old' Biology course.

### 2.3.9 SELECTION OF A METHOD OF IDENTIFYING THE STUDENTS POSITION ALONG THE PERRY SCHEME FOR THIS STUDY

Many of the methods developed to measure students' stages of intellectual development have been time consuming, subjective and limited in their usage with large numbers of students, such as structured interviews (Perry, 1970; Blake,1976; Meyer, 1977).

In this study, a structural communication grid and Perry statements were used. These were devised in 1994 by my supervisor, Prof. Johnstone (see appendix B).The statements on the grid were revised to reflect the students' views on, their role as students, the role of the teachers and their views on knowledge and examinations.

The statements were categorised according to three Perry positions namely, dualism, multiplicity and relativism.

First year students are normally found in positions 2 - 6 on the Perry model : hence the statements were designed to test the characteristics of these stages only. The six stages relate to students epistemological and intellectual development.

The Perry statements that were included in this study are those that were given to the students to agree or disagree with and justify their answer.

The grid and the statements were included as a section in the questionnaire on Biology teaching in 1994/95, while in 1995/96 only the grid was used because of time factors. This has the advantage that large numbers of students could be tested at one time and the subjectiveness of assessment was removed.

The statements in the grid were not given to the students as arranged in their distinctive categories but they were reshuffled so as not to give the students a definite pattern of arrangements that could affect their responses and thereby ensure the reliability of students responses.

## 2. 4 SUMMARY OF CHAPTER TWO

Autonomy was seen as a responsiveness to one's environment and the ability to make creative and unique responses to situation as they arise, while autonomous learning was seen as the ability to take charge of one's learning. The need to develop in the students habits of independent intellectual inquiry cannot be overemphasised. Little (1970) found that this need was rated highest by the students of the University of Melbourne. In using the laboratory method to encourage autonomous learning in the students there is the need for the laboratory activities to be meaningful and to encourage the students to think and act for themselves.

In tutorials, an atmosphere should be provided whereby problems or difficulties that students encountered in lectures or in any other aspects of the course are eased so that learning becomes satisfying, thereby achieving a greater degree of independence.

In project methods, learning situations should be provided to students where they can teach themselves. The students should assume a greater responsibility for their learning and should be able to feel the maximum of involvement.

An autonomous learner and a relativistic thinker of the Perry model exhibit a mind of their own and act according to it. Therefore the Perry model is used as an observational tool to identify the ways in which students think and behave.

# CHAPTER 3

# METHODOLOGY

## 3.1 INTRODUCTION

The research is concerned with the examination of the extent to which the changes made in the first year biology course affected the students' attitudes to the way they learn and also the extent to which the teaching strategies used, viz.; laboratory, tutorials and project, encouraged the students to become autonomous.

This chapter describes the population and procedures which were adopted in gathering relevant data for this study. The specific purposes served are as follows : -

(a) To describe the target population and the sample.

(b) To describe the instrument used in the study and the data collecting procedure.

(c) To describe the reliability and the validity of the instrument used.

(d) To describe the pilot study.

(e) To present an overview of the statistical procedure employed for analysing the data.

## 3.2 THE TARGET POPULATION

The population for this study consisted of first year (level one) biology students of Glasgow University. These students are drawn into the course from the Faculties of Science, Arts and Social Sciences but predominantly Science. They come into the course with various backgrounds such as different entry qualifications and previous experience; some had no previous knowledge of biology.

Two groups were involved in the study : - (a) The first year biology students of the 1994/95 session when changes in the course had not yet been made. (b) The first year biology students of 1995/96 session, when major changes in the course had been made.

### 3.2.1 THE SAMPLE

The sample consisted of five hundred (500) students drawn from each of the groups. Class size in each case was 700 plus but in 1994/95, a group of 100 students was used to test out the questions that were to be used. Since the students had been exposed to the questions already, these students were excluded from the final version of the questionnaire. A similar number was sampled in the second year. These supplied information on their backgrounds, the course in general, assessment, assignment, project, tutorials, laboratory and lectures by means of responses to questionnaires.

After the administration of the questionnaire, the actual sample size became 491 for the 1994/95 group and 495 for the 1995/96 group. The shortfall was as a result of the failure to fill the questionnaire by some students. This high percentage of return was achieved because permission was negotiated with class tutors to administer the questionnaires during the laboratory classes.

The sample was selected during the laboratory periods as these times were most convenient for the administration of the questionnaires since all the students were together. Each lab session consisted of about 100 students, hence for each lab session 100 questionnaires were distributed and collected. The students attendance was not grouped according to other science courses they were taking, so that the possibility sampling bias was ruled out. The first 500 students were taken to be the sample.

### 3.3 THE INSTRUMENT

The instrument used to gather the relevant data for this study was the questionnaire.

There were two major parts in the questionnaire.These were : -

(a) Part 1 : This part sought information about the nature and the characteristics of the students: that is, their highest previous qualification, age, gender, and their intended course for further studies.

(b) Part 2 : This is the analytical part of the questionnaire, concerned mainly with measurement. This is the section that provided the relevant information needed for the study. This information relates to the attitudes of the students.

For the 1994/95 session, the first questionnaire to be given to the students was on laboratory work. The analytic part of this questionnaire was divided into three parts. Part B was on laboratory work in general, Part C was on the comparison between a less investigative laboratory and a more investigative laboratory. Part D was on any general comments the students might have on the laboratory work.

The second questionnaire was on the biology course in general: the analytical section was divided into two parts, parts B and C. Part B was sub-divided into three sections. Section I was on the course in general; section II was on the assessment procedures and section III was on tutorials. Part C was on the Perry model. In addition, a space was provided for the students to make any general comments that they might have on the biology course in general.

For the 1995/96 session, the analytical part of the questionnaire consisted of the following parts : - Part B, section I, was on the biology course in general; section II was on assessment procedures and section III was on the study project on AIDS. Part C was on the Perry model. Part D was on a comparison of two lectures. Part E was on the laboratory work in general. Part F was on a comparison between a less investigative laboratory session and a more investigative laboratory session. Part G, section I, was on the tutorials and section II was on the assignments. Finally, Part H was on any general comments the students might have on any aspect of the course.

Since all the questionnaires were intended to identify the attitudes of students to the biology course, a rating scale was used called the Likert scale ( Olomolaiye,1986). The technique consisted of a body of items given to the students. They were requested to indicate the degree of their agreement or disagreement with each statement on a five point scale. The five degrees of agreement are : - Strongly agree, Agree, Neutral, Disagree and Strongly disagree. Agreeing with the statement indicated a positive attitude and vice versa. Hence a high score will indicate a positive attitude. The following scoring guide was applicable to all the items : - Strongly agree = 5, Agree = 4, Neutral = 3, Disagree = 2, Strongly Disagree = 1.

One obvious advantage of the Likert scale as with any other rating scale is that it directs observation towards specific and clearly defined aspects of behaviour and also it provides a common frame of reference for comparing individuals.

**3.4 DATA COLLECTING PROCEDURE.**

The research commenced with a pilot study in which various aspects of the course were observed and some of the questions to be asked were tested before the actual administration of the questionnaires. After the pilot study, two sets of questionnaires were then administered to the 1994/95 group. The first was the one on the laboratory work which was administered at the end of the second term and this was followed by a second one on the biology course in general, tutorials, and assessment procedures which was administered in term three at the end of the session giving a space of two months between the first administration and the second. The administration of the questionnaire during the second term was necessary because of the pressure on the students at the time. It is not expected that this will affect the results when compared with that of 1995/96 because the students had covered more than half of the coursework and were therefore in a position to know whether the labwork had encouraged them to become autonomous in their learning.

For the 1995/96 session, one set of questionnaires was administered to the group. These questionnaires were administered during the third term: that is, towards the end of the session.

During the administration of the final questionnaires, students were given 15 - 20 minutes to complete the questionnaires in 1994/95. In 1995/96 they were given 20 minutes. There was a real concern to keep the number of questions reasonably short because of possible unreliability resulting from boredom of students when completing long questionnaires. Also before the start of each exercise, the students were acquainted with the purpose and importance of the research by the tutor in charge of each laboratory and they were encouraged to answer the questions fully and correctly. Table 1 gives a summary of the returns.

**TABLE 1**

**SUMMARY OF RETURNS**

| **THE QUESTIONNAIRES** | **No of questionnaires given** | **No of questionnaires returned** | **Percentage returned** |
|---|---|---|---|
| 1994/95 session Laboratory work | 500 | 398 | 79.6 |
| 1994/95 session Biology Teaching in general | 500 | 491 | 98.2 |
| 1995/96 session | 500 | 495 | 99.0 |

## 3.5 RELIABILITY AND VALIDITY OF THE INSTRUMENT

Reliability refers to the attribute of consistency of the instrument and validity tell us whether the instrument measures what it is supposed to measure. In order to ensure the validity and the reliability of the instrument used in this study the following procedures were adopted.

(a) Some of the test items were subjected to a test during the pilot study.

(b) The test items were submitted to the scrutiny of my two supervisors who assessed them on factors of relevance and suitability. Then items that were not valid were reconstructed and new ones were added to obtain the final instrument.

(c) Some of the test items were also stated in pairs in the first set of questionnaires issued to the students. The pair of questions set out to measure the same opinion dimension. If these correlate well, the reliability was taken to be acceptable.

The reliability of the Likert scale, according to Oppenhein (1966), is good because of the greater range of answers permitted to respondents. He added that the reliability could be as high as 0.85 when compared with what is obtainable in other rating scales such as Thurstone. The Thurstone scale, according to Olomolaiye (1986), is known as the equal appearing interval scale; it is so called because the psychological distance between the items is deemed to be equal. It involves asking each respondent to tick each item with which he agrees. The scale value of each item indicates the strength of attitude of an agreement response to the item. Its reliability is as high as 0.61.

The Likert scale can be affected by what is generally referred to as the ' halo' effect. This points to the fact that one's objectivity in rating a person or object might be influenced by one's like or dislike for the person or object such that a liked person is rated highly while a disliked person is given a low rating. The halo effect may present a systematic bias. In this case, the 'halo' effect seems very unlikely considering the large sample size and the internal consistency of the pattern of the results obtained from the various sections of the questionnaires.

The weaknesses that are often associated with the Likert scale are that : - (a) For each respondent, the scores on the scale only have meaning relative to the scores on the distribution obtained from other respondents. The data produced are therefore best treated as ordinal. (b) The undecided score, 3, presents a problem, because this central score could reflect a lot of undecided answers or could comprise a collection of strongly for and strongly against answers. In which case it is often thought that perhaps the scale measures two different attitudes. The scores were therefore treated solely as frequencies and so there was no assumption made about their cardinal value.

### 3.6 THE PILOT STUDY

The research commenced at the beginning of the second term of the 1994/95 session with an observation of the activities within the classroom and the biology department as a whole. During the observation it became necessary to subject some of the questions I might want to ask later to a test before the actual administration of the questionnaire. This was done to check for reliability and validity of the instrument and also to acquaint me with the administration procedures, thus maximising efficiency during the final administration.

Possible difficulties that might be associated with the instrument were expected to be identified and accordingly rectified before the execution of the main study. The result of the pilot study yielded some valuable information. It clearly indicated which of the statements were useful and those that were not because of the internal consistency of the results (see table 3 ) One of the laboratory groups was used for the pilot study. This group was not included in the main study. One hundred of the questionnaires were given out to the students and sixty eight were returned. The pilot study was on the laboratory work in general. All the test items were constructed by myself in consultation with books and other relevant materials such as journals.

The results obtained from the data were expressed in terms of percentages. The opinions of the students are tabulated in table 2.

**TABLE 2**

**RESULTS OF THE PILOT STUDY ON THE LABORATORY WORK IN GENERAL (Results in percentages : n = 67 )**

| Statements | Agree | Neutral | Disagree |
|---|---|---|---|
| The demonstrators were effective | 88.2 | 11.8 | 0.0 |
| The lab enhances students initiative | 61.2 | 22.4 | 16.4 |
| The lab challenges students to find out things for themselves | 61.8 | 25.0 | 13.2 |
| The lab stimulated my data gathering skills | 53.9 | 27.7 | 18.4 |
| The lab stimulated students interest | 53.7 | 25.4 | 20.9 |
| The lab manual was clear and easy to follow | 50.8 | 23.8 | 25.4 |
| The lab adds reality to the lecture material | 46.1 | 35.4 | 18.5 |
| The lab provides the right balance with lectures | 39.8 | 30.9 | 29.4 |
| The lab leaves me unsure of what to do | 31.4 | 26.9 | 41.8 |
| The lab is confusing | 32.9 | 29.9 | 37.3 |
| The lab is boring | 25.0 | 23.5 | 51.4 |

Table 2 show the results of the students responses arranged according to their degree of agreement. The students strongly agreed that the supervisors offer effective supervision and that the labs enhance their initiative. They also agreed strongly that the labs challenged them to find out things for themselves. The students also agreed though not strongly that the labs enhanced their data gathering skills and stimulated their interest; they also agreed that the lab manual was clear and easy to follow. The students agreed weakly that the labs added reality to the lecture materials. Hale (1964) noted that labs may be quite unrelated to the topics which are being studied at the same time.

The students disagreed though not strongly that the labs were boring and disagreed weakly that the labs leave them unsure of what to do and that they are confusing. This last statement shows that some of the labs could become quite confusing to the students.

**TABLE 3**

**INTERNAL CONSISTENCY OF THE PILOT STUDY RESULTS**

| Statements | Agree | Neutral | Disagree |
|---|---|---|---|
| The lab stimulated students interest | 53.7 | 25.4 | 20.9 |
| The lab is boring | 25.0 | 23.5 | 51.4 |
| | | | |
| The lab adds reality to the lecture material | 46.1 | 35.4 | 18.5 |
| The lab provides the right balance with lectures | 39.8 | 30.9 | 29.4 |
| | | | |
| The lab leaves me unsure of what to do | 31.4 | 26.9 | 41.8 |
| The lab is confusing | 32.9 | 29.9 | 37.3 |

Table 3 show the results of paired statements from the pilot study that reveal a good level internal consistency in the students' responses. This same pattern occurred in the main study, that is, where a statement was reframed the results obtained were almost the same. Hence because of this internal consistency, the results of the pilot study were considered as reliable and all the statements in table 2 were included in the main study with the exception of the last four. The one on data gathering skills was reframed.

During the construction of the questionnaires, test items other than the ones relating directly to attitudes and autonomous learning were included in order to ensure that the organisation of the course as a whole facilitated the change in students attitudes towards autonomous learning. For example statements such as the clarity of the objectives was necessary to ensure that students knew what was expected of them so as to encourage them to work on their own. Also the unique characteristics of the various teaching strategies in encouraging autonomous learning were also considered.

This research overall measures what the students think about their level of understanding of the biology course with respect to being autonomous in their learning. However according to Dunham (1974), attitudes may influence or even determine the learning which occurs in the classroom. He explained that the learner is not merely a cognitive entity but exhibits affective states in his personality, intentions and so on which all influence his learning. He added that the learner selects from and processes the information in his environment according to his ideas, values and feelings as well as his concepts.The questionnaire is designed to respond to these ideas.

## 3.7 STATISTICAL ANALYSIS

The statistical methods used in this study include percentages, Chi square ( $X^2$ ), Bar charts. Chi square is used to test the relationship or association between two distributions. It establishes if difference between the two distributions is significant. Different groups among the students were identified for the purpose of determining possible differences between the students. These groups are : -

## 3.8 THE GROUPS OF STUDENTS IDENTIFIED FOR THE STUDY

### 3.8.1 HIGHER AND LOWER

The higher group included students who came into the biology course with higher entry qualifications such as Sixth Year Studies, Highers, Advanced levels and Higher National Certificate. The lower group included students who came into the course with lower entry qualifications such as Standard Grades, General Certificate of Secondary Education and some with no previous knowledge in biology. Hence the higher group came into the course with a more advanced knowledge of biology than the lower group and consequently they may find some of the aspects of the course repetitive and possibly boring.

### 3.8.2 MALE AND FEMALE

Research findings have shown that biology is apparently preferred more by females than males (Meyer,1963; Clarke ,1971 ). This preference is polarised when they are educated together (Ormerod, 1975). Roberts and Higgins (1992 ) showed that males are more confident than females about passing their courses.

### 3.8.3 OLDER AND YOUNGER

The older students are those whose ages are from 21 years and above, while the younger ones are those whose ages are below 21 years. The older students are far from being a homogeneous group, representing a wide range of ages, qualifications, background experiences and commitments (Johnstone,1988 ). Older students are used to controlling their environments and often feel more vulnerable in unpredictable situations than the younger students (Redmond, 1980 ). They are much more critical of what is considered to be poor lectures, seminars or tutorials than younger students (Roderick,1981 ). And they find the volume of work related to their course higher than they anticipated. According to (Roberts and Higgins 1992), older students find the first year of university more time consuming than the younger ones with more recent study experience.

### 3.8.4 INTENDING AND NON - INTENDING BIOLOGY COURSE STUDENTS

The intending biology course students are those who are anticipating specialisation in the various aspects of a biology degree programme, while the non - intending biology course students are those who do not intend to specialise or continue with any of the aspects of the biology degree programme but are studying biology as a subsidiary subject.They also are not a homogenous group: their degree intensions include physical or mathematical sciences, arts and social sciences.

# CHAPTER 4

## LEVEL 1 BIOLOGY 1994/95 SESSION

### 4.1 INTRODUCTION

This chapter presents the results regarding students' attitudes to teaching strategies aimed at encouraging them to became autonomous in their learning. The results as presented show the responses of the students to the 'old' biology course for the 1994/95 session.

As earlier stated the purpose of the research is to determine the attitudes of students towards the teaching of the first year biology course. The researcher is of the opinion that such research might provide an insight into the following : -

(a) The extent to which the teaching of the first year biology course has affected the attitudes of the students to the course.

(b) The extent to which the teaching strategies used encouraged the students to become autonomous in their learning.

The order of presentation is as follows : -

4.2 Findings from the observation of the old biology course for the 1994/95 session.

4.3 General findings from the course - Students' responses.

4.4 Examination of hypotheses.

4.5 Summary of results.

The results presented in the various tables in this chapter show only the three points of the scale, that is, agree, neutral and disagree. This is done in order to reduce the size of the tables. The letter A in the tables represents Agree - indicating, a positive attitude, and the score for A comprises the frequencies for agree and strongly agree added together. The letter N stands for the neutral point, while the letter D stands for disagree - indicating a negative attitude. The score for D comprises the frequencies for disagree and strongly disagree added together. Any results not shown in the tables are given in the Appendix A. All results are shown as percentages of the frequencies of the total numbers.

### 4.2 FINDINGS FROM THE OBSERVATION OF THE OLD BIOLOGY COURSE

**Student enrolment -** This course had a student population of 725 with about 50 lecturers, 25 demonstrators, a tutor in charge, a course co-ordinator and an assistant course co-ordinator. These figures show that the department is large. Large departments have problems of communication and information. Collecting and managing information about students is more laborious in large classes (Hale, 1964 ).

**The curriculum** - The curriculum was a broad - based foundation course. Students spend their first year following an introductory course in biology and other subjects before deciding on their subsequent choice of specialisation. The broad - based curriculum does not take into consideration individual students' interests by allowing for independent study through greater course flexibility. An advantage claimed for this kind of curriculum is that it has coherence.

**The aim of the course** - There was one broad aim for the course which was to provide a basic understanding of the principles of the biological sciences, so that by the end of the course students were expected to be able to know basic biological theories and facts, understand scientific procedures used in the biological sciences and also analyse and interpret information using a critical scientific approach. This type of aim needs to be broken down into several aims that are specific and measurable so that students know precisely what they are expected to learn. Even though each block of lectures had specific objectives to be met, some of them were not measurable: for example those of them that used words like 'know' and 'understand'. The course consisted of 20 course units to be taken in one year. The course was intended to occupy one third of a 'full - time' student's first year.

**Lecturers** - Fifty different lecturers were used in the course, each giving between 1 - 16 lectures per term. Advantages of using so many lecturers are :- (1) The variety of minds and points of view students are exposed to. (2) Each subject area is taught by a specialist who knows the field well. A disadvantage of such a large number of lecturers from different departments is the lack of management of the lecturer's time by the Biology department : there was an inability to arrange for individual contact time between staff and students because the staff contributing to the course came from many different buildings and mostly only gave a few lectures to the class. Another potential problem with having so many lecturers is the difficiency of achieving real coherence in the course.

**Lectures** - Observation of some of the lectures revealed that most of the lecturers used teaching aids so as to assist the students towards the understanding of the lectures. Most of them also gave handouts to the students. Lecturing to large classes does bring special problems of less interaction and lower feedback from the students. Hence the interaction in some of these lectures was not as effective as it could be.

**Teaching aids** - These help to focus the attention of the students as they see what the lecturer is talking about. They provide variety in teaching and help to make the subject matter more interesting. They enrich the experiences of the students by giving them the opportunity to see things which they ordinarily may not have the opportunity to see. Lecturers that use the overhead projector as their only teaching aid may make it difficult for students to follow what is happening as the lecture can be turned into a speed writing competition which does not give them time to stop and listen to what is being said.

**Learning Resources** - These are available in the self instructional laboratory for student use throughout the working week. These include; (1) 'Study aids' booklets containing useful information that introduces students to note-taking and scientific writing and helps students adjust to university - style teaching and examinations, (2) Microscope slides, electron micrographs, diagrams and notes on laboratory materials, (3) Books and articles, (4) Video cassette player with a selection of videos on a range of biological topics. All these enriched the students experience and aided their understanding of the course.

**Practicals** - The whole class was divided into 12 sections for practical work and there was a practical class each week for each student. Each lab booklet contains the syllabus for the term, laboratory schedules and a set of exercises on problem solving in biology. For each laboratory schedule there were objectives to be met by the students The laboratories offer the students a wide range of techniques : for example, demonstrations, dissections, experiments and observations. Hence the students were exposed to a wide range of techniques and materials. This ensures that each student was given an opportunity to participate effectively in these activities. Students were encouraged to work in groups or teams to benefit from the perceptions of others and from subsequent interaction and discussion. The sitting arrangement was good. Each student maintained the same seat for the term with adequate working space. Each student had some essential equipment beside him/her for example, a microscope, plain slides and cover slips and so on. A great value of practical classes is in bringing students and their teachers together for informal discussions of the subject. There was one lab leader and three demonstrators for fifty students.

The demonstrators were twenty five in all and each was assigned about 18 - 20 students which they maintained throughout the term. This was necessary so that the demonstrators would get to know the students very well. Demonstrators were postgraduate students or experienced graduates some of whom had demonstrated on the course for several years. Their functions consisted of assisting students by answering their questions, helping them with their apparatus and observations. Some of the problems they faced included dealing with the wide range of abilities of the students assigned to them, motivating them and answering questions in unfamiliar areas.

Demonstrators attended a demonstrators meeting before each new laboratory; a member of staff involved in the design of the practical outlined the contents of the practical, and any problems likely to arise. Demonstrators had a chance to try out any procedures they were unfamiliar with at the meeting.

Some of the demonstrators might require training of some sort to enable them to have more tips on explaining difficult concepts, have more technical skills and benefit from up to date modern techniques. New demonstrators might need to have their experiences monitored so as to ensure effectiveness. The training on the job was good since it is not always possible to anticipate how things will go as all students have different levels of knowledge, proficiency and commitment.

**Tutorials** - These were held once in each term, and they were mainly arranged to assist students with examination formats and practicals. Tutorials are student-centred activities where students are given the opportunity to air their views and are helped with any difficulties they might have from the lectures. Ideas are discussed and exercises on particular skills are performed. Hence tutorials have a special role in discussing essays, exams and practicals. The tutorials for the 1994/95 session were somewhat limited both in number and their scope. Because of the many possible purposes of tutorials, frequency seemed inadequate and the activities needed to become more varied so that the students could derive full benefit from them.

A **safety handbook** was made available to the students.

There were **colloquia** to which students were invited. These seminars are subject - centred compared to the tutorials which are student - centred, but they served the same purpose which is to develop student's powers of thinking as well as to teach them the subject.

**Library** - The Department had a small library for the students to use. It had copies of the recommended textbook for consultation and other relevant books and papers. Students were also encouraged to use the university's main library.

There was a **study room** with study desks and books for the students to use.

**The methods of assessment** - These include :- (1) Class examinations, (2) Degree examinations, (3) Assessment of laboratory schedules and (4) Assessment of essays.

Essays written during term time were intended to give students practice in scientific essay writing, so that their potential to write good essays in examinations could be improved. Essays were assessed and discussed in tutorials. Marks were not used for examination purposes. Only a sample of laboratory schedules was assessed. This helped students to see whether they were doing the work of the laboratory to an adequate standard. The assessments were not recorded for examination purposes, but students were not exempted from degree examinations unless they had submitted laboratory schedules for assessment.

The two class examinations in January and April ensured that students experienced progressive assessment which encouraged learning. Achievement of a satisfactory standard in the two class exams by a student could earn him/ her an exemption from the degree exams. The students that fell below that standard would sit the degree examinations. The questions in both the class and the degree exams were of the same types. The only difference was in the area of coverage. The degree exams covered the whole syllabus while the class exams were restricted to a term's work.

**Degree examination** - This was held at the end of the session. Students could be exempted from the degree examination by fulfilling the following conditions. (1) Achievement of a satisfactory standard in each of the class examinations (January and April). (2) Submission of laboratory work for assessment. (3) Presentation for assessment of one or two essays on specified topics. Class tickets are awarded to students in order to permit them sit the degree examinations. Good attendance at the laboratory and tutorials are the minimum requirements for issuing the class tickets.

The exam question format was good including application exercises with portions requiring skill and ingenuity. The questions fitted the syllabus and the exam instructions were explicit, comprehensive, clear and unambiguous. The questions were linked to a comprehensive marking scheme. The students were to answer all the questions but they had a choice within the essay question. They were given five essay titles to select one. This was good as it offers a consistent measurement of all the students who were being assessed. The students were given different kinds of questions which were intended to test different aspects of the course and different abilities. For example (1) The multiple choice questions - these were used to measure detailed factual information of the course. They provided a greater reliability than the essay questions. (2) The essay questions - these encourage the students to think for themselves, to organise and express their thoughts coherently and precisely. Only a limited section of the syllabus can be covered by these questions. (3) Short answer questions - these have the same characteristics as the essay questions. (4) 'Problem' questions relating to laboratory work - these enabled the students to demonstrate that they understood the theoretical underlying principles and to show that they are able to draw logical conclusions from the findings presented to them.

**Student feedback and evaluation processes** - These include :- (1) A termly questionnaire completed by all students : this assessed all aspects of the course. Results are made available to all contributing staff members, the management committee, the staff/student committee and the external examiner. (2) The staff/ student committee - This comprises a tutor, deputy tutor in charge, Course Administrator (Chairman), Biology class tutor and one student per laboratory class who is elected by the members of the class. The committee meets once a term. This committee is considered as a channel of communication of information between the staff and the students. At the meetings the students are encouraged to give their comments with respect to any aspect of the course. Comments such as criticisms or complaints were always welcome. Here students were given greater access to decisions which affect them. They were permitted to have some say in their education. They were given the opportunity at least of being heard whatever their views may be. This encourages learning and independence of mind to a great extent.

**Adviser of studies** - Each student was assigned to an adviser of studies who provided guidance and gives approval on choice of curriculum. The adviser of studies helps the student with all aspects of being at university and usually stays with the student through the 4 years.

**Evaluation of teaching** - This was made on the basis of the student questionnaire returns, staff/student committee, individual contributing staff members and the management committee who evaluate it annually.

The students' questionnaire included items such as; information about the student such as his age, year of study, highest previously attained biology qualification and intention for further study. Also students views on textbooks, demonstrators, general organisation of the course, interest in biology, amount of continuous assessment and the workload compared to other courses were sought for. Lecturer's presentations and the content presented were all assessed by the students. This evaluation improves the teaching thereby making learning more pleasurable for the students

The **recommended text** - was Neil Campbell's Biology, third edition, which was published in 1993. The text was chosen by the staff after an evaluation of several other texts. Other books are recommended by lecturers during the session.

## 4.3 GENERAL FINDINGS FROM THE COURSE

The results in tables 4 - 10 are presented in rank order of the highest percentage of agreement and disagreement of student responses. The word 'agree' in the tables indicates statements with which the students agree and the word 'disagree' indicates the statements with which the students disagree on the basis of the balance of percentages in the A and D columns, and irrespective of percentages in the N column.

### 4.3.1 THE BIOLOGY COURSE IN GENERAL

For the course in general, questions 1 - 12 of Part B section 1 of the questionnaire on biology teaching were used (see Appendix A). Respondents' opinions are shown in table 4. The sample size (N) was 491 for tables 4, 5 and 7 while tables 6, 8 and 9 had a sample size of 398. The responses are expressed as percentages.

## TABLE 4

## STUDENTS RESPONSES TO THE BIOLOGY COURSE IN GENERAL

| **STRONGLY AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. I learnt a great deal of factual material from this course | 80.7 | 15.1 | 4.3 |
| 2. Overall I will rate the biology course as very good | 67.4 | 27.5 | 5.1 |
| 3. The course content was well organised | 63.8 | 30.6 | 5.7 |
| **AGREE OVERALL - 50%** | | | |
| 4. Recommended readings from the text contributed to my understanding of the course | 58.3 | 26.1 | 15.7 |
| 5. Lectures relate to my existing knowledge and experiences | 57.6 | 32.4 | 10.0 |
| 6. The different parts of the course were well integrated | 52.6 | 39.5 | 7.9 |
| **AGREE > DISAGREE** | | | |
| 7. My interest in the course increased as the course progressed | 47.9 | 35.9 | 16.3 |
| 8. I felt motivated and challenged to learn in this course | 47.1 | 38.5 | 14.5 |
| 9. Compared to other courses the work load for this course is very heavy | 37.3 | 37.7 | 25.1 |
| 10. The course objectives were clear to me at the beginning of the course | 36.3 | 34.2 | 29.5 |
| **DISAGREE > AGREE** | | | |
| 11. The course co-ordination was poor | 6.9 | 35.0 | 58.1 |
| 12. The pace of the course was too fast | 29.3 | 40.3 | 30.4 |

**Key :** > **means greater than**

Table 4 reveals that the students strongly agreed that they have learnt a great deal of factual material from the course. This often present a problem whereby the students spend too much of the limited time at their disposal on memorising facts and will always have insufficient time to master the principles underlying their subject and to develop their powers of thought. One remedy could be constant review of the course in order to eliminate all unessential material.

The students strongly agree that the overall rating of the biology course was very good. This indicate that the objectives, resources for teaching , teaching methods, students assessment and feedback and evaluation of various aspects of the course have been adequately considered.

The students also strongly agree that the course content was well organised. The course content include all aspects of knowledge, skills and attitudes which we wish to impart to the students. The students response indicates that the topics to be presented to them were organised in a sequence (that is, from specific to general) that makes learning meaningful to them. Hence they also agreed that the different parts of the course were well integrated and that the course co-ordination was good. Notice that statements 3,6 and 11 offer a control on consistency of completion by the students since 11 is essentially the opposite of 3 - 6 and gives opposite results.

The students agreed but less strongly, that the lectures relate to their previous experiences. This was good and it always leads to a greater understanding of the course. But it could lead to boredom and frustration if the course is not made sufficiently interesting and challenging.

The students agreed that the recommended text contributed to their understanding of the course. This response indicates that the text must have covered the requirement of the syllabus and its language must have been suitable for them to read and understand.

The students agreed that their interest in the course increased as the course progressed and that they also felt motivated and challenged to learn in the course. These ratings were lower, with overall more students neutral or disagreeing than agreeing. This indicates that the students may need to be progressively given a greater authority and challenge over how and what they study especially during their first year at the university.

On work load, opinion was very mixed. We should remember that these students are taking a wide variety of other courses, all with different workloads. The rating for this question does not suggest that the workload in biology is excessive.

Opinion was also very mixed on whether the course objectives were clear. The objectives can only be clear if they are stated in behavioural terms which can be measured. This will lead to the students knowing precisely what they are expected to learn.

The students were divided in opinion about the pace of the course being too fast. The majority of the students did not find the course too fast, though a minority - not unexpected, given the mixed background of the intake - did have problems.

### 4.3.2 ASSESSMENT PROCEDURES

For the assessment procedures questions 13 - 16 section 2 part B of the questionnaire on biology teaching were used and respondents opinions are shown in table 5.

## TABLE 5

## STUDENTS RESPONSES TO THE ASSESSMENT PROCEDURES

| AGREE > DISAGREE | A | N | D |
|---|---|---|---|
| 1. The examination questions were reasonable in difficulty | 48.5 | 37.1 | 14.5 |
| 2. The methods of assessment used measured my competence | 32.7 | 41.3 | 26.0 |
| 3. I did not get valuable feedback on my learning as I progressed | 29.3 | 45.0 | 25.7 |
| **DISAGREE > AGREE** | | | |
| 4. The exam questions covered most aspects of the course content | 34.4 | 21.8 | 43.8 |

Table 5 shows that none of the statements in this section gave overall majorities in any column : that is, opinion on all assessment questions was more mixed than on the course in general. The results reveal that the students agreed that the examination questions were reasonable in difficulty. This shows that for most of the students, the exam questions were of the right standard and fair. The students were always made aware of the type of questions to be expected and were given practice on how to tackle these questions.

The results also show that the students disagreed that the exams covered most aspects of the course content. It is interesting that the students did not overall perceive that the examination covered most aspects of the content of the course. The multiple choice questions were drawn from the complete lecture course, and from laboratories : but clearly, not every detail was examined.

The students were even more divided in opinion as regards the methods of assessment measuring their competence. Care should be taken to ensure that individual differences amongst students is adequately taken care of during assessment.

There was a similar result concerning feedback on their learning as they progressed . Good assessment requires that marked work should be returned with constructive criticisms. Attention should be drawn to errors and goodwork should be praised. Model answers should be provided and discussed with the students (Cox, 1994). If these are lacking students will be dissatisfied. It is clear from the results that many students were dissatisfied on this aspect.

### 4.3.3 THE LABORATORY WORK IN GENERAL

For the laboratory work in general, questions 1 - 22 of part B of the laboratory questionnaire were used and the responses of the students are shown in table 6. The sample size (N) for the laboratory work was 398.

**TABLE 6**

**THE LABORATORY WORK IN GENERAL**

**STUDENTS RESPONSES TO THE LAB WORK IN GENERAL**

| STRONGLY AGREE | A | N | D |
|---|---|---|---|
| 1. For every lab session the necessary materials were always readily available | 76.1 | 13.6 | 10.3 |
| 2. The lab sessions helped me to understand some of the topics covered during the lectures | 67.8 | 22.6 | 9.6 |
| 3. In some practical sessions, I was only following the instructions just like a recipe | 65.6 | 24.4 | 10.1 |
| 4. In some lab sessions, I found it difficult to make any deductions | 61.1 | 26.6 | 12.3 |
| 5. The lab work added reality to the lecture material | 60.6 | 28.6 | 10.8 |
| **AGREE OVERALL - 50%** | | | |
| 6.The lab sessions were well organised | 54.5 | 34.1 | 11.5 |

**TABLE 6 CONT'D**

**THE LABORATORY WORK IN GENERAL**

**STUDENTS RESPONSES TO THE LAB WORK IN GENERAL**

| STATEMENTS | A | N | D |
|---|---|---|---|
| **AGREE OVERALL - 50%** | | | |
| 7. The total work load for the lab sessions is very heavy | 51.5 | 33.7 | 14.8 |
| **AGREE > DISAGREE** | | | |
| 8. The lab work stimulated my interest in biological science | 48.2 | 34.7 | 17.1 |
| 9. The lab procedures were clearly explained in the manuals | 45.7 | 33.7 | 20.6 |
| 10. I needed more instructions on how to write up my lab reports | 44.7 | 34.9 | 20.4 |
| 11. It was easy to follow the lab manual because it was well organised | 43.0 | 40.0 | 17.1 |
| 12. The purpose of each lab session was clear to me from the beginning | 40.0 | 36.7 | 23.4 |
| 13. I would prefer immediate feedback on how well I have done in my lab work | 38.2 | 37.9 | 23.9 |
| **AGREE > DISAGREE** | | | |
| 14. My skills in interpreting data were enhanced by the labs | 33.7 | 48.7 | 17.6 |
| 15. The lab work trained me to interpret data | 28.9 | 50.5 | 20.6 |
| **DISAGREE > AGREE** | | | |
| 16. I dislike practicals that require me to think for myself | 11.3 | 24.6 | 64.1 |
| **DISAGREE > AGREE** | | | |
| 17. Almost every week, I read the appropriate part of the lab manual before coming to the practicals | 24.0 | 27.3 | 48.7 |

**Key : > means greater than**

**TABLE 6 CONT'D**

**THE LABORATORY WORK IN GENERAL**

**STUDENTS RESPONSES TO THE LAB WORK IN GENERAL**

| STATEMENTS | A | N | D |
|---|---|---|---|
| **DISAGREE > AGREE** | | | |
| **18**. The details demanded in the lab manuals are far too much | 22.6 | 39.5 | 37.9 |
| **19**. The use of films/videos added considerable assistance to my understanding of the labs | 31.9 | 34.7 | 33.4 |

**Key : > means greater than**

Table 6 shows that for every lab session, the necessary materials were always readily available. This is good, but sometimes where apparatus is in short supply time could be wasted while students wait to take their turn : this appears rarely to happen from the students responses.

The students agreed strongly that the lab added reality to the lecture material. This is one of the purposes of the labs - to illustrate, supplement and emphasise points from lectures or private reading.

The table also reveals that students strongly agreed that in some practical sessions they were only following the instructions just like a recipe. This situation may arise partly due to time limitation, so that in order to finish the exercise on time, students had to work fast and this was only possible if they followed a very clear set of detailed instructions. The exercises planned need to be carefully selected so that the students have time to think them through. Lab times needed to be balanced so that it is not too short or too long as the case may be.

The students agreed that the labs were well organised but much less strongly than on the statement (1) on the availability of materials. This may indicate some problems with the organisation of certain labs.

The students agreed overall that the total workload for the lab sessions was very heavy but almost 50% were prepared to state that the work load was not excessive. This result may indicate a need for re-examination and reduction of some lab activities.

Opinion was very mixed over the next set of statements, with more agreeing than disagreeing but with up to 50% neutral.

The students slightly agreed that the lab work stimulated their interest in the biology course. This low rating showed that there is a need for more challenging activities in the labs.

The students also slightly agreed that the lab manual was clear and easy to follow. This result indicates that lab manuals are too often not clear and some instructions may be ambiguous. Those manuals that are badly explained could lead to non - functioning of experiments. Since students depend on teacher guidance and direction, the lab manual should be clear.

The students also only agreed slightly that the purpose of each lab was clear to them at the beginning of the lab. This result is quite similar to that for the course objectives (Table 4, statement 10). The result indicates that not all students had a clear idea of the purpose of the lab. Moreira (1980) found that very few students had a clear idea of the purpose of labs and therefore they learn very little. The purpose of each lab needs to be made clear to the students at the beginning of the lab session.

Opinion was also very varied on whether immediate feedback was desirable on how well the students had done in their lab work. According to Boud (1981), good feedback is that which is readily received, respected and heeded by the students. It has specific comments and it is directly given after the work has been completed.

Almost half of the students agreed that they needed more instructions on how to write up their lab reports. This could be done during prelab activities or during tutorial sessions.

The students were divided in opinion about their skills in interpreting data being enhanced by the labs. The more investigative labs can be good at developing interpretative data analysis skills (Boud, 1981).

The students strongly disagreed that they dislike practicals that require them to think for themselves. This result reveals their great desire for independence in learning.

The students were divided in opinion about films aiding their understanding of the lab. The timing of the presentation of these films may be important. They should not be presented when students are tired and cannot concentrate anymore. The use of videos is important because :- (1) Techniques and skills can be presented in a form which permits the students to gain an overview of procedures. (2) Specific procedures can be displayed in a manner that is not readily available in other format. (3) Some techniques are shown which may be difficult to demonstrate to large groups of students in the laboratory. (4) The ability of videos to focus on specific parts and exclude others is very useful (Boud, 1981). (5) They could encourage creative thinking (Hill, 1976). So why do the students give them a mediocre rating? Perhaps standard of presentation is poor!

### 4.3.4 TUTORIALS

Questions 18 - 21 of section 3, part B of the biology teaching questionnaire were used to ascertain the opinion of students to tutorials. Their responses are shown in table 7.

**TABLE 7**

**STUDENTS RESPONSES TO THE TUTORIALS**

| STRONGLY - AGREE | A | N | D |
|---|---|---|---|
| 1. The size of the tutorial class was appropriate for the students participation | 62.1 | 25.1 | 12.8 |
| **AGREE OVERALL - 50%** | | | |
| 2. The topics for discussion were always clear to me | 54.4 | 28.7 | 16.9 |
| **AGREE > DISAGREE** | | | |
| 3. Each tutorial was well organised | 38.1 | 35.4 | 26.5 |
| 4. I felt free to express my opinion in the tutorial group | 34.6 | 36.7 | 28.7 |
| **DISAGREE > AGREE** | | | |
| 5. The essay writing improved my style and fluency of writing | 16.3 | 34.0 | 49.7 |

**Key : > means greater than**

Findings from table 7 are that the size of the tutorial class was appropriate for effective student participation. In this study the number of students in each tutorial group was 25. The tutorials were arranged mainly to assist students with examination formats and practicals. The size of the tutorial group for this session was considered appropriate considering the nature of the activities. Hale (1964) observed that if the main virtues of the tutorial system are that it encourages regular habit of work and regular writing about the object of study, with the actual tutorial discussion playing a minor part, then the size of the tutorial group can become unimportant. Overall you will get better student participation in smaller tutorials groups. Hence the most appropriate tutorial group size varies with what the work of the tutorial consists of.

The students agreed that the topic for discussion at the tutorial session was always clear to them. The rating was good because it indicated that students always have a clear understanding of what was to be discussed at the tutorial. Where this is lacking the students would become bored and disinterested.

The students were divided in opinion about the organisation of the tutorials. The tutorials were held once a term and if the purposes of the tutorials are to be achieved then they needed to be made more frequent and more varied so that they can become more beneficial to the students.

The students were also very divided over whether they felt free to express their opinion during the tutorial sessions. For first year students, their immaturity and shyness or low responsiveness prevents them from getting the benefit they should from tutorials. Hale (1964) explained that it is believed that these students know too little of their subjects to participate effectively in their subject. Some students are difficult to draw out and great perseverance is required by the teacher to make contact with them. Since the students come prepared to the tutorial they cannot be said to be ignorant. Large group size can contribute to their lack of freedom of expression.

The students disagreed that the essay writing exercises improved their style and fluency of writing. A possible reason for this negative attitude could be as a result of a lack of valuable feedback from the marked essays. Written essays are of value in training the student to work on his own, and to read the literature of the subject with an alert and critical mind. Essays help to give coherence to student thinking and training in the necessary art of using language and communicating ideas. Hence this aspect needs to be examined. Sometimes students may copy their work. If such instances are noted then care should be taken to minimise them.

### 4.3.5 THE LESS AND THE MORE INVESTIGATIVE LABORATORIES

These are two different labs that were looked at separately for the purpose of comparison. The less investigative laboratory (on Immunology) offered the students a lesser degree of autonomy than the more investigative laboratory (on Mammalian skulls) where the students assume a greater responsibility for their learning by finding out more things for themselves. In asking for responses to these two laboratories students were not told that staff regarded one as more investigative than the other. The students opinions on both of these labs are shown in tables 8 and 9. Part C questions 20 - 25 of the laboratory questionnaire were used to elicit sttudents responses. (See Appendix D - T2W14 & T2W18).

**TABLE 8**

**STUDENTS RESPONSES TO THE LESS INVESTIGATIVE LABORATORY - IMMUNOLOGY**

| **AGREE OVERALL - 50%** | **A** | **N** | **D** |
|---|---|---|---|
| 1. This lab session challenged me to find out things for myself | 54.3 | 35.6 | 10.1 |
| **AGREE > DISAGREE** | | | |
| 2. The time allotted for this lab was adequate | 50.7 | 28.8 | 20.5 |
| 3. The manual for this lab was very clear and straightforward | 48.9 | 35.9 | 15.2 |
| 4. This lab work helped me to develop my problem solving skills | 40.2 | 42.6 | 17.3 |
| 5. This lab session was mainly investigative | 39.9 | 48.7 | 11.4 |
| **DISAGREE > AGREE** | | | |
| 6. There was too much of a cook - book approach in this lab | 23.2 | 44.0 | 32.8 |

**Key > means greater than, Sample size (N) = 398**

The students agreed that the lab challenged them to find out things for themselves. They were very divided over whether the lab helped them to develop their problem solving skills. The less investigative labs are generally good at developing manual skills and not problem solving skills (Boud, 1981).

The time allotted the lab and the clarity of the lab schedules are essentially control questions where we would not expect a difference between the two labs.

They disagreed that there was too much of a cook - book approach in the lab. The students were however very divided in opinion.

**TABLE 9**

**STUDENTS RESPONSES TO THE MORE INVESTIGATIVE LABORATORY - THE MAMMALIAN SKULLS**

| STRONGLY - AGREE | A | N | D |
|---|---|---|---|
| 1. This lab session was mainly investigative | 66.9 | 23.7 | 9.3 |
| **AGREE OVERALL - 50%** | | | |
| 2. This lab session challenged me to find out things for myself | 53.4 | 31.1 | 15.5 |
| **AGREE > DISAGREE** | | | |
| 3. The manual for this lab session was clear and straight - forward | 50.7 | 34.0 | 15.3 |
| 4. The time allotted for this lab session was adequate | 44.2 | 23.7 | 32.1 |
| 5. This lab work helped me to develop my skills in problem solving | 31.5 | 41.5 | 27.0 |
| **DISAGREE > AGREE** | | | |
| 6. There was too much of a cook - book approach in this lab | 17.9 | 46.4 | 35.6 |

**Key > means greater than, Sample size (N) = 398**

Table 9 shows that the students did perceive that the lab was mainly investigative and that it challenged them to find out things for themselves. The students did not regard the lab as helping them to develop their problem solving skills. The allotted time and clarity of manuals are essentially controls where one wouldn't expect a difference between the two labs.

The students disagreed that there was too much of a cook - book approach in the lab. They were however divided in opinion.

**TABLE 10**

**THE DIFFERENCES IN STUDENTS ATTITUDES BETWEEN THE LESS AND THE MORE INVESTIGATIVE LABS FOR 1994/95**

| | LESS | | | MORE | | | |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | $X^2$ |
| 1. The time allotted for this lab session was adequate | 50.7 | 28.8 | 20.5 | 44.2 | 23.7 | 32.1 | **13.13 |
| 2. This lab session challenged me to find out things for myself | 54.3 | 35.6 | 10.1 | 53.4 | 31.1 | 15.5 | 5.54 |
| 3. This lab work helped me to develop my skills in problem solving | 40.2 | 42.6 | 17.3 | 31.5 | 41.5 | 27.0 | **12.12 |
| 4. There was too much of a cook-book approach in this lab | 23.2 | 44.0 | 32.8 | 17.9 | 46.4 | 35.6 | 3.22 |
| 5. This lab session was mainly investigative | 39.9 | 48.7 | 11.4 | 66.9 | 23.7 | 9.3 | ***58.74 |
| 6. The manual for this lab was very clear and straight-forward | 48.9 | 35.9 | 15.2 | 50.7 | 34.0 | 15.3 | 0.30 |

**Key : ** $P < 0.01$, *** $P < 0.001$**

Comparing the results from the two laboratories we can draw the following conclusions:-

(a) For the time allotted and manual comparison - the 'control' questions, the results are similar, as expected. The difference between less and the more investigative labs with respect to time allotment was however significant in favour of the less investigative lab.

(b) On the students being challenged to find out things for themselves, the results are also very similar : which means that the students have not really been aware of a major difference in the approach.

(c) On the lab being mainly investigative, there was a difference, with the more investigative lab scoring higher. However, on the statement relating to challenge to find out things for themselves there was very little difference. This is puzzling, since investigation and finding out for yourself are very similar. The difference in the two statements is mainly to do with challenge : it seems that the students overall regarded the two labs as equally challenging.

### 4.3.6 ENCOURAGEMENT TOWARD AUTONOMOUS LEARNING

Questions 2 and 6 of part B in the biology teaching questionnaire and also questions 4, 10, 15, 24, 25, and 27 of part B and C in the laboratory questionnaire were used in order to ascertain whether students are being encouraged to become autonomous. The results obtained are shown in table 11. The sample size was partly from the course in general which was 491 and from the laboratory which was 398.

**TABLE 11**

**STUDENTS RESPONSES TO ENCOURAGEMENT TOWARDS AUTONOMOUS LEARNING**

| STATEMENTS | A | N | D |
|---|---|---|---|
| **THE COURSE IN GENERAL** | | | |
| 1. I felt motivated and challenged to learn in the course | 47.1 | 38.5 | 14.5 |
| **THE LESS INVESTIGATIVE LABORATORY** | | | |
| 2. This lab challenged me to find out things for myself | 54.3 | 35.6 | 10.1 |
| 3. This lab helped me to develop my problem solving skills | 40.2 | 42.6 | 17.3 |
| **THE MORE INVESTIGATIVE LABORATORY** | | | |
| 4. This lab session challenged me to find out things for myself | 53.4 | 31.1 | 15.5 |

The finding from table 11 is that about half of the students clearly were aware of being motivated and challenged to learn and find out things for themselves, in various aspects of the course. In terms of agreement ratings, these are not in the 'strongly agree' category but there is a comfortable majority of agree over disagree in all cases. This of course does not reveal whether or not the students enjoyed these challenges. Chapter 7 on the Perry model investigates their attitudes to modes of learning.

### 4. 4 EXAMINATION OF THE HYPOTHESES

Having looked at the overall results, we can now take a closer look at the subsets of the class and compare their attitudes and test the hypotheses. There are four subsets as stated earlier on in chapter 3, and they are :- (1) The students with higher entry qualifications and those with lower entry qualifications. (2) Male and female students. (3) Older and younger students (4) Students intending to do biology versus those that do not intend to follow biology further.

There are four hypotheses to be tested in this chapter. In testing the hypotheses, the Chi square statistic was used to compare the differences between observed and expected frequencies. This measures differences between two distributions. In calculating the Chi square value, the data were not used in their original five categories but in the three categories as shown in the tables ( that is, combining strongly agree and agree; strongly disagree and disagree). In this way all cells in the contingency tables were of a size amenable to Chi square calculation. Data used for the Chi square calculations were the original numbers, not the percentages. In producing the Bar charts, the percentages of the frequencies were used. This is to ensure an easier visual comparison of the differences and similarities between the groups. The results in tables 12 - 15 are expressed as percentages of degree of agreement or disagreement of the various groups of students. While examining the hypotheses, the results that indicate a significant difference between the two groups are shown in the tables. The level of significance is taken to be the rejection of the null hypothesis at the 5% level. The remaining results where the groups showed no significant difference are shown in Appendix A.

## 4. 4. 1 Hypothesis one

**There are no significant differences in attitudes between the students with higher entry qualifications and those with lower entry qualifications to the course.**

In testing this hypothesis, all statements in Part B of the biology teaching and all statements in Part B and C of the laboratory questionnaire were examined to find out if there is any significant difference between the two groups. The results obtained are shown in table 12. The number of statements tested was 45.

**TABLE 12**

**THE DIFFERENCES IN ATTITUDES BETWEEN THE HIGHER AND LOWER STUDENTS**

| STATEMENTS | HIGHER N = 409 | | | LOWER N = 58 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. The pace of the course was too fast | 26.0 | 41.7 | 32.3 | 46.7 | 30.0 | 23.3 | **10.99 |
| 2. Lectures relate to my existing know ledge and experiences | 63.2 | 29.3 | 7.6 | 22.0 | 50.8 | 27.1 | **42.25 |
| **ASSESSMENT** | | | | | | | |
| 3. The methods of assessments used in the course measure my competence | 33.7 | 42.1 | 24.2 | 23.3 | 36.7 | 40.0 | *7.09 |
| **TUTORIALS** | | | | | | | |
| 4. Each tutorial is well organised | 39.9 | 35.3 | 24.8 | 26.7 | 35.0 | 38.3 | *6.01 |
| **MORE INVESTIGATIVE LAB** | | | | | | | |
| 5. This lab session challenged me to find out things for myself | 51.7 | 31.5 | 16.7 | 70.0 | 22.0 | 8.0 | *6.07 |

**Key : * $P < 0.05$, ** $P < 0.01$**

Table 12 shows where there are significant differences between students with higher entry qualifications and those with lower entry qualifications. These two groups showed significantly different responses for 5 out of the 45 statements tested. The main reason for the differences between these two groups may be their educational backgrounds: the higher group with their greater background knowledge of biology and the lower group with little or no background knowledge of biology. For this reason the higher group did not find the pace of the course too fast and agreed that lectures related to their existing knowledge and experiences while the lower group overall did find the pace of the course too fast and found much less relation to their previous experience. On these two statements the differences were highly significant. On the other three statements the level of significant was lower.

The lower group felt highly challenged by the more investigative lab to find out things for themselves while the higher group agreed less to the statement.

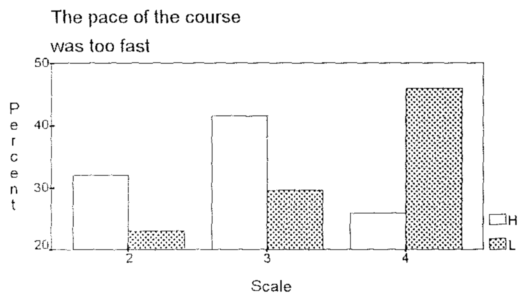
With respect to the methods of assessment used in measuring their competence, the higher group were significantly more satisfied. A possible reason for the difference in response could be that the lower group might have needed some remedial sessions to enable them meet assessment demands.

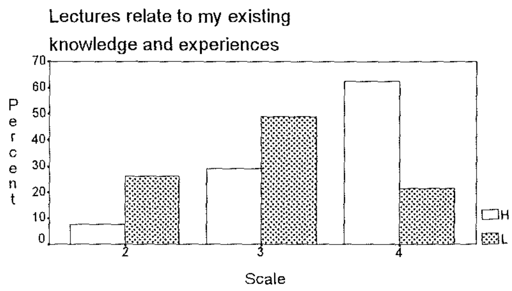
With regards to the organisation of the tutorials, a reason that could be responsible for the difference between the two groups might be that the lower group might have not benefited much from the exercise or they might have just become critical of the tutorial method.

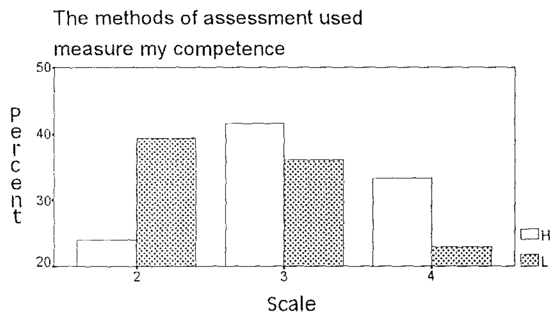
Based on these observations hypothesis one could be rejected at the 5% probability level for 5 out of the 45 aspects of the course that I assessed.

# FIGURE 1

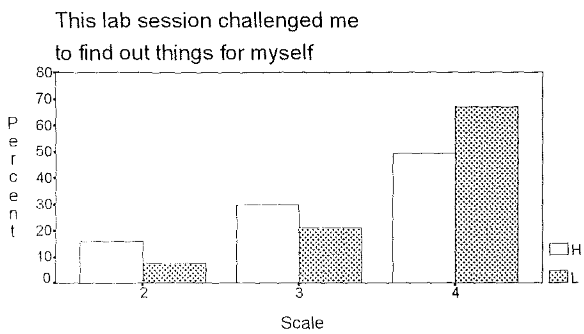
## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN HIGHER AND LOWER STUDENTS IN 1994/95








**Key :** 4 = Agree
3 = Neutral
2 = Disagree
H = Higher
L = lower

## 4. 4. 2 Hypothesis two

**There are no significant differences in attitudes between the male and female students to the course.**

In testing this hypothesis all statements in Part B in the biology teaching and the laboratory questionnaire were examined and the differences found are tabulated in table 13.

**TABLE 13**

**THE DIFFERENCES IN ATTITUDES BETWEEN MALE AND FEMALE**

| STATEMENTS | MALE N = 160 | | | FEMALE N = 304 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. Overall, I will rate the biology course as very good | 57.7 | 34.0 | 8.3 | 73.9 | 22.1 | 4.0 | **13..13 |
| 2. I felt motivated and challenged to learn in this course | 38.6 | 44.3 | 17.1 | 52.1 | 34.8 | 13.1 | *7.64 |
| 3. I learnt a great deal of factual material from this course | 79.1 | 12.0 | 8.9 | 83.3 | 14.1 | 2.6 | *9.08 |
| **ASSESSMENT** | | | | | | | |
| 4.The examination questions covered most aspects of the course content | 43.9 | 21.3 | 34.8 | 30.0 | 20.8 | 49.2 | **10.42 |
| **THE LABORATORY WORK IN GENERAL** | | | | | | | |
| 5. For every lab session, the necessary materials were always readily available | 67.1 | 20.1 | 12.8 | 82.6 | 9.1 | 8.3 | **13.06 |
| 6. The lab procedures were clearly explained in the manuals | 42.3 | 40.9 | 16.8 | 47.9 | 28.9 | 23.1 | *6.42 |

## TABLE 13 CONT'D

## THE DIFFERENCES IN ATTITUDES BETWEEN MALE AND FEMALE

| STATEMENTS | MALE N = 160 | | | FEMALE N = 304 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | **$X^2$** |
| 7. I needed more instructions on how to write up my lab report | 37.7 | 34.9 | 27.4 | 49.6 | 33.3 | 17.1 | *7.53 |
| **8.** In some labs, I find it difficult to make any deductions | 51.7 | 28.9 | 19.5 | 36.5 | 44.0 | 19.5 | **11.40 |
| 9. I would prefer immediate feedback on how well I have done in my labwork | 40.5 | 28.4 | 31.1 | 36.5 | 44.0 | 19.5 | **11.40 |
| **10**. I dislike practicals that require me to think for myself | 13.4 | 16.8 | 69.8 | 5.5 | 28.9 | 65.6 | *7.85 |
| **THE LESS INVESTIGATIVE LAB** | | | | | | | |
| **11**. This lab session challenged me to find out things for myself | 46.4 | 40.0 | 13.6 | 58.8 | 33.0 | 8.2 | *6.18 |
| **12**. This lab session was mainly investigative | 32.1 | 52.9 | 15.0 | 44.6 | 45.9 | 9.4 | *6.63 |

**Key :** * $P < 0.05$

** $P < 0.01$

The table reveals that a significant difference between the males and the females occurred in responses to 12 out of the 45 statements, 5 highly significant and seven less so. One of the probable reasons for the differences between the two groups is the lack of preference for biology by the males. This reason was reflected in their lower overall rating of the biology course as very good and their lower feeling of being motivated and challenged to learn in the biology course. The reason for the difference in the rating of learning a great deal of factual material in the biology course is probably as Simpson (1968) found out that females learn more by memorisation while the males tend to try to master the underlying principle. The reason behind the difference in response to the exam questions covering most aspects of the course content could be as Power (1973) found out that the males are intellectually more bright, confident and science oriented than the females. The reason also behind the difference in response to the availability of the necessary materials during each lab session could be because the females are less critical of their departments than the males (Robert 1992).

As for the lab procedures being clearly explained in the lab manuals, no possible explanation could be given. The relative lack of interest in biology by the males might be a contributing factor to this difference.

The difference in response to the need for more instructions to write up their lab reports, shows that the males are more confident in their performance in the course than the females.

The reason for the difference in response to their finding it difficult to make any deductions in some labs may be that the males are spatially biased while the females are verbally biased. The males have a capacity to draw simple inferences and this develops later in females (Council Curriculum Bulletin No 3 1970).

The group seem divided in opinion concerning their preference for immediate feedback on how well they have done in their lab work. No possible reason could be given to this difference between the groups.

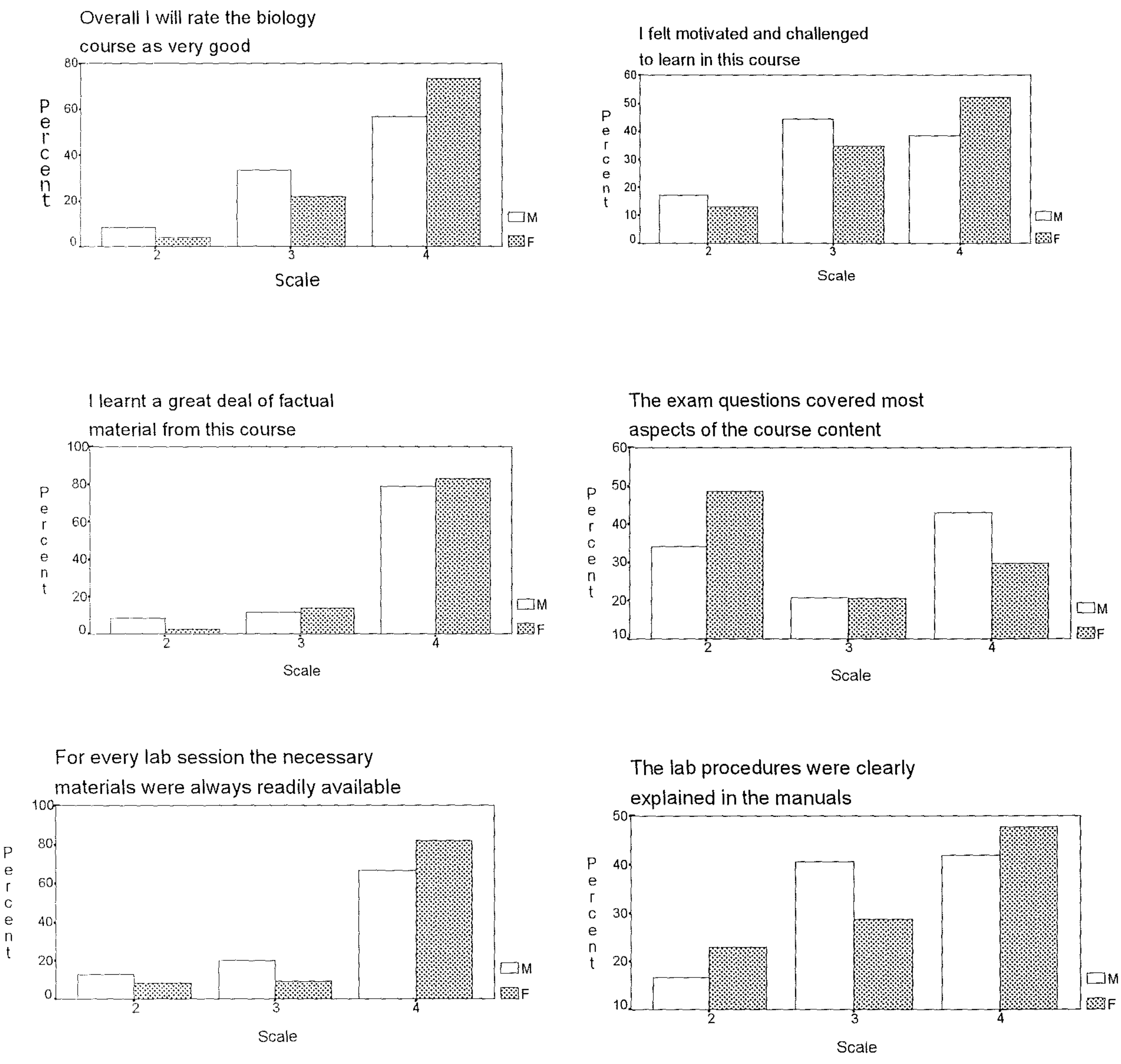
The difference in response to their liking for practicals that require them to think for themselves reveals the strong desire in males for abstraction and independence.

The difference in response to the less investigative lab challenging them to find out things for themselves and also being mainly investigative reveal the confidence and the intelligence that is being reported in the males.

Based on these observations, hypothesis two could be rejected at the 5% probability level for 12 out of the 45 statements I tested, a considerably greater difference than that between 'higher' and 'lower' students.

**FIGURE 2**

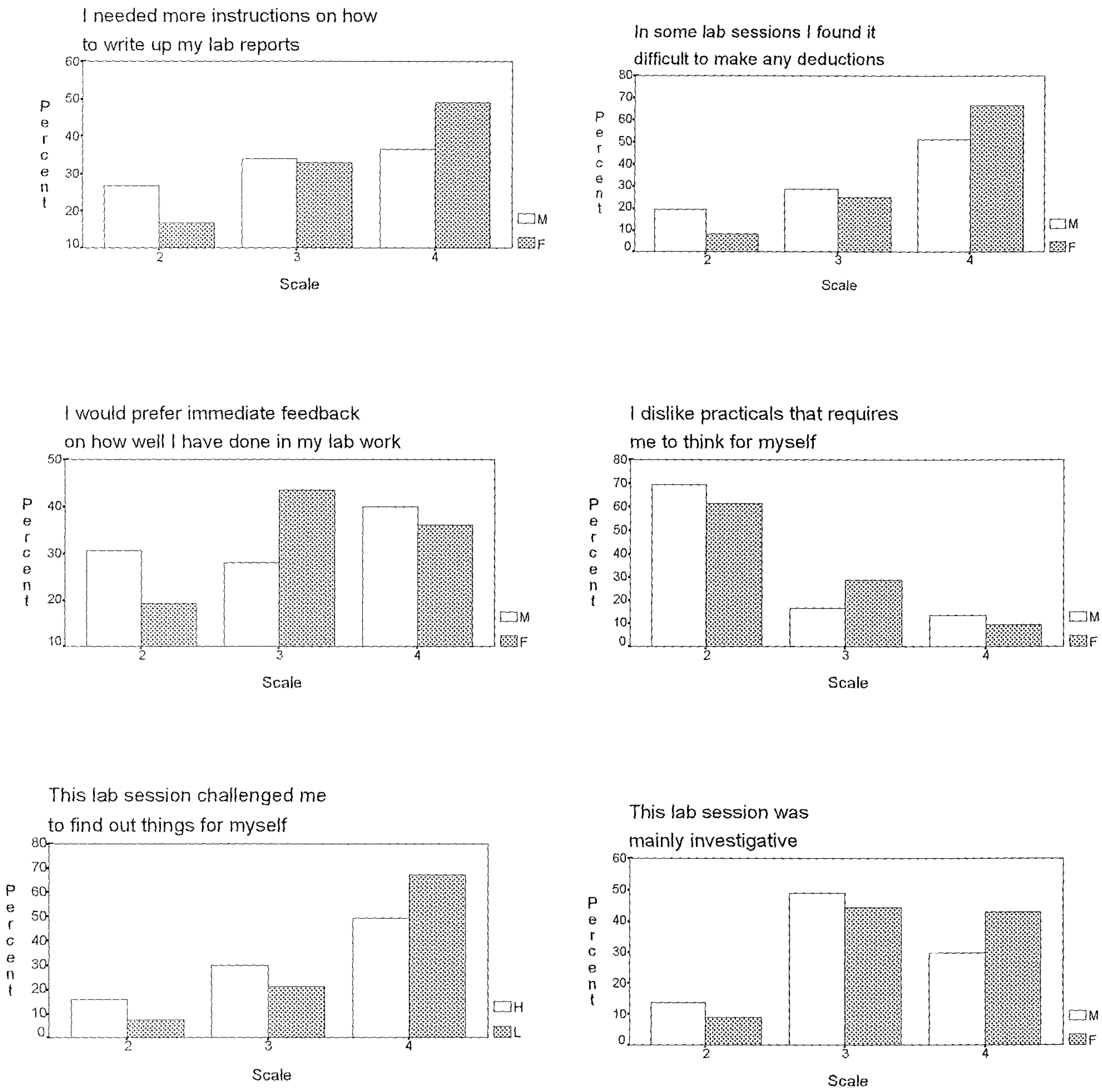
**BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN MALE AND FEMALE STUDENTS IN 1994/95**




**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

**FIGURE 2**

**BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN MALE AND FEMALE STUDENTS IN 1994/95**




**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

**M = Male F = Female**

### 4. 4. 3 Hypothesis three

**There is no significant difference in attitudes between the older and the younger students to the course.**

In testing this hypothesis, all statements in part B of the biology teaching questionnaire, and part B and C of the laboratory questionnaire were examined and the differences found are shown in table 14.

**TABLE 14**

**THE DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS**

| STATEMENTS | OLDER N = 122 | | | YOUNGER N = 365 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. My interest in the course increased as the course progressed | 40.5 | 35.5 | 24.0 | 51.2 | 34.7 | 14.1 | *7.58 |
| 2. Compared to other courses, the work load for this course is very heavy | 47.5 | 31.7 | 20.8 | 34.4 | 38.8 | 26.7 | *6.58 |
| 3. I learnt a great deal of factual material from this course | 70.5 | 18.9 | 10.7 | 85.8 | 11.8 | 2.5 | **19.55 |
| 4. I felt motivated and challenged to learn in this course | 44.3 | 34.4 | 21.3 | 48.5 | 39.5 | 12.1 | *6.40 |
| **ASSESSMENT** | | | | | | | |
| 5. I did not get a valuable feedback on my learning as I progressed | 28.6 | 36.1 | 35.3 | 30.6 | 46.7 | 22.8 | *7.78 |

**Key : * P < 0.05, ** P < 0.01**

**TABLE 14 CONT'D**

**THE DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS**

| STATEMENTS | OLDER N = 122 | | | YOUNGER N = 365 | | | Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| **TUTORIALS** | | | | | | | |
| 6. The size of the tutorial class was appropriate for students participation | 52.1 | 29.8 | 18.2 | 67.3 | 21.3 | 11.4 | *9.29 |
| **THE LABORATORY WORK IN GENERAL** | | | | | | | |
| 7. Almost every week, I read the appropriate part of the lab manual before coming to the practicals | 36.1 | 27.8 | 36.1 | 20.2 | 27.3 | 52.5 | **11.73 |
| 8. The details demanded in the lab manuals are far too much | 21.7 | 28.9 | 49.5 | 23.2 | 42.4 | 34.3 | *7.92 |
| 9. The use of films/videos added considerable assistance to my understanding of the labs | 48.5 | 29.9 | 21.6 | 26.7 | 35.8 | 37.5 | **17.00 |

**Key : * P < 0.05**

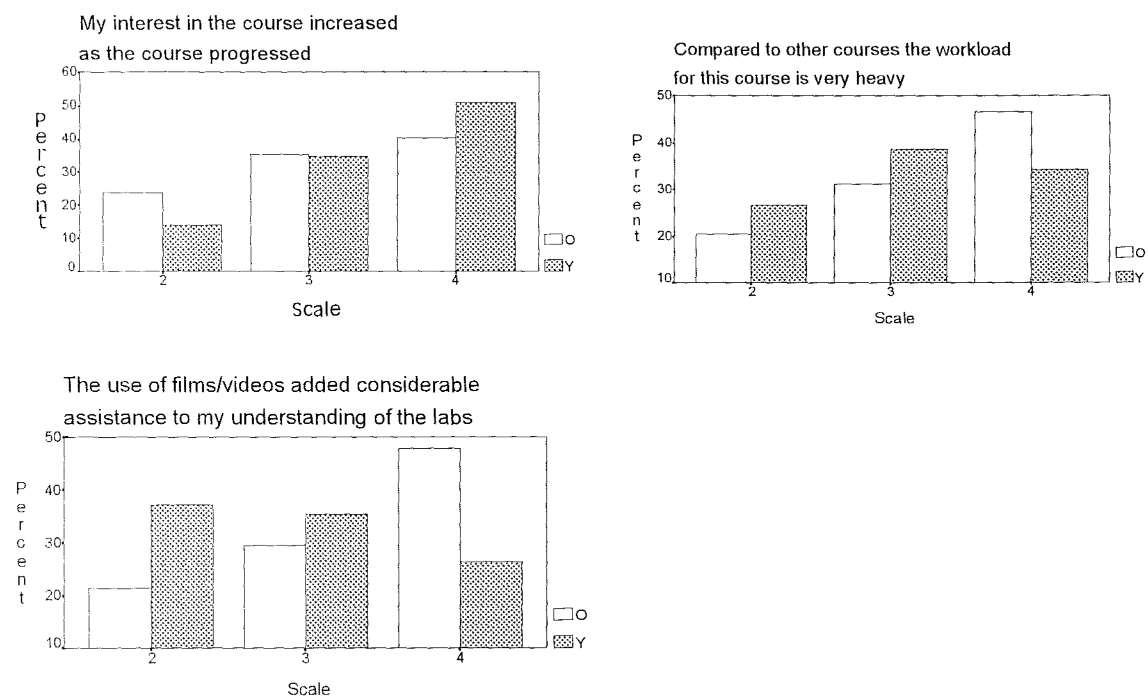
**** P < 0.01**

The table reveals that a significant difference occurred in responses to 9 out of the 45 statements, 3 highly significant 6 less so between the younger and older groups. The main probable reason for the differences between the groups is the many commitments of the older group and their finding the first year's work more time consuming than they had anticipated: hence they found the work load heavy, the details demanded in the lab manual as too much, their interest in the course not increasing much as the course progressed and their feeling less motivated to learn in the course. Another reason for the differences between the two groups is the critical tendency of the teaching methods by the older group. Hence their lower rating of the tutorials and the assessment procedures. The previous experiences of the older group might have contributed in enabling them to read the lab manual before coming to the lab. The younger group with their recent study experiences did learn a great deal of the factual material from the course. The older group found the use of films/videos a considerable assistance to their understanding of the course. The timing of the presentation of the videos is very important.

Based on these observations, hypothesis three could be rejected at the 5% probability level for 9 out of the 45 statements, a result intermediate to that for hypothesis 1 and 2.

**FIGURE 3**

**BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS IN 1994/95**

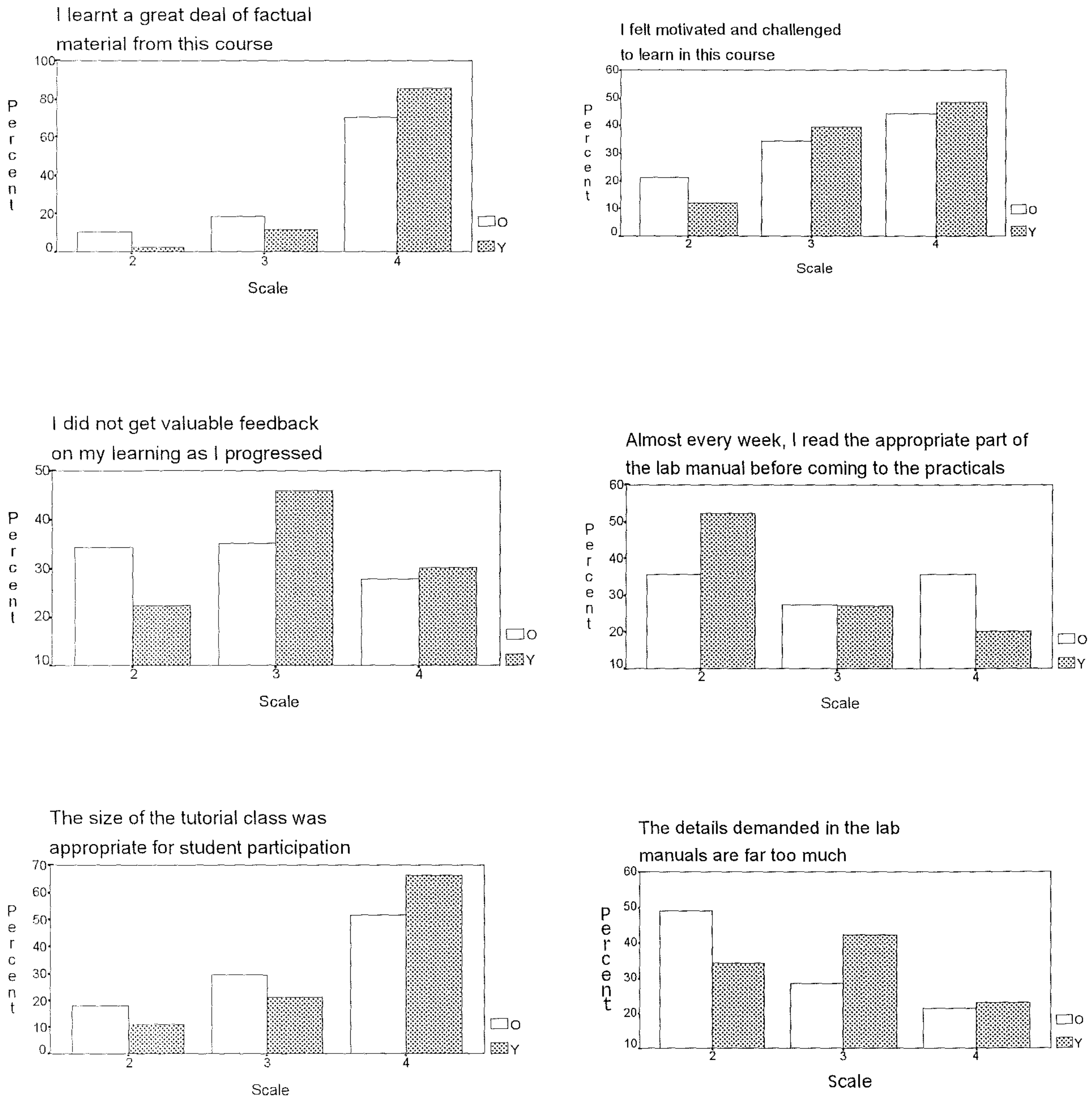



**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

**O = Older Y = Younger**

## FIGURE 3

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS IN 1994/95




**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

**O = Older Y = Younger**

## 4. 4. 4 Hypothesis four

**There are no significant differences in attitudes to the course between students who intend to continue with biological studies and those who do not intend to continue with biological studies.**

In testing this hypothesis also, all the statements in part B of the biology teaching questionnaire and part B and C of the laboratory questionnaire were examined and the respondents' opinions are tabulated in table 15.

**TABLE 15**

**THE DIFFERENCES IN ATTITUDES BETWEEN STUDENTS WHO INTEND TO CONTINUE WITH BIOLOGY AND THOSE WHO DO NOT INTEND TO CONTINUE WITH THE COURSE**

| STATEMENTS | Intending Bio N = 354 | | | Non-Intending Bio N = 76 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. The course objectives were clear to me at the beginning of the course | 35.5 | 37.8 | 26.7 | 38.5 | 20.5 | 41.0 | **10.12 |
| 2. Recommended readings from the text contributed to my understanding of the course | 61.1 | 24.4 | 14.5 | 43.6 | 34.6 | 21.8 | *8.05 |
| 3. I felt motivated and challenged to learn in this course | 52.1 | 36.1 | 11.8 | 32.1 | 47.4 | 20.5 | **11.08 |

**Key : * P < 0.05**

**** P < 0.01**

The table reveals that 3 out of 20 statements showed significantly different responses, two highly significant. The shortfall in the number of statements for the Intending and non -

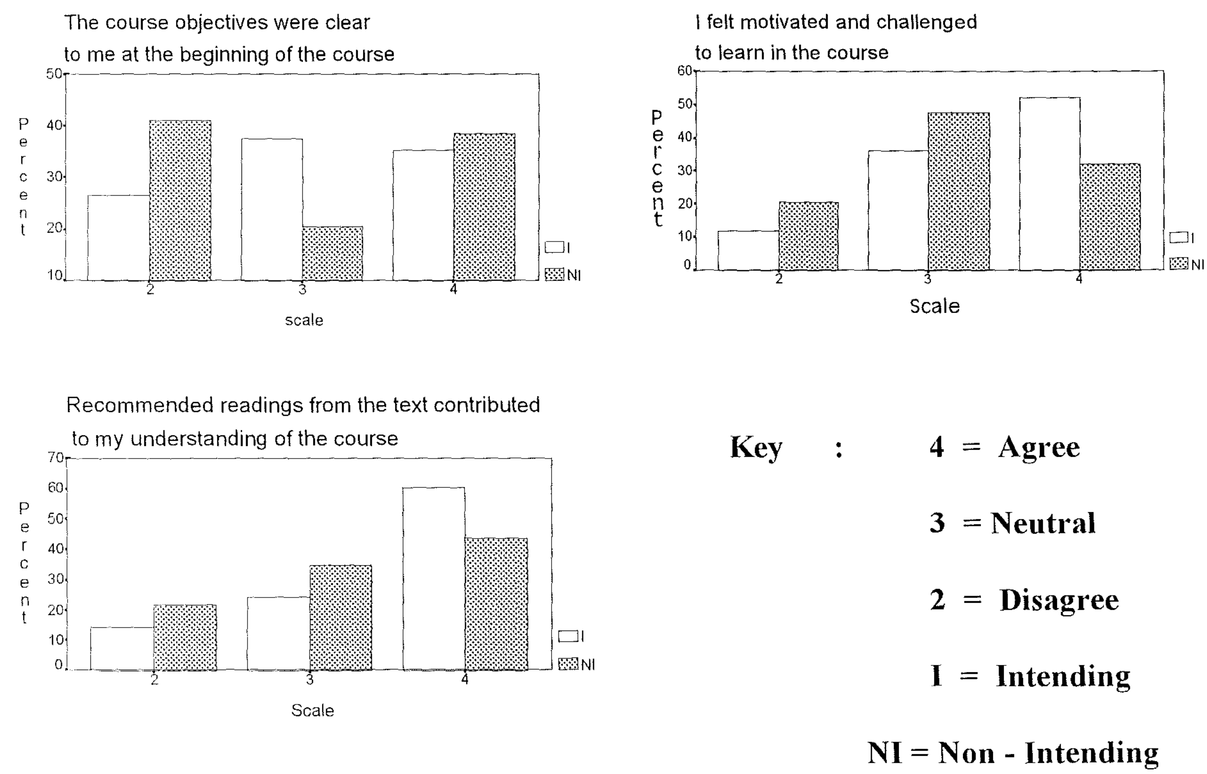
intending biology group was because this variable was not included in the first set of the questionnaires that were administered (the laboratory work in general) in 1994/95. It was later included in the second set of questionnaires to be administered - the biology teaching in 1994/95.

The main reason for the differences between these two groups may be the lack of interest in biology by the non - intending group. This might lead to the lower rating on all aspects. There is a need for activities that motivate and challenge these students.

Based on these observations, hypothesis 4 could be rejected at the 5% probability level for 3 out of the 20 statements tested. It is interesting how few statements showed a difference for these two groups.

**FIGURE 4**

**BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN INTENDING AND NON-INTENDING STUDENTS IN 1994/95**



### 4.5 SUMMARY OF RESULTS

From the observation of the old biology course, it became apparent that, in the organisation of the course, provision has been made to assist the students in understanding the basic principles of the course, as is stated in its objectives. In the laboratory sessions for example, a wide range of techniques have been introduced so that each student can have the opportunity to participate effectively in the various aspects of the laboratory. Also during lectures, a wide variety of teaching aids are being used and some lecturers in addition give out handouts to students.

Learning resources are varied as well as the assessment procedures. This is an attempt by the department to ensure that each student is aided in one way or the other towards effective academic progress. Students are also given the opportunity to air their views with regards to all the activities of the course. These views could be compliments, criticisms and complaints. This is made possible at the staff and student committee. The tutorials for this session were organised mainly to assist the students with their examinations and practicals. The work load however, looks heavy for the students. They have 129 lectures apart from the laboratories schedules.

Results from tables 4 to 9 revealed that the students in general most probably have a positive attitude towards the biology course as a whole. Hence, they rated the course as very good and agreed that the laboratory helps them towards the understanding of the lectures and encouraged them to find out things for themselves. They also agreed that the assessment methods measure their competence and the tutorials are well organised.

The result in table 11 showed that the students are most probably being encouraged to become autonomous in their learning for example the laboratory encourages the students to find out things for themselves, the students feel motivated and challenged to learn in the biology course and their skills in problem solving are being enhanced.

Considering the responses of the groups, table 16 gives a brief summary of the number of statements in which the responses of the groups were significantly different.

**TABLE 16**

**THE NUMBER OF STATEMENTS THAT WERE SIGNIFICANTLY DIFFERENT**

| Groups and Sample sizes | Total No of statements | No of statements that are significantly different | Statements significant at 5% p level | Statements significant at 1% p level |
|---|---|---|---|---|
| Higher / lower<br>H = 409, L = 58 | 45 | 5 | 3 | 2 |
| Male / Female<br>M=160, F=304 | 45 | 12 | 7 | 5 |
| Older / Younger<br>O=122, Y=365 | 45 | 9 | 6 | 3 |
| Int. / Non-Int<br>Int=354, N-I=76 | 20 | 3 | 1 | 2 |
| | 155 | 29 (18.7%) | 17 (11.0%) | 12 ( 7.7%) |

Table 16 reveals the total number of statements responded to by each group of students under this study, the number of statements that were significantly different and the probability level at which they were significantly different.

The results show that the total number of statements that were significantly different for each group were very few at 5% probability level and were even fewer at 1% probability level compared to those that showed no significant difference.

The results showed that some differences between the groups were identified. With respect to the higher and lower group the differences were probably due to their background knowledge of biology. The higher group has much prior knowledge in biology while the lower group had little or no background knowledge in biology. A remedy could be to provide activities that are challenging to the higher group and provide remedial assistance to the lower group.

With the male and female group the differences were probably due to their preference to biology. The females had more preference to biology than the males. Notice that many more females chose to study biology than did males (304 females to 160 males). Males are thought to show a spatial bias and hence their quest for abstraction while the females show a verbal bias. The males also exhibit more confidence in their performance in the course than the females. Activities that encourage these students to find out things for themselves will satisfy the quest for abstraction in the males and improve that of the females.

For the older and younger group, the differences may be due to the fact that the older group showed poor study habits, unrealistic expectations of structure of courses and teaching methods, family commitments and experiences while the younger group showed recent study experiences, good learning techniques , lack of commitments and experiences. Pre counselling courses will lessen the unrealistic expectations in the older groups and also improve their study habits while more challenging activities will stimulate the interest of the younger group.

With the intending and non - intending group the few differences may be due to the lack of interest in biology by the non - intending students. Challenging and interesting activities may improve their interest in the course.

In conclusion, it is apparent that the course has indeed made a positive impact in the attitudes of students to the course, and also differences, even though small in number did exist amongst the various groups and they are worth noting so that the issues raised can be addressed and the groups affected can be assisted accordingly.

# CHAPTER 5

## LEVEL 1 BIOLOGY 1995/96 SESSION

### 5.1 INTRODUCTION

This chapter presents the results regarding students attitudes to the teaching of the new biology course for the 1995/96 session. This was when the changes were made to the 'old' biology course and the curriculum pattern became modular. It is hoped that this study will provide an insight into : -

(a) The extent to which the changes made in the first year biology course affected the attitudes of students to the course.

(b) The extent to which the teaching strategies used in the new biology course encouraged the students to become autonomous in their learning.

The order of presentation is as follows : -

5.2 Findings from the observation of the new biology course for the 1995/96 session.

5.3 General findings from the course.

5.4 Examination of the hypotheses - Students responses.

5.5 Summary of results.

The results presented in the various tables, show only the three points of the scale, that is, agree, neutral and disagree. This is done in order to reduce the size of the tables and to avoid underpopulated contingency tables for Chi square tests. The letter A in the tables represents Agree - indicating, a positive attitude, and the score for A is comprised of the frequencies for agree and strongly agree added together. The letter N stands for the neutral point, while the letter D stands for disagree - indicating a negative attitude. The score for D is comprised of the frequencies for disagree and strongly disagree added together. Any results not shown in the tables are given in appendix A. All results are shown in percentages of the frequencies of the total numbers but the Chi square values have been calculated on raw frequencies.

## 5.2 FINDINGS FROM THE OBSERVATION OF THE NEW COURSE

**Student enrolment** - This course had a student population of 720, with 22 lecturers, 4 teaching assistants, a co-ordinator and a deputy co-ordinator. With such large departments administration takes up more time and the interchange of information about a student's progress becomes laborious.

**Curriculum** - The curriculum was the unit course system, that is, modularity. A module is a short unit, complete in itself which may be linked to further units towards the achievement of long term goal. One of the advantages of this kind of curriculum is that it takes into consideration individual student interests by allowing for independent study through greater course flexibility. Weaknesses of a modular curriculum include one aspect being over presented and another hardly presented at all. The course was divided into four modules of equal weight, each lasting 12 weeks. Although students could take modules on their own, they were encouraged to take the complete package of four, and nearly all did so.

**Aim of the course** - The overall aims of the course were many. They were specific and measurable. Each module had clearly defined goals. It is from these goals that their content emerge and move towards their fulfilment. With these aims the students would have a clear understanding of what they are expected to learn.

**Lectures** - These were held three times in the day instead of two times a day as was the case in the 'old' course. This made the timing of the lectures quite flexible for the students, giving them a better opportunity to attend lectures at a convenient time, thereby encouraging regular attendance of the lectures. Guidance on effective note taking was provided to students and more provision was made for students to have contact with their lecturers. Lecturers used a variety of teaching aids and most of them also gave handouts to students so as to assist them towards the understanding of the lectures. The large number of students did not allow for class participation to be as effective as it could be. There were fewer lectures than in the 'old' course. There were 99 lectures in the new course compared to 129 in the old course. The total number of the new lectures includes the revision lectures : there are three of such lectures per module. To reduce the lectures to 99 some topics were omitted entirely, for example developmental biology; biology and society. This was to allow students more time for private study. The nature and intensity of private study vary from subject to subject and all students are not equally diligent. The more conscientious both attend more classes and also spend more time on the reading advised them.

Large classes present the problem of less interaction and lower feedback. Possible alternatives to ensure effectiveness in the teaching of large groups has been suggested to be a reduction in contact time (Cox, 1994). There is the need for students to teach themselves a certain portion of the course material. A teacher, for example may reduce the number of his lectures and give students directed reading or self learning material for the routine subject content, reserving his lecturing for difficult aspects of the course. If this is well prepared with effective supporting facilities, students may welcome the independence and the flexibility offered by such teaching. Rapid feedback could be arranged by computerised marking of regular tests. It is helpful to teach in a way which enables the learner to cover at least some of the syllabus on their own. An active, reflective participatory orientation is encouraged in the learner by giving him an opportunity to learn. Learners should be enabled to tackle that which they need to learn in a direct and carefully structured way.

**Lecturers** - The number of lecturers even though reduced was still considered adequate enough to provide the variety of ideas needed for effective development of the students' powers of thought. Twenty two lecturers were used in the course, each giving 1-9 lectures per term. Students were encouraged to contact any member of staff if in difficulty with any aspect of the course. The numbers of the offices, telephone extensions and e-mail addresses of the staff teaching the modules were made available to them in the Course Information Document.

**Practicals** - These run in sets of 16 repeats from Mondays to Fridays. Each laboratory manual consists of laboratory schedules, aims and continuous assessment activities (objective questions, assignments and essays). The laboratory activities include dissections, data analysis, personal 'hands-on' work at the bench, discussions, simulations and demonstrations. Each of the modules has a slightly different style and mix of tasks. The tasks for the laboratories were however carefully chosen to amplify and deepen the students' knowledge of the subject matter and to give them some degree of autonomy. There are fewer labs than in the 'old' course. Also the lab activities were made more varied than in the 'old' course Students were strongly encouraged to read the lab schedules in advance. An attendance register was marked during the laboratory sessions. The reduction in the number of labs was to allow students more time for private study. The working in pairs of students during the practicals could at times lead to confusion and distractions for the pupils ( see explanation in chapter 7 on Perry model).

**Simulations** - The use of simulations was good as they simplify complex reality. They were used during lab times. Examples of such activities include the marking of essays by students so that they have an idea of what to look for in an essay. The aim in using simulations was to create a learning atmosphere that will encourage student- centred interaction.

**Teaching Assistants** - Four teaching assistants were used in the course. The functions of the teaching assistants consisted of supervising the labs, helping students with problems, training demonstrators, organising demonstrators notes and general administration : for example, keeping students records, marking assignments and taking attendance.They also had examination duties, for example : invigilation, marking, sorting out examination materials. They consider their workload as heavy. They also consider the regular demonstrators meetings as very important to them because they refresh their memory and allow discussion and exchange of ideas with other staff and this helps them in the performance of their duties.

**Tutorials** - These were made more frequent. There were 2 - 4 per module, plus the tutorials that were part of the study project on AIDS. Tutorials gave the students experience in small groups, interpretation of data, discussing results, essays and biological issues and also excursions to museums. Students are given every encouragement to participate actively during the tutorials. The expansion made in the tutorials programme was considerable compared to the 'old' course.

**Study project credits** - This is common to all modules and it yields 10% of the final mark for the year. According to the Course Information Document (1996), the aims of the study project on AIDS are : - (1) To enable the students to study a subject by reading assigned material, without the aid of lectures. (2) To enable the students to take personal responsibility for planning and carrying out their studies independently of class work. (3) To enable the students to become familiar with reading scientific material from journal and newspaper articles as well as text books. (4) To enable the students to meet with a member of IBLS staff to discuss the essay and related issues.

Students work in a co-operative learning team ( tutorial group ), learning from each other. They abstract and discuss the content of scientific articles and present a well structured essay at the end of the project. This early introduction of autonomy in learning is necessary for the effective development of skills required for independent learning which are necessary for the students' greater autonomy and responsibility.

**Awards of distinction** - Students who perform their study skills project report to a very high level with considerable evidence of individual initiative and understanding have their personal academic record marked with the award of a distinction.

**Safety procedures** - remained the same as in the 'old' course.

The **recommended text** remained the same also: that is Neil Campbell's Biology, third edition. With an increase in the use of the tutorial method there will be the need for an adequate supply of books in order to ensure that the full benefit of the tutorial is achieved, as students will be required to read a lot for their essays and so on.

**Assessment of students performance** - This has become varied and includes : - Course work (laboratory reports and tests) = 15%, Module essay = 15%, Degree examination = 70% and also credits are gained from the study project.

The students submit an essay for each module. These essays gave them training in writing a scientific article and they were also designed to lead them into a more investigative and thoughtful style of study - independent study. Some of these essays were written under exam conditions. Tests or assignments were submitted at the end of each lab. These were also designed to draw their laboratory knowledge together.

There were also objective questions for the students work at the end of each lab which were also marked. Since a wider range of the students' ability was being tested, the inclusion of many smaller elements in the objective test provided a greater reliability than the essay questions. The objective tests do not however test the ability of the students to organise facts and ideas.

The degree exams come after each respective module, giving the students an experience of progressive assessment that encourages learning.

The lab schedules are submitted after each lab and are returned by the next lab. The assessment of the lab schedules gives the students an opportunity to demonstrate the various scientific skills they have acquired.

A problem of written lab reports is that they may be copied from fellow students. This can be overcome by the use of individual sets of activities so that collusion with fellow students is reduced. Students can be given different samples to prepare or different variables or the characteristics of different materials or organisms to measure. Another alternative is for a student to record results in a lab duplicate note book (Boud, 1981). At the end of the lab session one copy of the results is handed in to the class tutor and the other is retained by the student. A written lab report cannot be used directly to assess many of the abilities needed in carrying out experimental activities but these can be inferred from the quality of the experimental results, provided that sufficient precautions have been taken to ensure that they are the student's own work. Also, with respect to the frequency of lab report presentation, if extensive reports of every weekly session are expected then it is likely that the quality will be low, because of the time required to produce them. It is also likely that such reports will not be carefully assessed. A full report could be made a few times during the term, and students could be allowed to choose from a set of activities, those for which a full report is prepared.

**Degree examinations** - These follow immediately after the respective module, in week 13 and weeks 26 - 30 respectively. The spread of the degree exams may be beneficial to the students because of the restriction to the area of coverage to each module. Students are not exempted. There is a resit examination. Class tickets are awarded as usual. There is an external examiner who oversees the nature of the examination papers, the position of the pass/fail boundary and the standard of marking of the examination papers and continuous assessment.

By taking these examinations immediately after each respective module, the student experiences a progressive assessment which influences programme choice in a healthy and constructive way. Knowledge of how he or she is doing will assist the student in working to his strengths, compensating for weakness and revising aims on an informed and realistic basis (Watson, 1989).

A look at the examination question papers reveals that the students were to answer all the questions but they had a choice within the essay question. This was good because the reliability of written exams as consistent measuring devices for student achievement is improved by reducing the extent to which students are offered a free choice of questions. A test of compulsory questions offers a consistent measure of all the students who are being assessed.

The exam question format included portions that require students to apply the knowledge they have received and also portions requiring skill and ingenuity. This was necessary because there is a need to introduce questions that compel students to exercise cognitive skills at higher levels than recall of knowledge.

**Continuous assessment** - This replaced the problem solving section of the lab schedule in the 'old' course. It comprised objective tests, assignments and an essay. Hence it is comprehensive, because it uses a variety of instruments to determine students performance. It carries 30% of the marks when a module is examined, therefore it is cumulative because all these measurements are taken into account when presenting a picture of the students at the end of the course. Continuous assessment provides the best opportunity for feedback on what students are learning from the course and also for reinforcing the teaching by positive comments and correction on the students performance.

Hence they are guidance oriented. With continuous assessment the students are able to identify their problems and make efforts to remedy them.

**Feedback to students on progress** - Marked work is returned with valuable comments and model answers are made available to the students.

**Student support** - These include (1) Advisers of studies - Each student is assigned to an adviser of studies who provides guidance and gives approval on choice of curriculum. (2) Staff/student committee - Each module has such a committee comprising of two members of staff, four students, one of the students to chair the meeting and another to act as its secretary. Minutes of each meeting are displayed on the notice boards for all the students to see and they are then sent to the UTU Offices where students' comments and any action necessary are monitored.

Other committees where students participate include (a) Level One Science Co-ordinating Committee, which has eight students representatives, (b) IBLS Quality Assurance Committee which has one student representative from level one (c) IBLS Teaching Committee which also has one student representative from level one.

These various committees on which students are members ensure that students have a say in their education . These are excellent steps taken by the department.

(3) Questionnaires - Each module is assessed by the students and the results are sent to the Level One Science Co-ordinating Committee.

In general students can only make informed comments on certain parts of the teaching activities. Even though their opinion can only be subjective it is important. The main types of evidence to be obtained from the students include processes of students learning, information on students approach to studying, students perception of the course and teaching, students appreciation of course objectives, students opinions on the course and the teaching (Cox, 1994). This information is a valuable input to the overall evaluation of the teaching. An objective view may not be obtained from students on the quality of the course and the teaching. Information from the students was however sought for on their background for example, age, year of birth , year of study, highest previously attained biology qualification and intention for further study. The students also assessed all aspects of the course such as; textbooks, demonstrators, general organisation of the course, interest in biology, work load, amount of continuous assessment, lecturer's presentation and the content being presented.

(4) Appeals - Students are able to appeal against any academic decisions on matters such as refusal of a class ticket, result of any assessment contributing to the final assessment , or the result of the degree examination. Students are advised to follow a prescribed appeal procedure. Students can also make a written complaint on a need they feel has not been dealt with by the appeal procedure.

(5) Adequate provisions have been made to cater for students with health problems.

(6) Guest Lectures - It has been noted that most students taking biological science subjects do not seek employment from this area after the completion of their degree. As an introduction to the range of opportunities available, the Department provides a series of seminars under the general title of Industrial Awareness.

The general findings will now be presented based on the students responses.

## 5.3 GENERAL FINDINGS FROM THE COURSE

The results in tables 17 - 29 are presented in rank order of the highest percentage of agreement and disagreement of students responses. The word 'agree' (A) in the table indicates statements with which the students agree and the word 'disagree'(D) indicates the statements with which the students disagree on the basis of the balance of percentages in the A and D columns, and irrespective of percentages in the neutral (N) column.

### 5.3.1 THE BIOLOGY COURSE IN GENERAL

For the course in general, questions 1 - 11 of part B section 1 of the questionnaire on biology teaching were used. ( see appendix B). Respondents' opinions are shown in tables 17. The sample size (N) for tables 17 - 29 is 495. Responses are expressed as percentages.

**TABLE 17**

**STUDENTS RESPONSES TO THE BIOLOGY COURSE IN GENERAL**

| **STRONGLY AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. The course in general was well organised | 78.5 | 16.0 | 5.5 |
| 2. Recommended readings from the text contributed to my understanding of the course | 69.7 | 23.6 | 6.7 |
| 3. The content of each module was well organised | 67.1 | 25.4 | 7.5 |
| 4. Overall, I will rate the biology course as very good | 65.5 | 26.3 | 8.2 |
| **AGREE OVERALL** | | | |
| 5. The objectives of each module was very clear to me | 52.4 | 30.1 | 17.5 |
| **AGREE > DISAGREE** | | | |
| 6. The course co - ordination was good | 49.4 | 42.0 | 8.6 |
| 7. My interest in the course increased as the course progressed | 47.7 | 35.3 | 17.0 |
| 8. Compared to other courses, the work load for this course is very heavy | 47.4 | 34.8 | 17.9 |
| 9. I felt challenged in this course to find out things for myself | 40.4 | 38.7 | 20.9 |
| **DISAGREE > AGREE** | | | |
| 10. I have more time in this course for private study | 16.5 | 46.2 | 37.3 |
| 11. The pace of the course was too fast | 15.1 | 51.4 | 33.5 |

**Key : > means greater than**

Table 17 shows that the students rated the organisation of the course and its individual modules as very good. They gave a very similar rating to the biology course as a whole.

The rating of the clarity of the objectives was lower, but still good. A majority of the students know exactly what is expected of them from each module. One of the main advantages of the modular structure is that attention is concentrated into a smaller sphere of activity and the objectives are seen in a sharper focus.

A good text has a good coverage of the syllabus and suitability of language. It shows coherence; that is , the topics discussed are set out in a logical order so that there is a continuous development of ideas. The rating for the recommended text of the biology course was high.

Opinion was very varied on all the other statements, with very high proportions in the neutral category. However, very few students found course co-ordination poor, or the pace of the course too fast.

### 5.3.2 ASSESSMENT PROCEDURES

For the assessment procedures, questions 12 - 15 section 2 of part B of the questionnaire on biology teaching were used and the respondents opinion are shown in table 18.

TABLE 18

**STUDENTS RESPONSES TO ASSESSMENT PROCEDURES**

| **STRONGLY AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. The examination questions were reasonable in difficulty | 70.4 | 22.9 | 6.7 |
| 2. The examination questions covered most aspects of the course reasonably well | 68.2 | 21.1 | 10.8 |
| **AGREE > DISAGREE** | | | |
| 3. The methods of assessment used in the course measured my competence | 40.2 | 38.7 | 21.1 |
| 4. I did get valuable feedback on my learning as I progressed | 38.7 | 38.5 | 22.7 |

**Key : > means greater than**

Responses in Table 18 are interesting. Students strongly agreed that the assessments covered the course and were reasonable in difficulty, but were much less sure that the assessment measured their competence : does this mean they regarded the assessment as not demanding enough? Opinion was very mixed on the quality of the feedback students received on their assessment.

### 5.3.3 ASSIGNMENTS

For the assignments, questions 75 - 80 section 2 of part G of the questionnaire on biology teaching were used and the responses of the students are shown in table 19.

**TABLE 19**

**STUDENT RESPONSES TO ASSIGNMENTS**

| **STRONGLY AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. Marked assignments were returned promptly | 74.8 | 15.0 | 10.2 |
| 2. The assignments were related to the biology course | 70.2 | 20.6 | 9.2 |
| **AGREE OVERALL - 50%** | | | |
| 3. Adequate time was allowed for completing the assignments | 58.2 | 23.3 | 18.5 |
| 4. The written assignments increased my understanding of the biology course | 51.3 | 29.3 | 19.4 |
| **AGREE > DISAGREE** | | | |
| 5. The instructions for the assignments were very clear | 42.3 | 32.9 | 24.9 |
| **DISAGREE > AGREE** | | | |
| 6. Marked assignments were returned with valuable comments | 22.8 | 33.6 | 43.6 |

**Key** **> means greater than**

Ratings were good for some aspects of the assignments, such as promptness of return, but less satisfactory for others. Only 51% felt they increased their understanding of the course, and less than 50% agreed that instructions were clear. Most worrying is the rating on feedback: a majority felt they did not get valuable comments on assignments.

### 5.3.4 THE LABORATORY WORK IN GENERAL

For the laboratory work in general, questions 29 - 49 of part E of the questionnaire on biology teaching were used ( see appendix B ) and the students' opinions are shown in table 20.

## TABLE 20

## STUDENTS RESPONSES TO THE LABORATORY WORK IN GENERAL

| STRONGLY AGREE | A | N | D |
|---|---|---|---|
| 1.The apparatus used during the lab sessions was not difficult to handle | 88.0 | 9.5 | 2.4 |
| 2. For every lab session, the necessary materials were always readily available | 84.5 | 10.8 | 4.7 |
| 3.The demonstrators offered effective supervision | 73.0 | 18.1 | 8.9 |
| 4. The lab sessions helped me to understand some of the topics covered in lectures | 69.3 | 18.2 | 12.5 |
| **AGREE OVERALL - 50%** | | | |
| 5. The lab sessions were well organised | 59.8 | 27.5 | 12.7 |
| 6. The lab procedures were clearly explained in the manuals | 57.8 | 25.5 | 16.7 |
| 7. The lab work encouraged me to think for myself | 55.6 | 33.9 | 10.6 |
| 8. The lab work stimulated my interest in the biological sciences | 55.4 | 31.0 | 13.6 |
| 9. My ability to observe things carefully was improved by the lab work | 51.3 | 39.2 | 9.5 |
| 10. The lab work improved my ability to draw conclusions on the things I observed | 50.4 | 39.3 | 10.3 |
| **AGREE > DISAGREE** | | | |
| 11. I can now do similar lab work without much instruction | 49.7 | 35.1 | 15.2 |
| 12. The lab work helped me to develop my problem solving skills | 46.3 | 41.6 | 12.2 |
| 13. My skills in interpreting data were improved by doing the lab work | 43.9 | 43.5 | 12.6 |
| 14. The lab sessions were mainly investigative | 43.5 | 47.0 | 9.5 |

**Key** > **means greater than**

**TABLE 20 CONT'D**

**STUDENTS RESPONSES TO THE LABORATORY WORK IN GENERAL**

| **STATEMENTS - AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| **15**. The purpose of each lab session was very clear to me at the beginning of the lab | 42.0 | 24.9 | 33.1 |
| **AGREE > DISAGREE** | | | |
| **16**. The preparation I did before coming to each lab session helped to understand what I was doing | 40.3 | 40.9 | 18.7 |
| **17**. I needed more instructions on how to write up my lab reports | 39.0 | 34.3 | 26.8 |
| **18**. I felt challenged to find out things for myself during the lab sessions | 35.7 | 44.0 | 20.3 |
| **19**. The total work load for the lab sessions was very heavy | 35.5 | 42.0 | 22.5 |
| **20**. I had an immediate feedback on how well I have done in my lab work | 32.1 | 36.8 | 31.1 |
| **DISAGREE > AGREE** | | | |
| **21**. Not enough time was given to complete each lab session | 23.7 | 23.3 | 52.9 |

**Key** **> means greater than**

Table 20 shows a high rating for the availability of equipment and materials and their ease of handling : this indicates that students are able to experience hands on experiments to a great extent.

The offering of effective supervision by the demonstrators shows that they are able to carry the students through an inquiry.

The results also show that the labs are fulfilling one of their primary functions of helping the students to understand some of the lecture topics.

The good organisation of the labs indicate that the lab activities and techniques makes learning more meaningful to the students.

The rating of the lab procedures was good because since the students depend on the guidance and direction of the teacher, the lab manual should be clear.

The rating of the lab work as stimulating the interest of the students and enabling them to think for themselves was good. A well designed lab should be a memorable experience for the students, but sometimes lab activities often simply illustrate concepts already understood by the students and are therefore easily forgotten. There is need for lab work that confronts students misconceptions.

Even though the rating of the development of problem solving, drawing conclusions and interpretative skills was fairly good, there is still room for improvement. These skills are mainly developed by investigative labs (Boud, 1981). Hence the need for more investigative labs.

The rather low rating for the purpose of each lab session being clear to the students indicates that there is need for students to understand better the purpose of each lab so that they can benefit from it by knowing what they have achieved in that session.

The results indicate also a need for more effective prelab activities as the rating was low. A need was also revealed by the students for more instructions on how to write up their lab reports. The rating was low and students were divided in opinion on this.

The work load for the lab sessions was considered by some as very heavy, but not by the majority overall. Most regarded the time allotted for each lab session as adequate. Students were divided in opinion that they had immediate feedback on how well they have done in their lab work. Feedback is crucial to student learning and progress. It should have a promptness and a directness in it.

### 5.3.5 TUTORIALS

For the tutorials, questions 58 - 74 section 1 part G of the questionnaire on the biology teaching were used and the respondents' opinions are shown in table 21.

**TABLE 21**

**STUDENT RESPONSES TO TUTORIALS**

| **STRONGLY AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. The lecturer had a friendly attitude towards the students | 84.6 | 11.6 | 3.9 |
| 2. The lecturer had a thorough knowledge of the subject matter | 84.0 | 12.2 | 3.9 |
| 3. The size of the class was appropriate for effective student participation | 78.6 | 11.6 | 9.8 |
| 4. The topic discussed at the tutorials was always very clear to me | 66.3 | 22.9 | 10.8 |
| 5. The lecturer encouraged the students to use their own initiative | 65.5 | 27.6 | 6.9 |
| 6. A relaxed atmosphere existed during the tutorial session | 64.5 | 21.1 | 14.4 |
| 7. I felt free to express my opinion in the tutorial class | 62.3 | 24.8 | 13.0 |
| 8. The tutorials helped me to understand some of the topics covered in the lectures | 61.5 | 22.9 | 15.7 |
| **AGREE OVERALL - 50%** | | | |
| 9. I was always encouraged to contribute during the tutorial session | 57.6 | 25.2 | 17.2 |
| 10. Each tutorial was well organised | 53.7 | 30.7 | 15.7 |
| **AGREE > DISAGREE** | | | |
| 11. The lecturer acted as a member of the class rather than as a leader | 49.3 | 21.5 | 29.2 |
| 12. During the tutorials some of the difficulties encountered during the lectures are cleared up | 48.7 | 32.5 | 18.9 |

**Key : > means greater than**

**TABLE 21 CONT'D**

**STUDENT RESPONSES TO TUTORIALS**

| **AGREE > DISAGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 13. The tutor clearly explained how the topic discussed relates to the biology course | 41.3 | 40.2 | 18.5 |
| 14. New materials are always covered during the tutorial sessions | 31.9 | 42.0 | 26.1 |
| 15. Tutorials stimulated my interest in the biology course | 27.5 | 44.9 | 27.6 |
| **DISAGREE > AGREE** | | | |
| 16. I knew the names of everyone in my tutorial group | 26.8 | 14.6 | 58.5 |
| 17. I look forward to tutorial sessions | 20.9 | 37.7 | 41.4 |

**Key : > means greater than**

The lecturer having a very friendly attitude towards the students would mean that a relaxed environment during tutorials can be created which elicits students participation and interest.

Also a lecturer having a thorough knowledge of the subject matter during tutorials is important because students have confidence in a lecturer who shows competence in his field. The teacher must however continue to learn with the students giving them a feeling that we are all together in this. It strengthens rapport. The rating was good.

A tutorial class of 25 may be appropriate considering the population of the whole class. However, the students have shown in this study that they do not know the names of everyone in their tutorial group: this is an indication that the group is large and may mean that the lecturer faces some interpersonal distances which can be overcome by getting the students to learn each others names. If the group is considered large and the room in which the tutorial is held is also large, the students could be split into smaller groups, the teacher touring between them and finally bringing them together for a plenary session.

The rating of the topic discussed at tutorial was good showing that the students do come to the tutorial session prepared. Students who lack knowledge or background on the topic may become bored and disinterested. Students could be involved in the selection of the topic because this ensures a greater commitment on the part of the students.

The teacher encouraged the students to use their own initiative : this rating was high. A good tutorial is that for which an antecedent effort is required from the student (Hale, !964). This effort is evoked by setting him some exercise to do which will be discussed at the next meeting. In this way the student is encouraged to make his/her contribution to the subject under discussion. It is important that each student feel that his contribution will be accepted or rejected on the basis of its merit after thoughtful consideration by the teacher.

The result also showed that the tutorials helped the students to understand some of the topics covered during the lectures. Normally lectures should be supplemented by tutorials where the student puts to test what he thinks he has learnt; if it is imperfectly done, he will show his teacher the gaps in his knowledge and understanding and he can therefore be helped accordingly.

The organisation of the tutorials was good. This means that the objectives, the size, the activities, the frequency of the tutorials were all beneficial to the students.

The lecturer acted as a member of the class rather than a leader. The rating was low, which means that there are occasions when some lecturers may have dominated the discussions. The role of the lecturer at these tutorials should be that of a facilitator because tutorials are student centred activities. When the discussion is dominated by the lecturer the tutorial loses some of its value.

On the teacher explaining how the topic relates to the biology course, the students were divided in opinion and the rating was low. Normally when a teacher explains the topic, he at the same time emphasises the importance of the topic and what knowledge or skills are to be gained by the student. If this is lacking it might explain the reasons for the low rating.

New materials were always covered at the tutorials. The rating was low because sometimes this may not be the case as the tutorials at times may concentrate on encouraging regular habits of work with the actual discussion playing a relatively minor part. Hence new materials may not always be covered.

The rating of the tutorial as stimulating the students' interest in biology was low. Tutorials serve two main purposes; firstly, the discovery of difficulties that students might have and dealing with them, thereby making learning more satisfying; secondly, the training of students to work on their own thereby enabling them to develop their reasoning powers. When these objectives are achieved, the students' interest should increase and consequently stimulate their interest in biology and result in the students looking forward to the tutorial sessions.

### 5.3.6 THE LESS AND THE MORE INVESTIGATIVE LABORATORIES

These two different labs were looked at separately for the purpose of comparison. The less investigative laboratory (on mammalian structure and function), offered the students a lesser degree of autonomy than the more investigative laboratory (on human energy and metabolism), where the students assume a greater responsibility for their learning by finding out more things for themselves. Different labs were compared in the new and the old course. Questions 50 - 57 of part F of the biology teaching questionnaire were used to determine the students opinion on these two labs. Their opinions are shown in tables 22 and 23. In asking for responses to these two laboratories, students were not told that staff regarded one as more investigative than the other. ( See Appendix D )

**TABLE 22**

**STUDENTS RESPONSES TO THE MORE INVESTIGATIVE LABORATORY**

**HUMAN ENERGY AND METABOLISM (ENERGY FLOW)**

| **STRONGLY AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. The manual for this lab was straightforward | 64.4 | 23.6 | 12.0 |
| 2. This lab session challenged me to find out things for myself | 62.7 | 27.1 | 10.2 |
| 3. The time allotted for this lab was adequate | 62.2 | 19.8 | 18.0 |
| 4. This lab session was mainly investigative | 60.9 | 30.5 | 8.6 |
| **AGREE OVERALL - 50%** | | | |
| 5. This lab work enabled me to use my own initiative | 57.1 | 33.1 | 9.8 |
| **AGREE > DISAGREE** | | | |
| 6. This lab work helped me to develop my problem solving skills | 46.2 | 41.3 | 12.5 |
| **DISAGREE > AGREE** | | | |
| 7. The tasks given in this lab were overwhelming | 13.6 | 38.7 | 47.7 |
| 8. There was too much of a cook - book approach in this lab | 23.7 | 45.2 | 31.1 |

**Key : > means greater than**

Table 22 shows that the students did perceive some degree of autonomy in this lab hence they felt strongly that the lab challenged them to find out things for themselves, enabled them to use their initiative and helped them to develop their problem solving skills. They also saw the lab as mainly investigative. The time alloted the lab and the clarity of the labs are essentially controls to compare with the less investigative lab.

# TABLE 23

## STUDENT RESPONSES TO THE LESS INVESTIGATIVE LABORATORY MAMMALIAN STRUCTURE AND FUNCTION (ANATOMY OF RAT)

| **STRONGLY AGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. The time allotted for this lab session was adequate | 68.0 | 20.6 | 11.4 |
| **AGREE OVERALL - 50%** | | | |
| 2. The manual for this lab was straightforward | 57.1 | 29.0 | 13.9 |
| **AGREE > DISAGREE** | | | |
| 3. This lab session was mainly investigative | 44.7 | 37.4 | 17.9 |
| 4. This lab session challenged me to find out things for myself | 40.0 | 37.1 | 22.8 |
| 5. This lab work helped me to develop my problem solving skills | 27.6 | 46.7 | 25.7 |
| 6. This labwork enabled me to use mt initiative | 29.3 | 42.1 | 28.6 |
| **DISAGREE > AGREE** | | | |
| 7. The tasks given in this lab were overwhelming | 10.6 | 39.4 | 50.0 |
| 8. There was too much of a cook-book approach in this lab | 25.8 | 43.9 | 30.4 |

**Key : > means greater than**

Table 23 reveals that the students did perceive a lesser degree of autonomy in the less investigative lab and hence the low rating that the lab challenges them to find out things for themselves, helped them to develop their problem solving skills and enabled them to use their initiative. The result also showed that the tasks given in the lab were not overwhelming. The statements on time allotted and the clarity of the lab manuals are essentially controls, and results on these statements for the two laboratories are quite similar.

# TABLE 24

## THE DIFFERENCES IN STUDENT ATTITUDES BETWEEN THE LESS AND THE MORE INVESTIGATIVE LABS

| | LESS | | | MORE | | | |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | $X^2$ |
| 1. The time allotted for this lab session was adequate | 68.0 | 20.6 | 11.4 | 62.2 | 19.8 | 18.0 | *8.41 |
| 2. The manual for this lab was straightforward | 57.1 | 29.0 | 13.9 | 64.4 | 23.6 | 12.0 | 5.51 |
| 3. This lab session was mainly investigative | 44.7 | 37.0 | 17.9 | 60.9 | 30.5 | 8.6 | ***31.41 |
| 4. This lab session challenged me to find out things for myself | 40.0 | 37.1 | 22.8 | 62.7 | 27.1 | 10.2 | ***55.21 |
| 5. This lab work helped me to develop my problem solving skills | 27.6 | 46.7 | 25.7 | 46.2 | 41.3 | 12.5 | ***46.74 |
| 6. This labwork enabled me to use my initiative | 29.3 | 42.1 | 28.6 | 57.1 | 33.1 | 9.8 | ***93.99 |
| 7. The tasks given in this lab were overwhelming | 10.6 | 39.4 | 50.0 | 13.6 | 38.7 | 47.7 | 2.19 |
| 8. There was too much of a cook-book approach in this lab | 25.8 | 43.9 | 30.4 | 23.7 | 45.2 | 31.1 | 0.55 |

**Key : * P< 0.05, *** P < 0.001**

The table shows the differences in attitudes between the less and the more investigative labs. The differences were highly significant with respect to the labs challenging the students to find out things for themselves, enabling them to use their initiatives, helping them to develop their problem solving skills and the lab being mainly investigative. All these were in favour of the more investigative lab thereby establishing the fact that the more investigative lab did encourage the students to became autonomous.

### 5.3.7 THE LECTURES ON MITOSIS AND ORGANELLES

These two lectures were looked at for the purpose of comparison, to see whether some lectures encourage the students to become autonomous in their learning. Questions 24 - 28 of part D of the biology teaching questionnaire were used to determine the opinion of students on these two lectures. These two lectures were chosen because one of them (mitosis) was rated by the students during their termly evaluation of lectures as the highest and the other (organelles) the lowest in terms of presentation. The responses of the students are shown in table 25 and 26.

**TABLE 25**

**STUDENT RESPONSES TO THE LECTURE ON MITOSIS**

| AGREE > DISAGREE | A | N | D |
|---|---|---|---|
| 1. The teaching aids used in this lecture improved my learning | 46.3 | 42.0 | 11.7 |
| 2. This lecture stimulated my interest in the biology course | 45.0 | 38.4 | 16.6 |
| 3. This lecture encouraged me to investigate this subject more | 35.0 | 38.9 | 26.0 |
| 4. This lecture encouraged me to think critically | 35.0 | 45.5 | 19.5 |
| 5. This lecture enabled me to transfer the knowledge I received to new situations | 34.6 | 40.0 | 25.4 |

**Key** > **means greater than**

Table 25 shows that the students were divided in their opinion on all aspects even though there was an overall positive attitude. The results however showed that lectures are capable of encouraging autonomous learning in some students. Aspects such as critical thinking, investigation and transfer of knowledge were encouraged in some.

**TABLE 26**

**STUDENTS RESPONSES TO LECTURE ON ORGANELLES**

| **AGREE > DISAGREE** | **A** | **N** | **D** |
|---|---|---|---|
| 1. This lecture stimulated my interest in the biology course | 33.5 | 48.6 | 17.9 |
| 2. The teaching aids used in this lecture improved my learning | 32.2 | 57.4 | 10.3 |
| 3. This lecture encouraged me to investigate this subject more | 27.6 | 46.0 | 26.4 |
| 4. This lecture encouraged me to think critically | 21.4 | 58.4 | 20.2 |
| **DISAGREE > AGREE** | | | |
| 5. This lecture enabled me to transfer the knowledge I received to new situations | 24.5 | 49.9 | 25.6 |

**Key : > means greater than**

Table 26 reveals a lower rating for this lecture by the students on all statements. The students were very much divided in their opinion on this lecture. This was the lecture that was rated lowest in presentation by the students during their termly evaluation. This results confirms their earlier rating as the lecture was again rated lower than the one on mitosis. Hence the results reveal that the students did perceive a lesser degree of autonomy in the lecture. Such aspects that could encourage autonomy in students were rated lowest for example, encouraging more investigation of the subject, critical thinking and transfer of knowledge. Lectures should kindle the enthusiasm of the students and stimulate their thought.

# TABLE 27

## THE DIFFERENCES IN STUDENT ATTITUDES BETWEEN THE LECTURE ON MITOSIS AND ORGANELLES

| | MITOSIS | | | ORGANELLES | | | |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | $X^2$ |
| 1. This lecture stimulated my interest in the biology course | 45.0 | 38.4 | 16.6 | 33.5 | 48.6 | 17.9 | ***14.12 |
| 2. The teaching aids used in this lecture improved my learning | 46.3 | 42.0 | 11.7 | 32.2 | 57.4 | 10.3 | ***24.30 |
| 3. This lecture encouraged me to investigate this subject more | 35.0 | 38.9 | 26.0 | 27.6 | 46.0 | 26.4 | *7.12 |
| 4. This lecture encouraged me to think critically | 35.0 | 45.5 | 19.5 | 21.4 | 58.4 | 20.2 | ***23.72 |
| 5. This lecture enabled me to transfer the knowledge I received to new situations | 34.6 | 40.0 | 25.4 | 24.5 | 49.9 | 25.6 | ***13.73 |

**Key : * $P < 0.05$, *** $P < 0.001$**

The table shows the differences in attitudes between the lecture on mitosis and organelles. The students were divided in opinion on all aspects especially with the lecture on organelles. The differences were highly significant on 4 out of 5 statements and all of them were in favour of the lecture on mitosis indicating that the lecture did encourage the students to become autonomous in their learning.

### 5.3.8 THE STUDY PROJECT ON AIDS

For this aspect of the course, questions 16 - 21 of section 3 part B of the biology teaching questionnaire were used to determine the students' opinions on it. The opinions of the students are shown in table 28.

**TABLE 28**

**STUDENT RESPONSES TO STUDY PROJECT ON AIDS**

| **AGREE OVERALL - 50%** | **A** | **N** | **D** |
|---|---|---|---|
| 1. The study project on AIDS has enhanced my ability to carry out my studies independently | 52.9 | 26.8 | 20.3 |
| 2. The project work has encouraged me to think for myself | 50.9 | 30.8 | 18.3 |
| **AGREE > DISAGREE** | | | |
| 3. My investigative skills were greatly improved by the project work | 38.5 | 37.1 | 24.3 |
| 4. My ability to integrate data has been enhanced by the project work | 31.4 | 46.5 | 22.1 |
| **DISAGREE > AGREE** | | | |
| 5. The project work has given me a chance in my university career to be creative | 27.6 | 40.5 | 31.9 |
| 6. Project work has been the most enjoyable aspect of my course | 18.5 | 31.1 | 50.4 |

**Key : > means greater than**

Table 28 shows that the study project on AIDS has succeeded in encouraging the students to become autonomous in their learning by enhancing their ability to carry out their studies independently and encouraging them to think for themselves. This means that the project on AIDS has encouraged the students to assume responsibility for their learning. Oguniyi (1986), with respect to independent learning, emphasised that learning is an individual affair and no lectures, discussion or even experimentation can substitute for what an individual learns on his own.

About a third of the students felt that their investigative skills had been greatly improved. This shows that these student to some extent might have been able to bring together experiences and skills of various kinds from the literature. Many were however neutral or disagreed : this could be because some felt their skills were already good, and the project made little difference. It is particularly interesting that a majority did not find the project enjoyable especially since final year students ( data not shown ) generally report their project as being the most enjoyable part of the year. Probable reasons for such an attitude could be the first year students may have found the project too time consuming and the marks allocated for such an assignment inadequate.

### 5.3.9 ENCOURAGEMENT TOWARDS AUTONOMOUS LEARNING

In determining whether students were being encouraged to become autonomous, questions 3 and 4 of part B, 16, 17 and 19 of part B section 111, 24, 27 and 28 of part D, 33, 35, 44, 45, 46, 47, 48 and 49 of part E , 51, 52 and 53 of part F, 61, 62 and 70 of part G were used. Respondents opinions are shown in table 29.

**TABLE 29**

**STUDENTS RESPONSES TO ENCOURAGEMENT TOWARDS AUTONOMOUS LEARNING**

| STATEMENTS | A | N | D |
|---|---|---|---|
| **THE COURSE IN GENERAL** | | | |
| 1. I felt challenged in this course to find out things for myself | 40.4 | 38.7 | 20.9 |
| **STUDY PROJECT ON AIDS** | | | |
| 2. The study project on AIDS has enhanced my ability to carry out my studies independently | 52.9 | 26.8 | 20.3 |
| 3. The project work encouraged me to think for myself. | 50.9 | 30.8 | 18.3 |
| **LECTURE ON MITOSIS** | | | |
| 4. This lecture encouraged me to investigate this subject more | 35.0 | 38.9 | 26.0 |
| 5. This lecture enabled me to transfer the knowledge I received to new situations | 34.6 | 40.0 | 25.4 |
| **THE LABORATORY WORK IN GENERAL** | | | |
| 6. The lab work encouraged me to think for myself | 55.6 | 33.9 | 10.6 |
| 7. My ability to observe things carefully was improved by the lab work | 51.3 | 39.2 | 9.5 |
| 8. The lab work improved my ability to draw conclusions on the things I observed | 50.4 | 39.3 | 10.3 |
| 9. I can now do similar lab work without much instruction | 49.7 | 35.1 | 15.2 |
| 10. I felt challenged to find out things for myself during the lab session | 35.7 | 44.0 | 20.3 |
| **THE MORE INVESTIGATIVE LABORATORY** | | | |
| 11. This lab session challenged me to find out things for myself | 62.5 | 27.3 | 10.2 |

**Key : > means greater than**

**TABLE 29 CONT'D**

**STUDENTS RESPONSES TO ENCOURAGEMENT TOWARDS AUTONOMOUS LEARNING**

| | A | N | D |
|---|---|---|---|
| **THE MORE INVESTIGATIVE LABORATORY** | | | |
| **12**. This lab work helped me to develop my problem solving skills | 46.2 | 41.1 | 12.7 |
| **THE LESS INVESTIGATIVE LABORATORY** | | | |
| **13**. This lab session challenged me to find out things for myself | 40.0 | 37.1 | 22.8 |
| **14**. This lab work helped me to develop my problem solving skills | 27.6 | 46.7 | 25.7 |

**Key : > means greater than**

Table 29 shows that many students clearly were aware of being motivated and challenged to find out things for themselves, in various aspects of the course. However, the ratings on these aspects are never particularly high. This does not reveal whether or not the students enjoyed these challenges. Chapter 7 on the Perry model investigates their attitudes to their modes of learning.

### 5.4 EXAMINATION OF THE HYPOTHESES

Having looked at the overall results, we can now take a closer look at the subsets of the class and compare their attitudes and test the hypotheses. There are four subsets as stated in chapter 3, and they are :- (1) The students with higher entry qualifications and those with lower entry qualifications. (2) Male and female students. (3) Older and younger students (4) Students intending to do biology versus those who do not intend to follow biology further.

There are four hypotheses to be tested in this chapter. In testing these hypotheses, the Chi square statistic was used to compare the differences between observed and expected frequencies. This measures differences between two distributions. In calculating the Chi square value, the data were not used in their original five categories but in the three categories as shown in the tables ( that is, combining strongly agree and agree; strongly disagree and disagree). This avoided having underpopulated cells in the contingency tables for Chi square calculations. Data used for the Chi square calculations were the original numbers, not the percentages. In producing the Bar charts, the percentages of the frequencies were used. This is to ensure an easier visual comparison of the differences and similarities between the groups. The results in tables 25 - 28 are expressed as percentages of degree of agreement or disagreement of the various groups of students. While examining the hypotheses, the results that indicate a significant difference between the two groups are shown in the tables. The level of significance is taken as the rejection of the hypothesis at the 5% level. The remaining results, where there was no significant difference are shown in appendix A.

### 5. 4. 1 Hypothesis one

**There are no significant differences in attitudes between students with higher entry qualifications and those with lower entry qualifications to the course.**

In testing this hypothesis, all the statements in parts B, D, E, F and G were examined and the results are tabulated in table 30. The number of statements tested was 78.

## TABLE 30

## DIFFERENCES IN ATTITUDES BETWEEN HIGHER AND LOWER STUDENTS

| STATEMENTS | HIGHER N = 421 | | | LOWER N = 59 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. The pace of the course was too fast | 13.4 | 50.5 | 36.1 | 27.1 | 59.3 | 13.6 | **15.13 |
| 2. The content of each module was well organised | 69.0 | 24.8 | 6.2 | 55.9 | 25.4 | 18.6 | **11.65 |
| 3. Compared to other courses, the total workload for this course is very heavy | 46.4 | 33.5 | 20.1 | 55.9 | 37.3 | 6.8 | *6.17 |
| 4. I felt challenged to find out things for myself | 38.0 | 40.3 | 21.7 | 55.9 | 33.9 | 10.2 | *8.11 |
| **STUDY PROJECTS ON AIDS** | | | | | | | |
| 5. My investigative skills were greatly improved by the project work | 35.8 | 39.1 | 25.1 | 54.2 | 25.4 | 20.3 | *7.69 |
| 6. My ability to integrate data has been enhanced by the project work | 29.4 | 48.7 | 22.0 | 45.8 | 30.5 | 23.7 | *8.19 |
| 7. The project work has been the most enjoyable aspect of my course | 17.0 | 29.7 | 53.3 | 28.8 | 35.6 | 35.6 | *7.71 |
| **LECTURE ON ORGANELLES** | | | | | | | |
| 8. This lecture encouraged me to investigate the subject more | 25.4 | 48.1 | 26.6 | 44.6 | 33.9 | 21.4 | **9.26 |
| 9. This lecture encouraged me to think critically | 19.1 | 59.9 | 21.0 | 41.1 | 42.9 | 16.0 | **14.06 |
| **LECTURE ON MITOSIS** | | | | | | | |
| 10. This lecture encouraged me to think critically | 31.7 | 47.6 | 20.7 | 52.6 | 33.3 | 14.0 | **9.73 |

**Key : * P < 0 .05, ** P < 0 .01**

## TABLE 30 CONT'D

## DIFFERENCES IN ATTITUDES BETWEEN HIGHER AND LOWER STUDENTS

| STATEMENTS | HIGHER N = 421 | | | LOWER N = 59 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE LECTURE ON MITOSIS** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| **11**. This lecture enabled me to transfer the knowledge I received to new situations | 32.7 | 40.6 | 26.7 | 49.1 | 33.3 | 17.5 | *6.21 |
| **THE LABORATORY WORK IN GENERAL** | | | | | | | |
| **12**. Not enough time was to complete each lab session | 21.9 | 23.1 | 55.0 | 34.5 | 27.6 | 37.9 | *6.68 |
| **THE MORE INVESTIGATIVE LABORATORY** | | | | | | | |
| **13**. The tasks given in this laboratory were overwhelming | 11.9 | 38.2 | 49.9 | 24.1 | 43.1 | 32.8 | *9.10 |
| **14**. There was too much of a cook-book approach in this laboratory | 22.2 | 46.9 | 30.9 | 36.8 | 31.8 | 31.4 | *7.07 |
| **TUTORIALS** | | | | | | | |
| **15**. I looked forward to the tutorial sessions | 19.1 | 38.3 | 42.6 | 34.5 | 36.2 | 29.3 | *8.07 |

**Key : * P < 0 .05**

**** P < 0 .01**

Table 30 shows the differences in response between the students with higher entry qualifications and those with lower entry qualifications. These two groups showed significantly different responses for 15 out of the 78 statements tested : on 5 out of the 15 the differences were highly significant ($P < 0.01$). The main reason for the differences between the two groups may be their background experience in biology. The higher group have considerable background in biology while the lower group have little or no background knowledge in biology. Hence the results revealed that the higher group felt less challenged to think or to find out things for themselves. The lower group on the other hand felt highly challenged to think or to find out things for themselves.

The difference in the response between the two groups with respect to the organisation of the modules may be because the lower group had problems with the modular system.

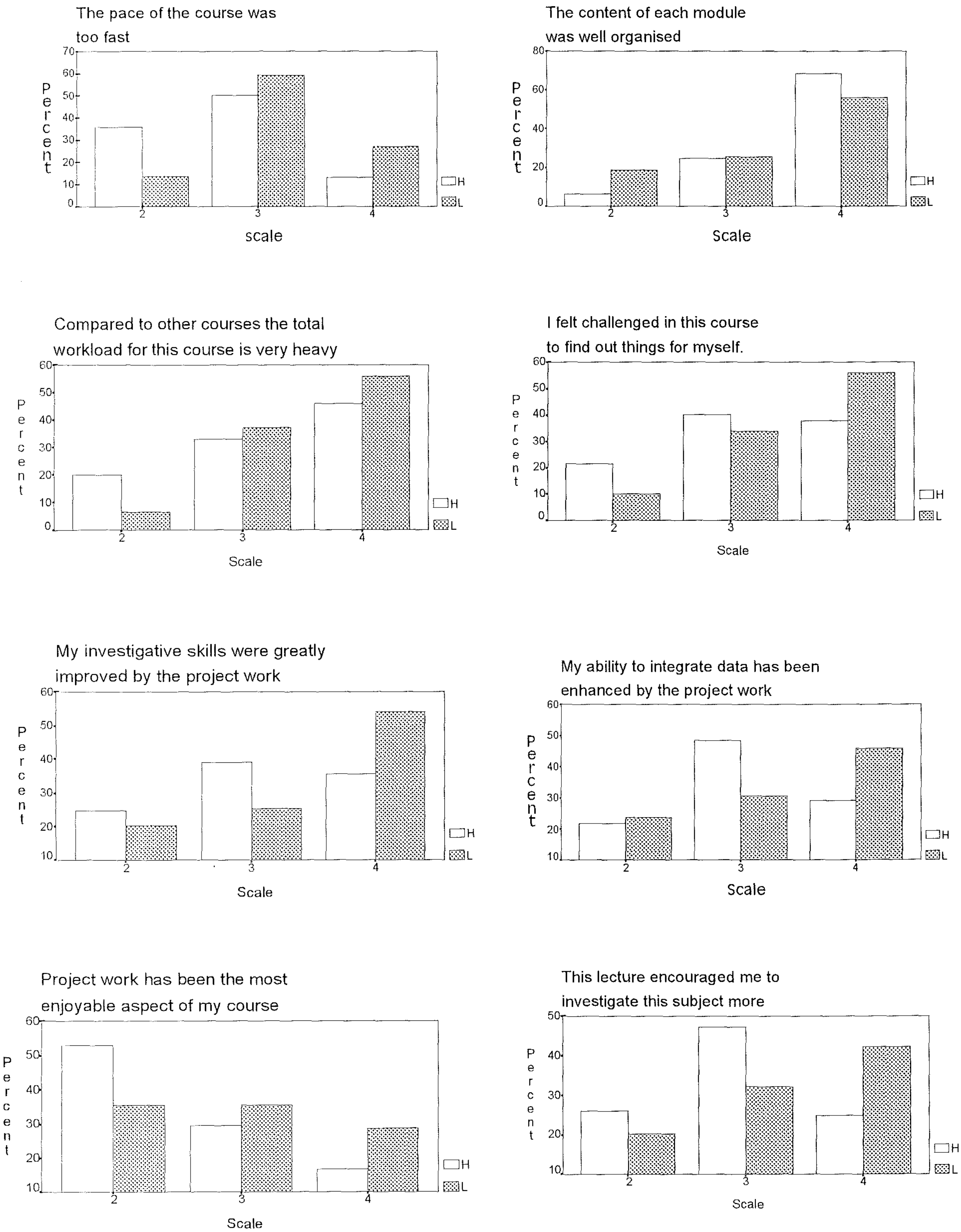
Almost all the statements where significant differences occurred between the higher and the lower group seem to be related to their background experiences. The higher group, because of their considerable background in biology might have not felt sufficiently challenged by the activities of the course. Hence the results showed a lower rating in almost all the aspects by the higher group than the lower group.

Based on these differences, the hypothesis could be rejected at the 5% probability level for 15 out of the 78 aspects of the course that I tested.

The differences between the two groups are further presented as bar charts in figure 5.

# FIGURE 5

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN HIGHER AND LOWER STUDENTS IN 1995/96

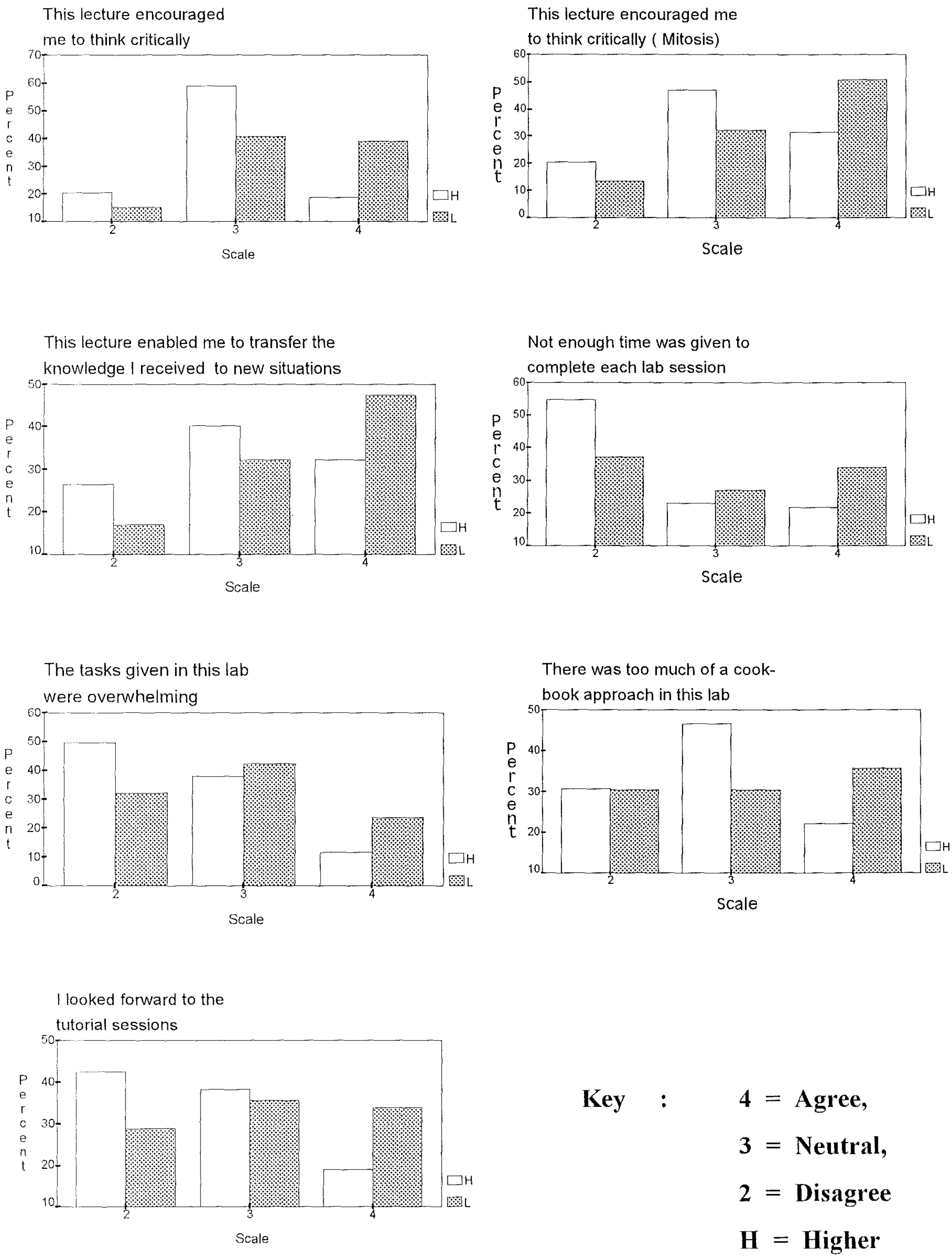



**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

**H = Higher L = Lower**

# FIGURE 5

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN HIGHER AND LOWER STUDENTS IN 1995/96




**Key : 4 = Agree,**
**3 = Neutral,**
**2 = Disagree**
**H = Higher**
**L = Lower**

## 5. 4. 2 Hypothesis two

**There are no significant differences in attitudes between the male and female students to the biology course.**

In testing this hypothesis, all the statements in parts B, D, E, F and G were examined and the results are shown in table 31.

**TABLE 31**

**DIFFERENCES IN ATTITUDE BETWEEN MALE AND FEMALE STUDENTS**

| STATEMENTS | MALE N = 166 | | | FEMALE N = 328 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. The recommended readings from the text contributed to my understanding of the course | 64.0 | 25.6 | 10.4 | 72.7 | 22.4 | 4.9 | *6.48 |
| **ASSESSMENT** | | | | | | | |
| 2. The examination questions were reasonable in difficulty | 64.9 | 24.2 | 10.9 | 73.1 | 22.3 | 4.6 | *6.42 |
| 3. I did get valuable feedback on my learning as I progressed | 43.6 | 30.3 | 26.1 | 36.4 | 43.1 | 20.5 | *7.65 |
| **STUDY PROJECT ON AIDS** | | | | | | | |
| 4. The study project on aids has enhanced my ability to carry out my studies independently | 44.2 | 30.9 | 24.9 | 57.5 | 24.5 | 18.0 | *7.84 |
| **LECTURE ON MITOSIS** | | | | | | | |
| 5. This lecture enabled me to transfer the knowledge I received to new situations | 28.9 | 39.2 | 31.9 | 37.6 | 40.4 | 22.1 | *6.62 |

**Key : * $P < 0.05$**

**TABLE 31 CONT'D**

**DIFFERENCES IN ATTITUDE BETWEEN MALE AND FEMALE STUDENTS**

| STATEMENTS | MALE N = 166 | | | FEMALE N = 328 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **LECTURE ON ORGANELLES** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 6. This lecture enabled me to transfer the knowledge I received to new situations | 22.4 | 44.8 | 32.7 | 25.6 | 52.5 | 21.9 | *6.75 |
| **THE MORE INVESTIGATIVE LABORATORY** | | | | | | | |
| 7. This lab session challenged me to find out things for myself | 56.7 | 28.0 | 15.2 | 65.8 | 26.5 | 7.7 | *7.63 |

**Key : * P < 0.05**

Table 31 shows the differences in attitudes between the male and female students. A significant difference occurred in responses to only 7 out of the 78 statements, none of them highly significant.

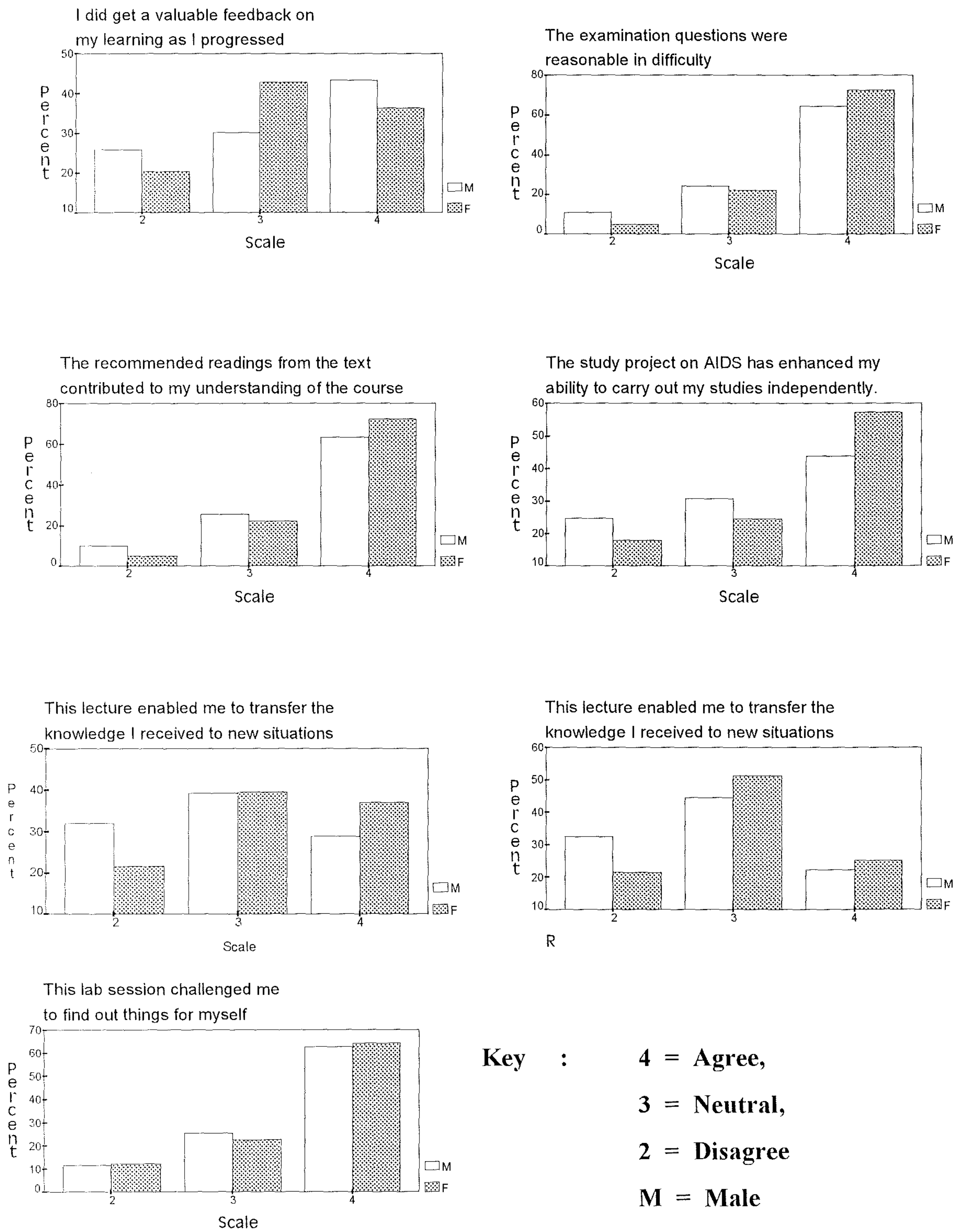
A probable reason for the differences between them may be their preference for biology. Even though these students have chosen biology as their course of study, some research findings have shown that females preferred biology more than the males. The ratio of the number of males to females in this course might be an indication to the existence of that attitude. There were 166 males to 328 females. Another reason that may bring about the differences between the males and females as indicated also by some research findings are that the males are spatially biased while the females are verbally biased. Hence they felt less challenged by the labs to think or find out things for themselves; they also felt that some lectures have not enabled them to transfer the knowledge they have received to new situations and they felt less challenged to carry out their studies independently. There is no obvious reason to explain the difference in their response to their getting valuable feedback on their learning as the course progressed. There is a need for more challenging activities that would stimulate the interest of the males in biology and satisfy their need for abstraction.

Based on these differences, the hypothesis could be rejected at the 5% probability level for 7 out of the 78 aspects of the course that I tested.

The differences between these two groups are further presented as bar charts in figure 6.

# FIGURE 6

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN MALE AND FEMALE STUDENTS IN 1995/96



## 5. 4. 3 Hypothesis three

**There are no significant differences in attitudes between the older and younger students to the biology course.**

In testing this hypothesis, all the statements in parts B, D, E, F and G were examined and the results are shown in table 32.

**TABLE 32**

**DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS**

| STATEMENTS | OLDER N = 66 | | | YOUNGER N = 424 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. The objectives of each module were very clear to me | 62.7 | 16.4 | 20.9 | 50.8 | 32.2 | 16.9 | *6.89 |
| 2. The pace of the course was too fast | 26.9 | 47.8 | 25.4 | 13.6 | 51.8 | 34.6 | *8.20 |
| 3. The course in general was well organised | 67.2 | 25.4 | 7.5 | 80.3 | 14.6 | 5.2 | *6.06 |
| 4. I felt challenged to find out things for myself | 59.7 | 26.9 | 13.4 | 37.3 | 40.6 | 22.1 | **12.07 |
| **LECTURE ON MITOSIS** | | | | | | | |
| 5. This lecture encouraged me to investigate this subject more | 50.0 | 32.8 | 17.2 | 32.7 | 39.9 | 27.4 | *7.62 |
| **LECTURE ON ORGANELLES** | | | | | | | |
| 6. This lecture encouraged me to investigate this subject more | 48.4 | 35.9 | 15.6 | 24.5 | 47.5 | 28.0 | **16.41 |
| **THE LABORATORY WORK IN GENERAL** | | | | | | | |
| 7. The lab sessions were well organised | 50.7 | 25.4 | 23.9 | 61.2 | 27.8 | 11.0 | *8.76 |

**Key : * $P < 0.05$ , ** $P < 0.01$**

**TABLE 32 CONT'D**

**DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS**

| STATEMENTS | OLDER N = 66 | | | YOUNGER N = 424 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTIGATIVE LABORATORY** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| **8**. This lab session enabled me to use my initiative | 41.5 | 38.5 | 20.0 | 27.3 | 42.7 | 30.0 | *6.07 |
| **9**. This lab work helped me to develop my problem solving skills | 38.5 | 46.2 | 15.4 | 25.9 | 46.8 | 27.3 | *6.34 |
| **10**. The tasks given in this lab were overwhelming. | 20.0 | 33.8 | 46.2 | 9.1 | 40.3 | 50.6 | *7.11 |
| **THE MORE INVESTIGATIVE LABORATORY** | | | | | | | |
| **11**. The tasks given in this lab were overwhelming | 24.2 | 36.4 | 39.4 | 12.0 | 39.1 | 48.9 | *7.48 |

**Key : * $P < 0.05$**

Table 32 shows the differences in attitudes between the older and the younger students. Significant differences occurred in responses to 11 out of the 78 statements tested, two of them highly significant, the rest less so.

Probable reasons for the differences may be ; (1) The experience and the maturity of the older group, and this might explain the difference in their responses to the statement that the objectives were clear. They were more positive.

(2) The commitments of the older group which result in their finding the first year work more time consuming than they had anticipated may explain the difference to their responses to the pace of the course being too fast. (3) The unrealistic expectation of the older group might probably be the reason that they agreed less that the course in general

was well organised. The younger group with more recent study experiences, and fewer outside commitments as shown by Robert (1992), may be the reason why they felt less challenged in the course and disagreed more that the tasks given in the labs were overwhelming.

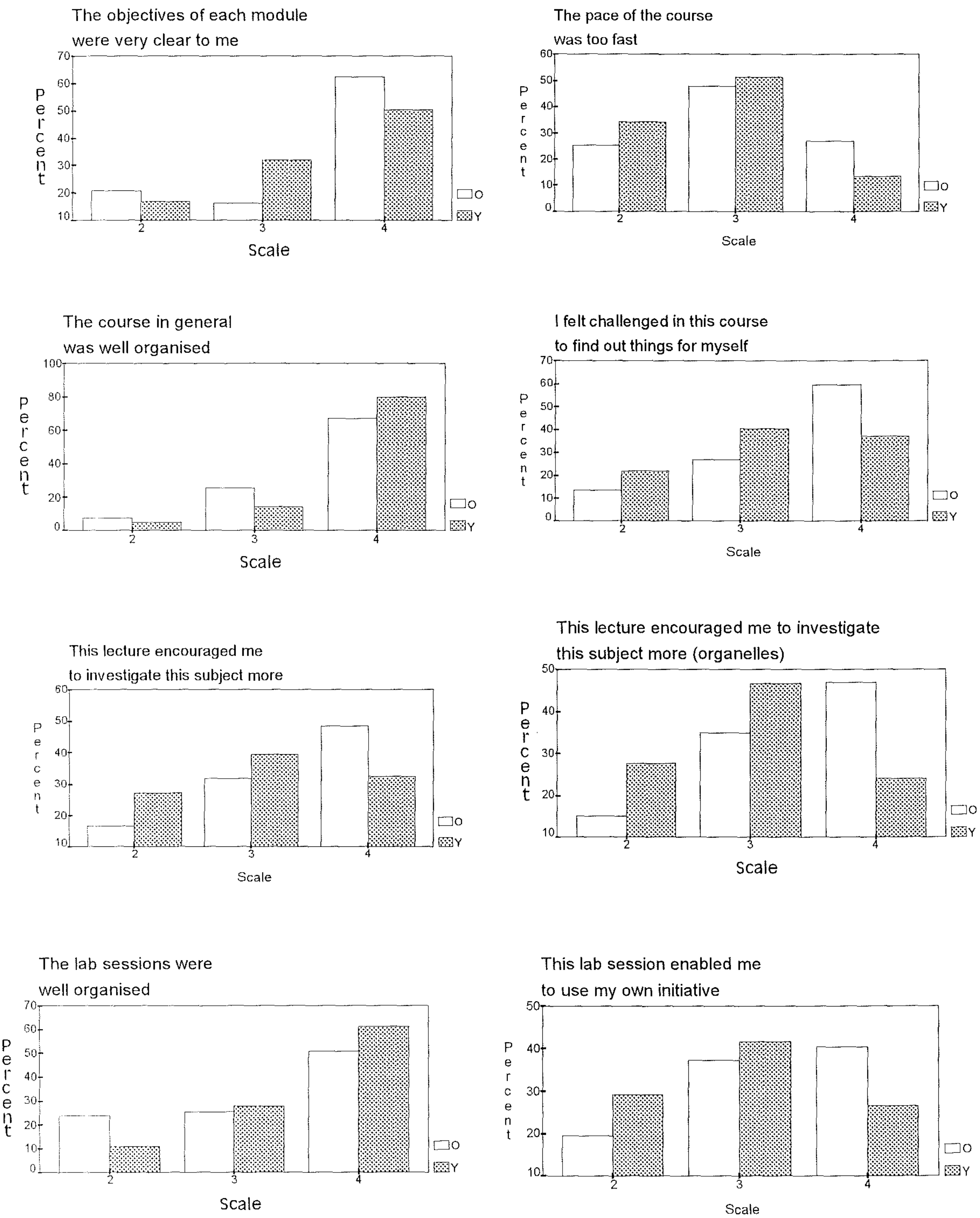
There is a need for more challenging activities for the younger groups. Pre-counselling courses for the older groups could lessen their unrealistic expectation and improved their poor study skills.

Based on these differences, hypothesis three could be rejected at the 5% probability for 11 out of the 78 that statements I tested.

The differences between the two groups are further presented as bar charts in figure 7.

# FIGURE 7

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS IN 1995/96

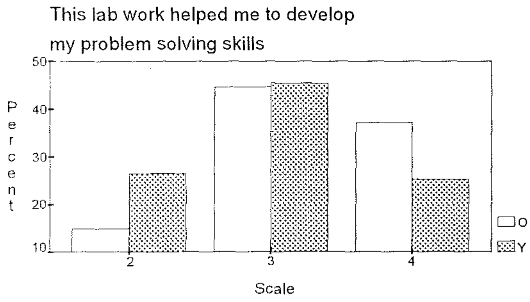


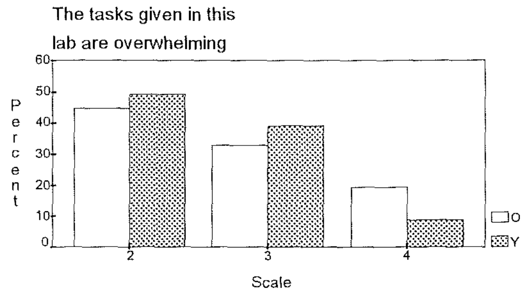

**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

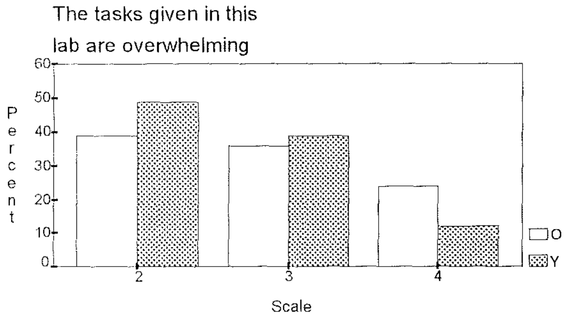
**O = Older Y = Younger**

# FIGURE 7

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN OLDER AND YOUNGER STUDENTS IN 1995/96




**Key :**

**4 = Agree,**

**3 = Neutral,**

**2 = Disagree**

**O = Older**

**Y = Younger**

## 5. 4. 4 Hypothesis four

**There are no significant differences in attitudes to the course between the students who intend to continue with the biology course and those who do not intend to continue with the course.**

In testing this hypothesis, all the statements in parts B, D, E, F and G were examined and the results are tabulated in table 33.

**TABLE 33**

**DIFFERENCES IN ATTITUDES BETWEEN STUDENTS WHO INTEND TO CONTINUE WITH THE BIOLOGY COURSE AND THOSE WHO DO NOT TO INTEND CONTINUE WITH THE COURSE**

| STATEMENTS | Intending Bio N = 352 | | | Non-Intending Bio N = 109 | | | Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 1. My interest in the course increased as the course progressed | 51.7 | 33.8 | 14.5 | 33.9 | 36.7 | 29.4 | **15.8 |
| 2. Overall, I will rate the biology course as very good | 69.1 | 24.6 | 6.3 | 50.5 | 33.0 | 16.5 | **16.55 |
| 3. The pace of the course was too fast | 13.1 | 51.4 | 35.5 | 21.3 | 52.8 | 25.9 | *6.04 |
| **LECTURE ON ORGANELLES** | | | | | | | |
| 4. This lecture stimulated my interest in the biology course | 37.9 | 44.0 | 18.1 | 22.9 | 59.0 | 18.1 | *9.19 |
| 5. This lecture encouraged me to investigate this subject more | 31.1 | 42.4 | 26.5 | 19.1 | 55.2 | 25.7 | *7.12 |
| 6. This lecture enabled me to transfer the knowledge I received to new situations | 26.8 | 48.1 | 25.1 | 17.1 | 61.0 | 21.9 | *5.99 |

TABLE 33 CONT'D

DIFFERENCES IN ATTITUDES BETWEEN STUDENTS WHO INTEND TO CONTINUE WITH THE BIOLOGY COURSE AND THOSE WHO DO NOT TO INTEND CONTINUE WITH THE COURSE

| | **Intending Bio N = 325** | | | **Non-Intending Bio N = 109** | | | **Chi square** |
|---|---|---|---|---|---|---|---|
| **THE LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | $X^2$ |
| 7. The total work load for the lab sessions was very heavy | 32.9 | 40.9 | 26.3 | 45.0 | 40.4 | 14.7 | *8.17 |
| 8. The lab work stimulated my interest in the biology course | 60.6 | 27.8 | 11.6 | 39.8 | 39.8 | 20.4 | **14.86 |
| 9. I can now do similar lab work without much instructions | 53.1 | 34.0 | 12.9 | 38.5 | 40.4 | 21.1 | *8.33 |
| **TUTORIALS** | | | | | | | |
| 10. The lecturer acted as a member of the group rather than as a leader | 52.0 | 19.7 | 28.3 | 38.5 | 27.5 | 34.0 | *6.34 |

**Key : * P < 0.05**

**** P < 0.01**

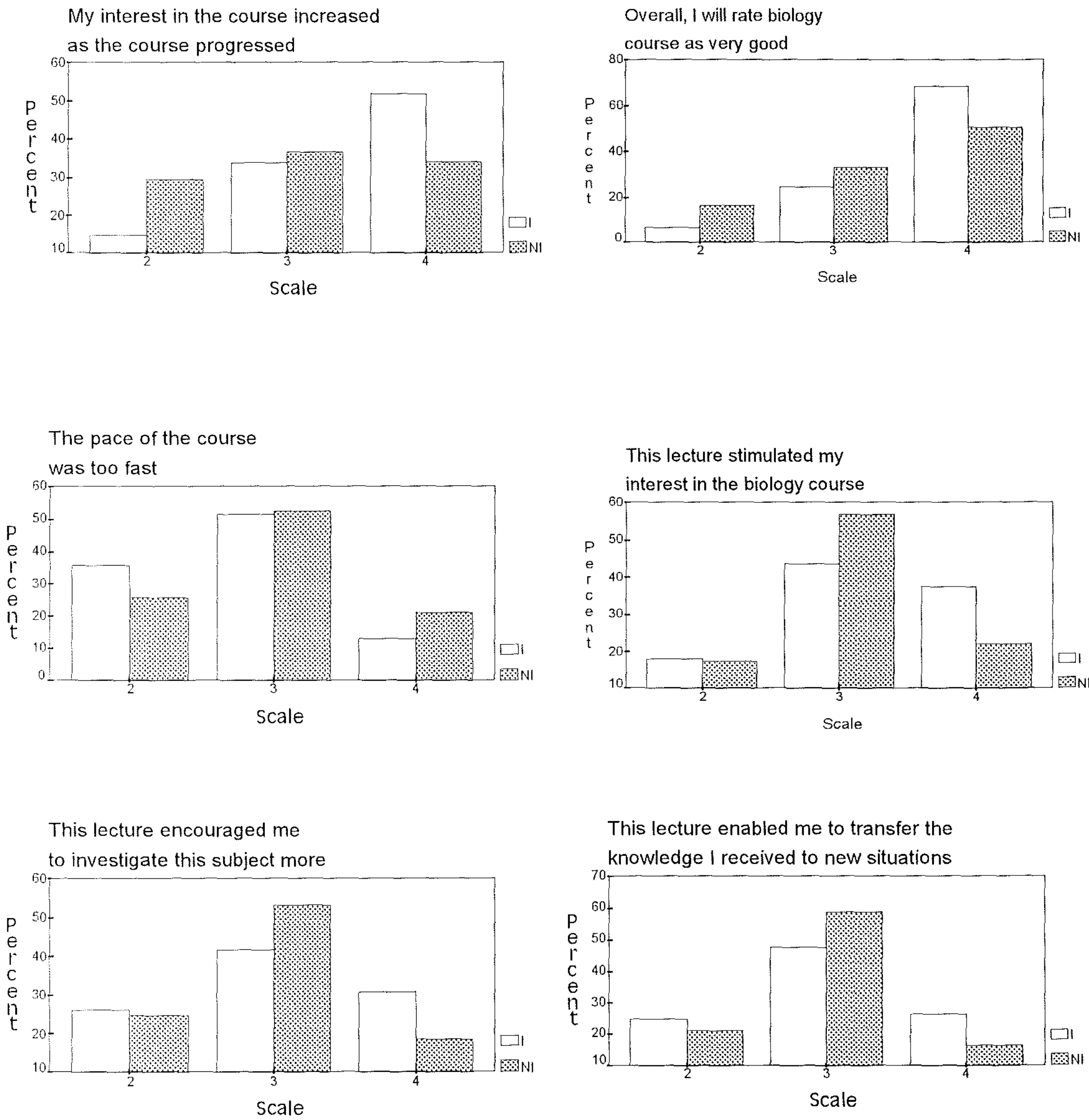
Table 33 shows the differences in attitudes between the non-intending group and the intending group. Significant differences occurred in 10 out of the 78 statements tested, 3 of them highly significant, the rest less so. A probable reason for the significant differences between these two groups may be the lack of interest in biology by the non - intending group. Hence they rated all statements lower than the intending group and they were much divided in their opinion. Hence there may be the need to develop remedial and challenging activities that will assist and stimulate the interest of the non - intending group.

Based on these differences, the hypothesis could be rejected at the 5% probability level for 10 of the 78 statements tested.

The differences between the two groups are further presented as bar charts in figure 8.

**FIGURE 8**

**BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN INTENDING AND NON-INTENDING STUDENTS IN 1995/96**

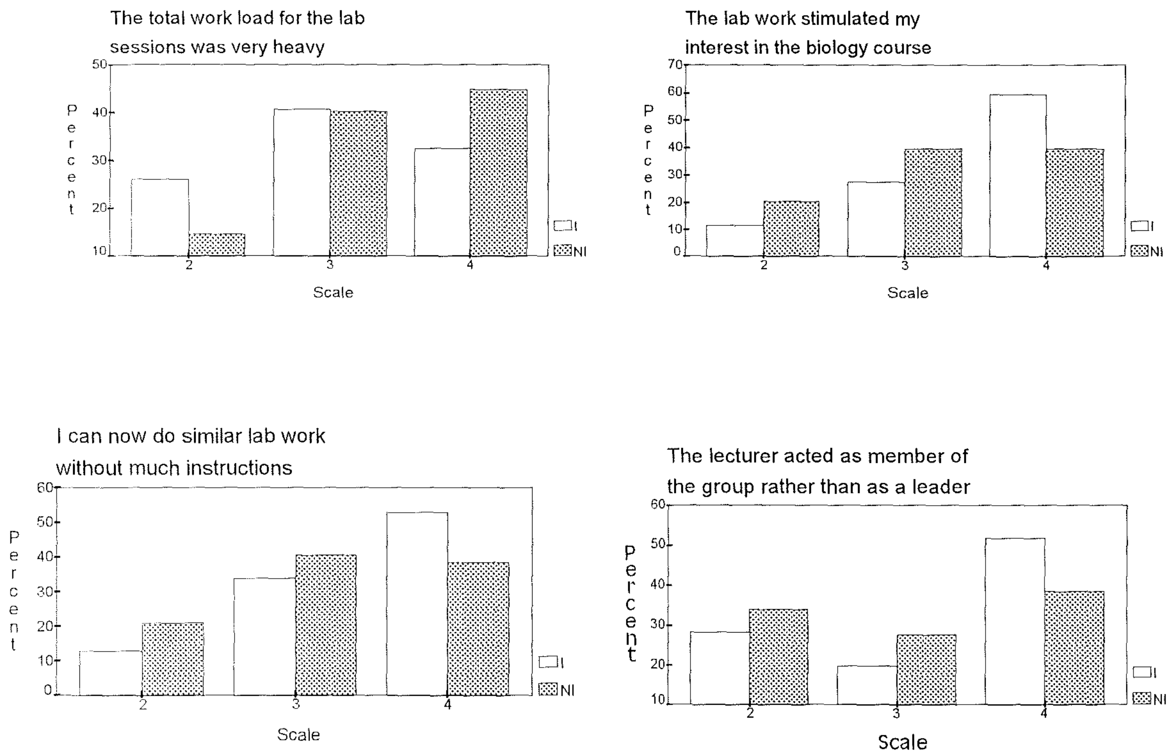



**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

**N = Intending NI = Non - Intending**

# FIGURE 8

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN INTENDING AND NON-INTENDING STUDENTS IN 1995/96




**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

**N = Intending NI = Non - Intending**

## 5.5 SUMMARY OF RESULTS

The results of the various analyses of the data for this chapter are presented according to the general findings from the course and the tests of the four hypotheses. The findings from the observation of the new biology course reveal that many changes have been made so as to provide better learning opportunities for all the students and thereby cater for each student as a unique individual.

The course was modularised, which means that consideration was made of individual interests by allowing for greater course flexibility, permitting a number of differing module combinations. The AIDS Study project was introduced into the course, and these are aspects that include some elements of autonomy which will consequently lead students to greater autonomy and responsibility.

Lectures are held three times instead of the usual two times in the day in order to encourage students attendance. Adequate provision was made for the students to have contact with their lecturers so as to assist them wherever possible. The laboratory activities have become more varied and more investigative in nature so as to deepen the students' knowledge and to give them a degree of autonomy. The tutorials are made more frequent, active and varied. Assessment procedures have become more varied in which students performance could be assessed.

Students are now involved in more committees than previously occurred. The department hoped that with these changes, students will be able to achieve a personal best in terms of academic progress.

The results from the course in general showed that the students have a positive attitude towards the biology course. The students rated the general organisation of the course highest, followed by the main text of the course which they agreed has contributed to their understanding of the course. The students agreed also that the content of each module was well organised. This was then followed by the rating of the whole biology course as very good. Their interest in the course increased as the course progressed and the students felt challenged to find out things for themselves both from the course as a whole and from the laboratories. It is most probable that -: (1) The labs enhanced their investigative skills and added reality to the lecture materials. (2) The assignments increased their understanding of the course and the assessment procedures measured their competence. (3) The tutorials helped them to understand some of the lecture topics and encouraged them to use their own initiative. (4) Some of the lectures encouraged the students to investigate the subject more. (5) The study projects on AIDS enhanced the students' ability to carry out their studies independently. The students agreed that they got valuable feedback on their work as they progressed The students' rating was lower in statements such as "their feeling challenged to find out things for themselves" and also in their initiative, investigative skills, problem solving and their interpretative skills being enhanced.

Table 29 shows positive reactions to statements that indicate that the course most probably encouraged the students to become autonomous in their learning. The table reveals that some elements of autonomy have been introduced in almost all aspects of the course. For example, in the course in general, students were encouraged to find out things for themselves. The study projects on AIDS encouraged them to think for themselves thereby enhancing their ability to carry out their studies independently. Also, as stated earlier, some of the lectures encourage the students to investigate the subject more and also enabled them to transfer the knowledge they had received to new situations. The study also reveals that some of the lectures did not adequately encourage such a transfer. The laboratories most probably encouraged the students to think for themselves and challenged them to find out things for themselves, so that students now feel that they can carry out similar labwork without much instructions. Their ability to observe things carefully and to draw conclusions from the things observed have most probably been improved by the lab work: the degree of agreement, however, was less in these two points. In the labs also, their problem solving skills were most probably being improved, but some of the students disagreed with the statement. During the tutorials the students felt free to express themselves. The tutorials might have helped them to understand some of the topics covered in the lectures by clearing away any difficulties they may have encountered during the lectures.

Considering the responses of the groups , table 34 gives a brief summary of the number of statements in which the responses of the groups were significantly different, and their probability levels.

**TABLE 34**

**THE NUMBER OF STATEMENTS THAT WERE SIGNIFICANTLY DIFFERENT**

| Group and sample sizes | Total No of statements | No of statements that are significantly different | No of statements significant at 5% p level | No of statements significant at 1% p level |
|---|---|---|---|---|
| Higher / Lower H=421, L=59 | 78 | 15 | 10 | 5 |
| Male / Female M=166. F=328 | 78 | 7 | 7 | 0 |
| Older / Younger O=66, Y=424 | 78 | 11 | 9 | 2 |
| Int / Non-Int Int=352, N-I=109 | 78 | 10 | 7 | 3 |
| | 312 | 43 (13.8%) | 33 (10.6%) | 10 (3.2%) |

Table 34 shows the total number of statements that were responded to by each of the groups that have been identified in this study, and also the number of statements that were significantly different and the probability level at which these significant differences occurred. The table also shows the sample sizes of the groups.

With regards to the higher and lower groups, the differences may be due to their different background experience in biology : the higher group with their greater background knowledge in biology and the lower group with little or no background knowledge in biology.

With the male and female comparison the probable reasons for the differences between them may be the difference in their interest in biology. Another reason may be that the need by the males for abstraction might have been the reason why they felt less challenged in the course than the females. Some researches have shown that males are spatially biased while the female are verbally biased.

For the older and younger group, the differences may be due to the fact that the older group showed poor study skills, unrealistic expectations of lectures and teaching methods, family commitments and experience while the younger group had recent study experience and good learning techniques and lack of commitments.

With the non- intending and the intending group, the differences may be due to the relative lack of interest in biology course by the non-intending students.

The number of statements that were significantly different were quite few at the 5% probability level and even fewer at 1% probability level, in comparison to the statements that showed no significant difference.

However the nature of the differences between the groups are real and they are worth noting so that the issues raised should be addressed and the affected group of students assisted.

Having examined the reactions of students to the old and the new course, chapter 6 will try to identify the differences between the 1994/95 and 1995/96 sessions.

# CHAPTER 6

# THE DIFFERENCES IN ATTITUDES OF STUDENTS IN THE OLD AND NEW BIOLOGY COURSES

## 6.1 INTRODUCTION

This chapter presents the differences in attitudes to the biology course between the students in 1994/95 and 1995/96 sessions. It is hoped that these findings will provide an understanding of : -

(a) The extent to which the students differ in attitudes to the biology course in 1994/95 and 1995/96 sessions.

(b) The extent to which the teaching strategies used differ in encouraging the students to become autonomous in their learning.

The order of presentation is as follows : -

6.2 The observed differences between the old biology course and the new biology course.

6.3 The differences from the findings of the course in general.

6.4 The differences from the various groups.

6.5 Summary of results.

## 6.2 THE OBSERVED DIFFERENCES BETWEEN THE OLD AND THE NEW BIOLOGY COURSE

From the observation of the old course and the new course, it was noted that, firstly, the high **enrolment** figure still remains the same, that is, over seven hundred students, both for 1994/95 and 1995/96 session. This called for the need to cater adequately for this inhomogeneity of experience and entry qualifications. Secondly, the **curriculum pattern** for 1994/95 was broad based, that is, where the students followed a carefully designed one year introductory course before deciding on their subsequent choice of specialisation. For 1995/96 session, the modular or unit course structure was introduced in place of the broad based curriculum pattern. This can take into consideration individual interest and allows for greater course flexibility by permitting different module combinations. The modular curriculum pattern offers the students freedom of choice while the broad based curriculum pattern does not. In the new course, however, all students intending to study biological sciences further were required to study all the four modules, so the students did not have much flexibility when this study was carried out. This may change in the future.

The general **aim of the course** - In 1994/95, there was one broad aim for the course. For it to become meaningful to the students it needed to be broken down into several specific aims that could be measured. Each block of lectures had objectives to be met but some of the terms used in stating these objectives were not measurable. With the new course, however, there were several overall objectives that were stated in measurable terms. The modular objectives specify the behaviour to be expected of the learner. The objectives make it clear what the learner is expected to do. They make it clear to the teacher and the examiner what exactly they are entitled to ask the learner to show that he has learned what is expected of him. The clarity of the course objectives was indicated by the students to be more in the new course than the old course (see table 35 statement 6).

### 6.2.1 STRUCTURAL CHANGES

The number of repeats of each **lecture** per day in 1995/96 was increased from two to three to give students an opportunity to attend one at a convenient time : this may have encouraged attendance. The overall number of lectures was reduced compared to 1994/95. This was to give more time to students for private study.

**Practicals** - The activities of the laboratories became more varied in 1995/96. In 1994/95, the lab activities included demonstrations, dissections, experiments and observations. In 1995/96 discussions and simulations were added to these activities. There were also fewer labs in the new course than in the old. This is also an attempt to give the students more time to study on their own. Practicals became more varied and this greater variety of practicals activities may cater for the needs of individual students.

**The laboratory manuals** - The contents of the lab manuals also differed. The items in the lab manual for 1994/55 included; the syllabus for the term, lab schedules and a set of exercises on problem solving in biology. In 1995/96, the lab manuals included the syllabus, lab schedules, aims, objective questions and assignments in addition to the above. The problem solving in biology exercises were omitted. These changes were made largely in order to ensure effectiveness in learning and assessment and to avoid overloading the students.

**Tutorials** - In 1994/95 they were held once per term and were held mainly to assist students with examination formats and practicals. But in 1995/96 they were made more frequent and more varied. Activities in the new tutorials included: discussion of results, biological issues and data interpretation. This was done to ensure that students derive more benefits from the tutorials.

**Assessment** - In 1994/95, assessment procedures included: written examinations at the end of terms 1 and 2, and assessment of a selection of the lab schedules. Assessment of the laboratory work was informal: it did not contribute marks but was part of the criteria for exemption from the degree examination. In 1995/96 these procedures became more varied and included formal assessment of lab reports, tests during lab and tutorial sessions, assignments, a module essay and degree examinations. Credits from the AIDS study projects are added as 'top-up' marks to module grades. Each module was assessed by (a) course work (30%) and (b) degree examination at the end of each module (70%). Course work varies with each module, but usually it includes an essay, some multiple choice questions in laboratory time and some assessment of lab work. The varied nature of the assessment is commendable: it helps ensure the validity of the assessment.

**Degree examinations** - In 1994/95, they were held at the end of the session and students could be exempted if their class examination performances were good. Class tickets were awarded to students in order to permit them to sit the exams. There was a resit examination in September if a student failed his exams in June. In 1995/96, the degree exams came immediately after each module. Students could not be exempted. Resit examinations still took place in September for all modules. Class tickets were issued to the students as usual. There was an external examiner as in 1994/95 to oversee the marking of the examination, the continuous assessment and the nature of the examination papers. The 12 week modular structure made end of term 'class' examinations redundant.

**Student support** - In 1994/95, there was a student /staff committee, which acted as a channel of communication between the staff and the students. A termly questionnaire was completed by the students on all aspects of the course . Each student had an adviser of studies but the adviser was not specific to the biology course : rather, the adviser supported the students on all aspects of their studies at the university. In 1995/96, these basic features were retained, but reorganised to suit the modular structure, so that each module had a staff / student committee, and an end of module questionnaire. Questionnaires were re-designed in an effort to make them more informative and improve feedback from the students.

**Learning resources** - In 1994/95, a study room containing limited resources (books, some permanent specimens used in laboratories) was available. In 1995/96, this study room was converted into a computer laboratory for student use. A limited library of texts directly relevant to the course continued to be available.

**Evaluation of teaching** - This was based on the course questionnaires and staff/student committee reports : the course management committee used these to evaluate teaching. Evaluation of the teaching is important because it improves teaching and reduces tension between teachers and students. There was no particular change in teaching evaluation between the old and the new courses.

## 6.3 THE PATTERNS ARISING FROM THE FINDINGS FROM THE COURSE IN GENERAL

Tables 35 - 41 show the differences in students' attitudes between 1994/95 and 1995/96 in all aspects of the course. The results are shown as percentages. The first aspect to be examined is the course in general.

### 6.3.1 THE COURSE IN GENERAL

For the course in general questions 5, 6, 7, 8, 9, 11 and 12 of part B of the questionnaire on biology teaching in 1994/95 and questions 2, 3, 6, 7, 8, 10, and 11 of part B of the questionnaire on biology teaching in 1995/96 were used and respondents opinions are shown in table 35.

## TABLE 35

### DIFFERENCES IN STUDENTS ATTITUDES TO THE COURSE IN GENERAL IN 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | 1994/95 | | | 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| 1. Overall, I will rate the biology course as very good | 67.4 | 27.5 | 5.1 | 65.5 | 26.3 | 8.2 | 3.64 |
| 2. The course content was well organised | 63.8 | 30.6 | 5.7 | 67.1 | 25.4 | 7.5 | 3.34 |
| 3. Recommended readings from the text contributed to my understanding of the course | 58.3 | 26.1 | 15.7 | 69.7 | 23.6 | 6.7 | ***22.92 |
| 4. My interest in the course increased as the course progressed | 47.9 | 35.9 | 16.3 | 47.7 | 35.3 | 17.0 | 0.09 |
| 5. Compared to other courses, the work load for this course is very heavy | 37.3 | 37.7 | 25.1 | 47.4 | 34.8 | 17.9 | **12.36 |
| 6. The course objectives were clear to me at the beginning of the course | 36.3 | 34.2 | 29.5 | 52.4 | 30.1 | 17.5 | ***30.66 |
| 7.The pace of the course was too fast | 29.3 | 40.3 | 30.4 | 15.1 | 51.4 | 33.5 | ***28.46 |

**Key : **P < 0.01, ***P < 0.001**

Table 35 shows the pattern in students attitudes comparing 1994/95 and 1995/96. The students responses showed a positive attitude to the course in both sessions. But this attitude was more in favour of the new course than the old one. The biology course as a whole was rated as very good by the students in both sessions.

In response to the course content being well organised, the difference shown was in favour of 1995/96 but it was not significant.

The difference in response to the recommended readings was in favour of 1995/96 and was highly significant. The result indicated that the recommended readings from the text and other literature assigned to the students in 1995/96 have greatly enhanced their understanding of the course. This is perharps because staff more clearly drew attention to readings from the textbook in the 'study guide' included in the course booklet.

The response to their interest in the course increasing as the course progressed did not however show any significant difference between the two sessions. The rate at which their interest in the course increased remained the same.

The difference in response to the work load was significant. It is particularly interesting that the students overall perception of a high workload was higher in the new course than in the old one, despite the considerable reduction in the number of lectures and laboratories. The most obvious interpretation of this is that the introduction of continuously assessed assignments and the AIDS study project put more continuous pressure on the students. Another possibility is that other courses taken by Biology students (Chemistry, Psychology etc) had also not reduced their workload, but I have no evidence on this.

In response to the course objectives being clear to the students, the difference was highly significant and in favour of 1995/96 which means the objectives were more specific and measurable and students were able to know precisely what they are supposed to learn.

The difference in response to the pace of the course was also significantly in favour of 1995/96. The students were very divided in opinion in both sessions with high proportions of neutral response.

### 6.3.2. ASSESSMENT PROCEDURE

For the assessment procedures, questions 13, 14, 15, of part B of the questionnaire on biology teaching in 1994/95 and questions 12, 13, 14, of part B of the questionnaire on biology teaching in 1995/96 were used and the respondents opinion are shown in table 36.

**TABLE 36**

**DIFFERENCES IN STUDENTS ATTITUDES TO ASSESSMENT PROCEDURES IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | 1994/95 | | | 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| 1. The exam questions were reasonable in difficulty | 48.5 | 37.1 | 14.5 | 70.4 | 22.9 | 6.7 | ***48.27 |
| 2. The methods of assessment used in the course measured my competence | 32.7 | 41.3 | 26.0 | 40.2 | 38.7 | 21.1 | *6.72 |
| 3. The exam questions covered most aspects of the course content | 34.4 | 21.8 | 43.8 | 68.2 | 21.1 | 10.8 | ***152.39 |

**Key : * P < 0.05, ***P < 0.001**

Table 36 indicates three significant differences in the students responses to the assessment procedures which were all in favour of 1995/96. The results revealed that the exam questions were fair and they were of the right standard. Students were more satisfied with the area of coverage of the exam questions in 1995/96 than 1994/95. However students were very divided in opinion with high neutral value in both years on whether the methods of assessment measured their competence.

### 6.3.3 THE LABORATORY WORK IN GENERAL

For this aspect of the biology course, questions 1, 2, 3, 4, 6, 11, 12, 13, and 14 of part B of the questionnaire on the laboratory in 1994/95 and questions 29, 30, 31, 32, 33, 34, 36, 39, and 47 of part E of the questionnaire on biology teaching in 1995/96 were used and the results of the students responses are shown in table 37.

**TABLE 37**

**DIFFERENCES IN STUDENTS ATTITUDES TO THE LABORATORY WORK IN GENERAL IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | 1994/95 | | | 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| 1. For every lab session, the necessary materials were always readily available | 76.1 | 13.6 | 10.3 | 84.5 | 10.8 | 4.7 | **12.63 |
| 2. The lab sessions helped me to understand some of the topics covered during the lectures | 67.8 | 22.6 | 9.6 | 69.3 | 18.2 | 12.5 | 2. 91 |
| 3. The lab sessions were well organised | 54.5 | 34.1 | 11.5 | 59.8 | 27.5 | 12.7 | 5.25 |
| 4. The total work load for the lab sessions is very heavy | 51.5 | 33.7 | 14.8 | 35.5 | 42.0 | 22.5 | *** 25.60 |
| 5. The lab work stimulated my interest in biological science | 48.2 | 34.7 | 17.1 | 55.4 | 31.0 | 13.6 | 5. 28 |
| 6. The lab procedures were clearly explained in the lab manuals | 45.7 | 33.7 | 20.6 | 57.8 | 25.5 | 16.7 | **12.41 |
| 7. I needed more instructions on how to write up my lab reports | 44.7 | 34.9 | 20.4 | 39.0 | 34.3 | 26.8 | 5.59 |
| 8. The purpose of each lab session was clear to me from the beginning | 40.0 | 36.7 | 23.4 | 42.0 | 24.9 | 33.1 | ***17.47 |
| 9. My skills in interpreting the data were enhanced by the labs | 33.7 | 48.7 | 17.6 | 43.9 | 43.5 | 12.6 | **10.13 |

**Key : ** P < 0.01, ***P < 0.001**

Table 37 reveals that the laboratory had made a positive impact on the attitudes of the students and this impact was again improved in many respects, comparing 1995/96 and 1994/95. The results show that there were 5 significant differences between the 1994/95 and 1995/96 responses to the labs, all generally in favour of 1995/96, that is availability of materials, work load, explanation of laboratory procedures, clear purpose of the lab and enhancement of data interpretation skills. The most disappointing result concerns the purpose of the labs : although the difference is significant, this is caused by a combination of a slight increase in agrees, and a bigger increase in disagrees, with neutrals reduced. It seems that there is more work to be done on this aspect.

### 6.3.4 TUTORIALS

For the tutorials, question 18, 19, 20 and 21 of part B section III of the questionnaire on biology teaching in 1994/95 and questions 58, 59, 60 and 62 of part G of the questionnaire on biology teaching in 1995/96 were used. Respondents opinion are shown in table 38.

**TABLE 38**

**DIFFERENCES IN STUDENTS ATTITUDES TO TUTORIALS IN 1994/95 AND 1995/96 SESSIONS**

| | 1994/95 | | | 19956/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| 1. The size of the class was appropriate for the students participation | 62.1 | 25.1 | 12.8 | 78.6 | 11.6 | 9.8 | ***31.94 |
| 2. The topics for discussion were always clear to me | 54.4 | 28.7 | 16.9 | 66.3 | 22.9 | 10.8 | ***14.37 |
| 3. Each tutorial was well organised | 38.1 | 35.4 | 26.5 | 53.7 | 30.7 | 15.7 | ***27.33 |
| 4. I felt free to express myself in the tutorial class | 34.6 | 36.7 | 28.7 | 62.3 | 24.8 | 13.0 | ***77.04 |

**Key : *** $P < 0.001$**

Table 38 shows that the tutorials also made a positive impact on the attitudes of the students and this impact was significantly greater on all counts in 1995/96. This result therefore indicates that with the improvement of the tutorials in 1995/96, the students have become more active during the tutorial sessions and they can air their views and any difficulties they may have without difficulty. It is clear from these results that the tutorials are becoming more helpful to the students which will consequently lead them to a sense of maturity and independence and overall satisfaction in learning.

### 6.3.5 THE LESS AND THE MORE INVESTIGATIVE LABORATORIES

For the comparison of the less and more investigative labs, questions 20 - 25 of part C in the laboratory questionnaire in 1994/95 and questions 50, 51, 53, 54, 55 and 56 of part F of the questionnaire on biology teaching in 1995/96 were used. The students opinions are shown in tables 39 and 40 respectively. The comparison has been made between the two less and two more investigative labs.

**TABLE 39**

**DIFFERENCES IN STUDENT ATTITUDES TO THE LESS INVESTIGATIVE LABS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | LESS - 1994/95 | | | LESS - 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| 1. The time allotted this lab session was adequate | 50.7 | 28.8 | 20.5 | 68.0 | 20.6 | 11.4 | ***27.66 |
| 2. The manual for this lab session was clear and straightforward | 48.9 | 35.9 | 15.2 | 57.1 | 29.0 | 13.9 | 5.93 |
| 3. This lab session was mainly investigative | 39.9 | 48.7 | 11.4 | 44.7 | 37.4 | 17.9 | **13.27 |
| 4. This lab session challenged me to find out things for myself | 54.3 | 35.6 | 10.1 | 40.0 | 37.1 | 22.8 | *** 29.15 |
| 5. This labwork helped me to develop my skills in problem solving | 40.2 | 42.6 | 17.3 | 27.6 | 46.7 | 25.7 | ***17.71 |
| 6. There was too much of a cook-book approach in this lab | 23.2 | 44.0 | 32.8 | 25.8 | 43.9 | 30.4 | .97 |

**Key : ** $P < 0.01$, *** $P < 0.001$**

This comparison is of more limited value than the others, because different laboratories are being compared, rather than different versions of the same laboratory. Although there are signifcant differences, they are not generally in favour of the 1995/96 session, unlike most of the comparisons reported in this chapter.

## TABLE 40

## DIFFERENCES IN STUDENT ATTITUDES TO THE MORE INVESTIGATIVE LABS IN 1994/95 AND 1995/96 SESSIONS

| | MORE-1994/95 | | | MORE-1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| 1. The time allotted this lab session was adequate | 44.2 | 23.7 | 32.1 | 62.2 | 19.8 | 18.0 | ***31.78 |
| 2. The manual for this lab session and straightforward | 50.7 | 34.0 | 15.3 | 64.4 | 23.8 | 11.8 | ***16.83 |
| 3. This lab session was mainly investigative | 66.9 | 23.7 | 9.3 | 60.9 | 30.5 | 8.6 | 4.83 |
| 4. This lab session challenged me to find out things for myself | 53.4 | 31.1 | 15.5 | 62.5 | 27.3 | 10.2 | *9.09 |
| 5. This labwork helped me to develop my skills in problem solving | 31.5 | 41.5 | 27.0 | 46.2 | 41.1 | 12.7 | ***35.75 |
| 6. There was too much of a cook- book approach in this lab | 17.9 | 46.4 | 35.6 | 23.7 | 45.2 | 31.1 | 4.77 |

**Key : * P $< 0.05$, *** P $< 0.001$**

As with table 39, two different laboratories are compared here. However, this set of comparisons is generally in favour of the 1995/96 lab in terms of investigative aspects, such as finding out and problem - solving skills.

### 6.3.6 ENCOURAGEMENT TOWARDS AUTONOMOUS LEARNING.

In order to determine the difference in students attitudes towards their encouragement to become autonomous in learning, question 19 of section III of part B of the questionnaire on biology teaching and questions 21, 22 and 23 of part C of the questionnaire on the laboratory in 1994/95 and also questions 62 part G, 51, 53 and 55 of part F of the questionnaire on the biology teaching in 1995/96 were used. Respondents opinions are shown in table 41.

**TABLE 41**

**DIFFERENCES IN STUDENTS ATTITUDES TOWARDS THEIR ENCOURAGEMENT TO BECOME AUTONOMOUS IN LEARNING IN 1994/95 AND 1995/96 SESSION**

| STATEMENTS | 1994/95 | | | 1995/97 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| **TUTORIALS** | | | | | | | |
| 1. I felt free to express my opinion in the tutorial class | 34.6 | 36.7 | 28.7 | 62.3 | 24.8 | 13.0 | *** 77.04 |
| **THE LESS INVESTIGATIVE LAB** | | | | | | | |
| 2. This lab session challenged me to find out things for myself | 54.3 | 35.6 | 10.1 | 40.0 | 37.1 | 22.8 | ***29.15 |
| 3. This lab work helped me to develop my skills in problem solving | 40.2 | 42.6 | 17.3 | 27.6 | 46.7 | 25.7 | ***17.71 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| 4. This lab session challenged me to find out things for myself | 53.4 | 31.1 | 15.5 | 62.5 | 27.3 | 10.2 | * 9.09 |
| 5. This labwork helped me to develop my skills in problem solving | 31.5 | 41.5 | 27.0 | 46.2 | 41.1 | 12.7 | ***35.75 |

**Key : *P < 0.05, *** P < 0.001**

Table 41 reveals that the students were clearly aware of being motivated and challenged in both 1995/96 and 1994/95 sessions to find out things for themselves in various aspects of the course. This awareness to these challenges appears to be more apparent in 1995/96. This again does not tell us whether the students enjoyed these challenges. However because several of the statements in this comparison refer to different aspects of the course, we cannot take too much from this, except to note that all aspects were in favour of the new course, except those concerning the less investigative lab. Chapter 7 on the Perry model investigates their attitudes to their modes of learning.

## 6.4 DIFFERENCES FROM THE VARIOUS GROUPS

Having looked at the differences concerning the course in general, we will now look at the differences among the various groups of students that have been identified in this study, namely (i) The students with higher entry qualifications and those with lower entry qualifications (ii) Male and female (iii) Older and younger students (iv) Intending biology course students and non- intending biology course students to see if any differences exist among the groups comparing the 1994/95 and 1995/96 sessions. Chi square values will be used to identify these differences.

The differences in attitudes for each of the groups between 1994/95 and 1995/96 are considered.

In this analysis and for all the groups with the exception of the intending and the non-intending groups, questions 5, 6, 7, 8, 9, 11 and 12 of section I part B; 13,14 and 15 of section II part B; 18, 19, 20, 21 of section III part B of the questionnaire on Biology teaching and questions 1, 2, 3, 4, 6, 11, 12, 13 and 14 of part B of the questionnaire on the laboratory were used in 1994/95 session. In 1995/96 session questions 2, 3, 6, 7, 8, 10 and 14 of section II part B on Biology teaching and questions 58, 59, 60 and 62 section I part

G on tutorials and questions 29, 30, 31, 32, 33, 34, 36, 39, and 47 of part E on the laboratory were used.

Because the lab sessions identified as more investigative or less investigative differed in the two years ( already commented on - see Tables 39 and 40 ), making the comparison between the years less direct, it seemed sensible to omit the statements relating to that laboratory comparison from this more focused analysis of the group responses.

For the intending and non-intending group of students, the aspects of the laboratory were not included because the group was not identified as one of the variables to be examined at that time.

23 statements were tested in all. For the intending and the non-intending groups however, 14 statements were tested because of the shortfall.

The results that indicate a significant difference between the groups across the two sessions are shown in the tables while the remaining results where the groups showed no significant difference are shown in Appendix C.

Bar charts were not presented for all the groups because of the similarity of the results obtained. Therefore the first four groups had bar charts presented in their analysis so as to show the general pattern of the results as obtained from the various groups.

### 6.4.1 HIGHER STUDENTS

**TABLE 42**

**DIFFERENCES IN ATTITUDES BETWEEN THE HIGHER STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | HIGHER 1994/95 N = 421 | | | HIGHER 1995/96 N = 409 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 69.8 | 26.3 | 3.9 | 66.3 | 25.7 | 7.9 | *6.09 |
| 2. Recommended readings from the text contributed to my understanding of the course | 56.8 | 26.9 | 16.3 | 71.5 | 21.8 | 6.7 | ***25.66 |
| 3. Compared to other courses, the work load for this course is very heavy | 35.9 | 37.1 | 26.9 | 46.4 | 33.5 | 20.1 | **10.45 |
| 4. The course objectives were clear to me at the beginning of the course | 36.4 | 34.2 | 29.4 | 54.1 | 29.7 | 16.3 | ***31.27 |
| 5.The pace of the course was too fast | 26.0 | 41.7 | 32.3 | 13.4 | 50.5 | 36.1 | ***21.02 |
| **ASSESSMENT** | | | | | | | |
| 6. The exam questions were reasonable in difficulty | 48.0 | 37.6 | 14.4 | 70.9 | 22.2 | 6.9 | ***45.44 |
| 7. The exam questions covered most aspects of the course content | 34.9 | 20.7 | 44.4 | 68.3 | 21.0 | 10.7 | ***130.32 |
| **TUTORIALS** | | | | | | | |
| 8. The size of the class was appropriate for the students participation | 63.2 | 23.9 | 12.9 | 78.2 | 11.7 | 10.0 | ***25.42 |

**Key : * P < 0.05, ** P < 0.01, *** P < 0.001**

**TABLE 42 CONT'D**

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**HIGHER STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| | HIGHER 1994/95 N = 421 | | | HIGHER 1995/96 N = 409 | | | X2 Chi square |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| **9**. The topics for discussion were always clear to me | 56.3 | 27.8 | 15.9 | 66.2 | 23.3 | 10.5 | **9.47 |
| **10**. Each tutorial was well organised | 39.9 | 35.3 | 24.8 | 53.2 | 31.0 | 15.8 | ***17.45 |
| **11**. I felt free to express myself in the tutorial class | 35.2 | 37.1 | 27.7 | 61.2 | 25.5 | 13.3 | ***59.06 |
| **LAB WORK IN GENERAL** | | | | | | | |
| **12**. For every lab session, the necessary materials were always readily available | 77.6 | 12.7 | 9.7 | 85.2 | 10.0 | 4.8 | *8.87 |
| **13**. The lab sessions were well organised | 53.2 | 35.6 | 11.2 | 61.3 | 25.9 | 12.8 | *8.37 |
| **14**. The total work load for the lab sessions is very heavy | 52.9 | 33.8 | 13.3 | 34.5 | 41.4 | 24.0 | ***28.51 |
| **15**. The lab work stimulated my interest in biological science | 48.6 | 35.3 | 16.0 | 58.5 | 29.0 | 12.5 | *7.30 |
| **16**. The lab procedures were clearly explained in the lab manuals | 46.5 | 32.9 | 20.5 | 59.4 | 24.7 | 15.9 | **12.34 |
| **17**. I needed more instructions on how to write up my lab reports | 45.1 | 34.0 | 20.9 | 36.2 | 35.2 | 28.6 | *8.04 |
| **18**. The purpose of each lab session was clear to me from the beginning | 40.5 | 36.0 | 23.6 | 43.0 | 25.7 | 31.4 | **10.82 |
| **19**. My skills in interpreting the data were enhanced bt the labs | 33.7 | 48.6 | 17.6 | 43.3 | 44.5 | 12.1 | * 8.83 |

**Key : ** $P < 0.01$ *** $P < 0.001$**

Table 42 shows the differences in responses between the higher students in 1994/95 and 1995/96. These two groups showed significantly different responses for 19 out of 23 statements tested : on 9 out of the 23, the differences were very highly significant ($P < 0.001$) while on 4, the differences were highly significant ($P < 0.01$) and the rest less so.

Of all the statements where a significant different occurred between the two years, all were in favour of session 1995/96, except statements 1 and 3. Interestingly, the overall rating of the course is better in 1994/95 (statement 1) and this group regards the work load as heavier in relative terms in 1995/96 (statement 3). As noted earlier, this may be because of the extra emphasis on continuous assessment.

On pace of course, recommended reading and course objectives, responses were significantly in favour of the 1995/96 course.

The results indicate that the recommended readings assigned to the students have greatly contributed to their understanding of the course and the increase in the clarity of the course objectives means that students are now able to know precisely what they are supposed to learn.

On the assessment procedures, the differences were highly significant in favour of 1995/96 on the aspects of the exam difficulty and coverage. These responses indicates that the examination questions were of the right standard and there was an adequate coverage of the course content.

With respect to the tutorials, the responses were highly significant in all the 4 statements tested and all were in favour of 1995/96 session. This result showed that a great improvement has been made on the tutorials in such areas as the clarity of the topic to be discussed, organisation and freedom of expression by the students at the tutorials. The size of the tutorial group was also considered very appropriate by the students.

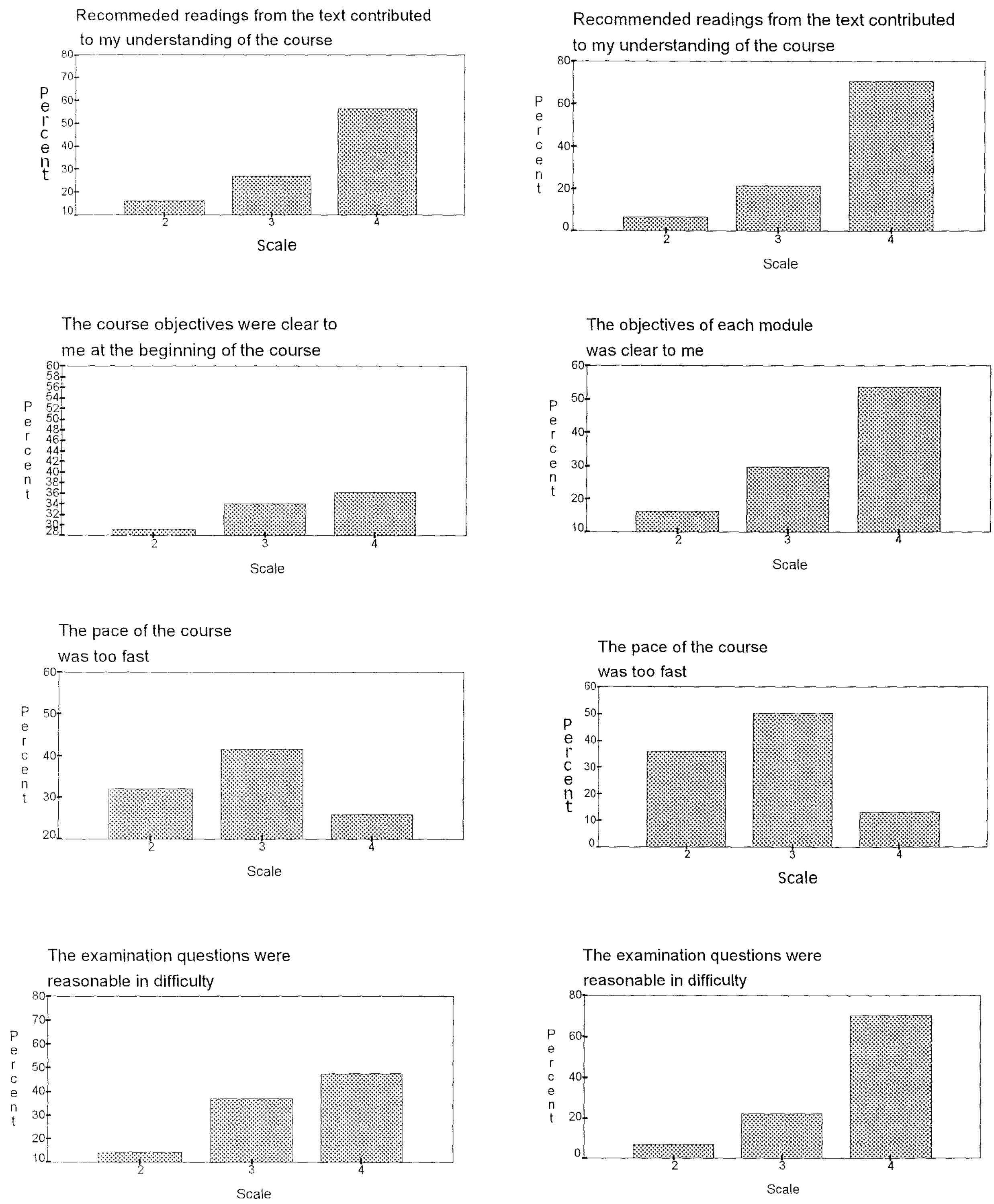
On the laboratory work in general, the differences in response between the two groups was highly significant with respect to the total work load for the lab sessions. The results clearly indicate a lowering of the total work load for the lab sessions in 1995/96 session thereby allowing more time for private study.

Other responses where the results were highly significant and in favour of 1995/96 session included the clarity of the lab procedures and that of the purpose of each lab. The result on the lab procedures indicated that these had been made more clearer and proved more helpful to the students.

Responses on availability of the necessary materials, organisation of the labs, the need for more instructions on how to write up their lab reports and the enhancement of their skills in interpreting the data were all significant and in favour of 1995/96 session. These results therefore indicates that with the changes made in the course in 1995/96 more lab materials were made available during the lab sessions and the labs became more organised. The need by the students for more instructions on how to write up their lab reports became less and the labs enhanced their data interpretative skills.

## FIGURE 9
## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN HIGHER STUDENTS IN 1994/95 AND 1995/96

**1994/95** **1995/96**

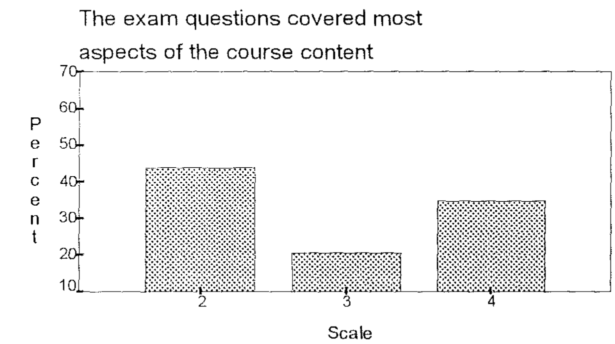


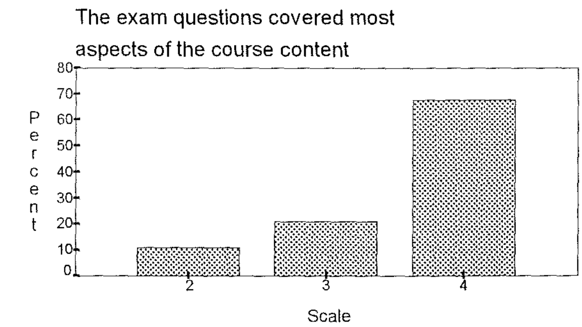

**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

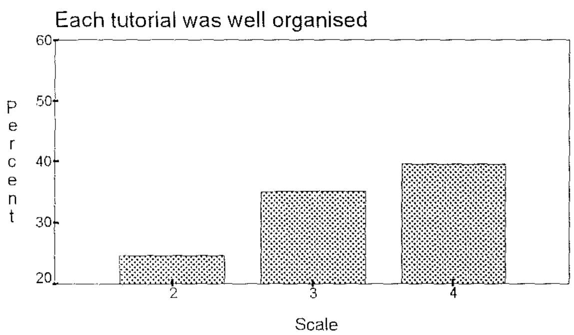
# FIGURE 9

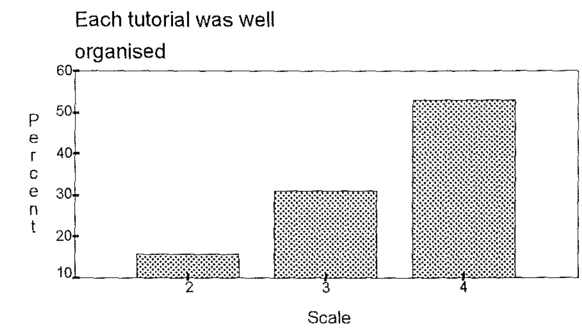
## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN HIGHER STUDENTS IN 1994/95 AND 1995/96

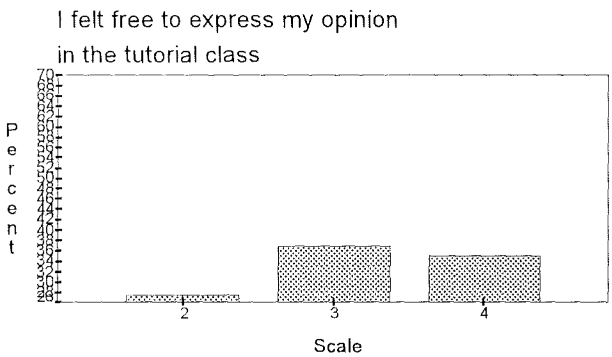
**1994/95** **1995/96**

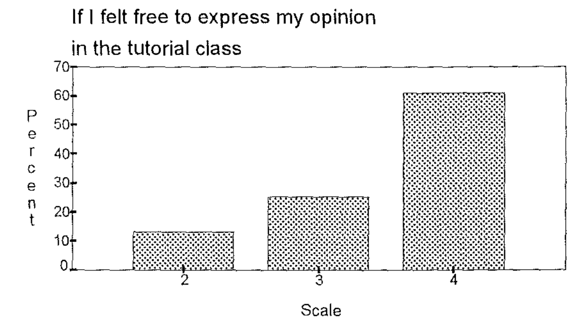


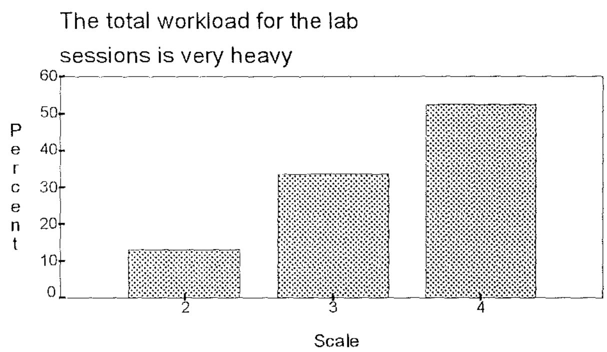



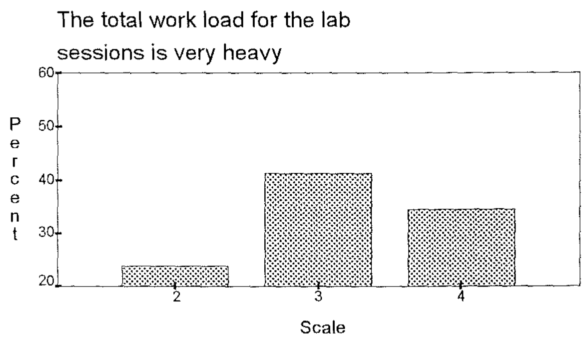




**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

## 6.4.2 THE LOWER STUDENTS

**TABLE 43**

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**LOWER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | LOWER 1994/95 N = 58 | | | LOWER 1995/96 N = 59 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The course content was well organised | 60.0 | 36.7 | 3.3 | 55.9 | 25.4 | 18.6 | *7.68 |
| 2. The course objectives were clear to me at the beginning of the course | 31.7 | 38.3 | 30.0 | 55.9 | 37.3 | 6.8 | **12.69 |
| 3.The pace of the course was too fast | 46.7 | 30.0 | 23.3 | 27.1 | 59.3 | 13.6 | **10.35 |
| **ASSESSMENT** | | | | | | | |
| 4. The exam questions covered most aspects of the course content | 31.7 | 21.7 | 46.7 | 67.8 | 20.3 | 11.9 | ***20.11 |
| **TUTORIALS** | | | | | | | |
| 5. The topics for discussion were always clear to me | 44.3 | 29.5 | 26.2 | 67.2 | 19.0 | 13.8 | *6.47 |
| 6. Each tutorial was well organised | 26.7 | 35.0 | 38.3 | 58.6 | 29.3 | 12.1 | ***15.41 |
| 7. I felt free to express myself in the tutorial class | 31.7 | 31.7 | 36.7 | 70.7 | 17.2 | 12.1 | ***18.59 |

**Key : * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$**

Table 43 shows where there are significant differences between the lower group of students in 1994/95 and 1995/96. These two groups showed significantly different responses for 7 out of the 23 statements tested. 5 of the statements were highly significantly different and 2 were less so.

The number of statements showing significant differences is much less than for the higher group, but this largely reflects sample size, there being many fewer 'lower' than 'higher' students. As with the 'higher' group, most differences were in favour of the 1995/96 course, except in this case statement 1, where more students regarded the course as well organised in 1994/95. This result may indicate that they are having problems with the modular system. The higher group did not show a difference over this statement.

With respect to the course in general, the difference in response to the clarity of objectives was highly significant and in favour of 1995/96 indicating an improvement in the course.

On assessment, the rating of the exam coverage of the syllabus was very good and in favour of 1995/96. The difference was highly significant.

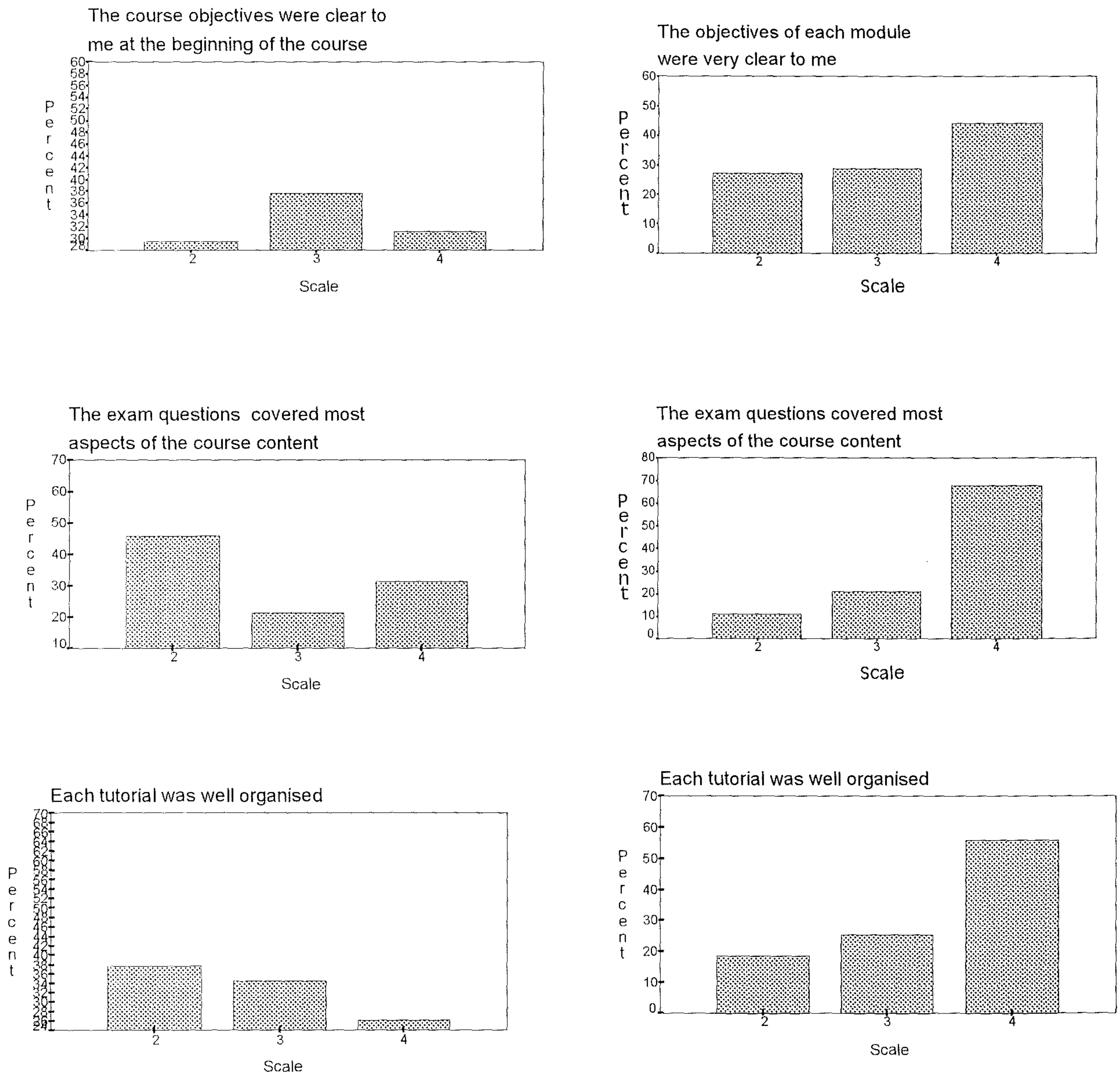
The responses of the lower group to the tutorials were highly significant for two of the statements and these are on the organisation of tutorials and the freedom of expression by the students at the tutorials. These results were in favour of 1995/96.

The difference in response to the clarity of the topic for discussion was significant and in favour of 1995/96. These results indicates that an improvement has been made in the tutorials.

## FIGURE 10

## BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN LOWER STUDENTS IN 1994/95 AND 1995/96

**1994/95** **1995/96**




**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

### 6.4.3 MALE STUDENTS

**TABLE 44**

**DIFFERENCES IN ATTITUDES BETWEEN THE MALE STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | MALE 1994/95 N = 160 | | | MALE 1995/96 N = 166 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Recommended readings from the text contributed to my understanding of the course | 56.4 | 21.8 | 21.8 | 64.0 | 25.6 | 10.4 | **7.81 |
| 2. The course objectives were clear to me at the beginning of the course | 34.0 | 35.3 | 30.8 | 50.3 | 30.3 | 19.4 | **9.81 |
| 3. The pace of the course was too fast | 26.3 | 42.3 | 31.4 | 15.2 | 53.9 | 30.9 | *7.09 |
| **ASSESSMENT** | | | | | | | |
| 4. The exam questions were reasonable in difficulty | 51.0 | 34.8 | 14.2 | 64.8 | 24.2 | 10.9 | *6.39 |
| 5. The exam questions covered most aspects of the course content | 43.9 | 21.3 | 34.8 | 66.7 | 24.2 | 9.1 | ***32.34 |
| **TUTORIALS** | | | | | | | |
| 6. The size of the class was appropriate for the students participation | 60.6 | 26.5 | 12.9 | 73.9 | 12.7 | 13.3 | **9.87 |
| 7. The topics for discussion were always clear to me | 55.2 | 29.9 | 14.9 | 69.7 | 20.6 | 9.7 | *7.19 |
| 8. Each tutorial was well organised | 40.0 | 35.5 | 24.5 | 57.6 | 29.1 | 13.3 | **11.37 |
| 9. I felt free to express myself in the tutorial class | 37.4 | 37.4 | 25.2 | 69.7 | 20.0 | 10.3 | **34.01 |

**Key : * P < 0.05, ** P < 0.01 *** P < 0.001**

**TABLE 44 CONT'D**

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**MALE STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | MALE 1994/95 N = 160 | | | MALE 1995/96 N = 166 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| **10**. For every lab session, the necessary materials were always readily available | 67.1 | 20.1 | 12.8 | 82.3 | 11.0 | 6.7 | *9.65 |
| **11**. The lab procedures were clearly explained in the lab manuals | 42.3 | 40.9 | 16.8 | 54.8 | 19.9 | 25.3 | ***16.88 |

**Key : * P < 0.05, *** P < 0.001**

Table 44 shows the differences in attitudes between the male students for the 1994/95 and 1995/96 sessions. A significant difference occurred in responses to 11 out of 23 statements. 2 of them were very highly significant, 5 were highly significant and 4 were less so.

Responses to the course in general showed a difference that was highly significant with respect to the recommended text and the clarity of the course objectives. These were all in favour of 1995/96 showing an improvement of the course.

With regards to the pace of the course they were very divided in opinion, but there was a significant shift in favour of the new course.

Responses on assessment showed an improvement in 1995/96. This shows that the exam questions were fair and there was an adequate coverage of the course content.

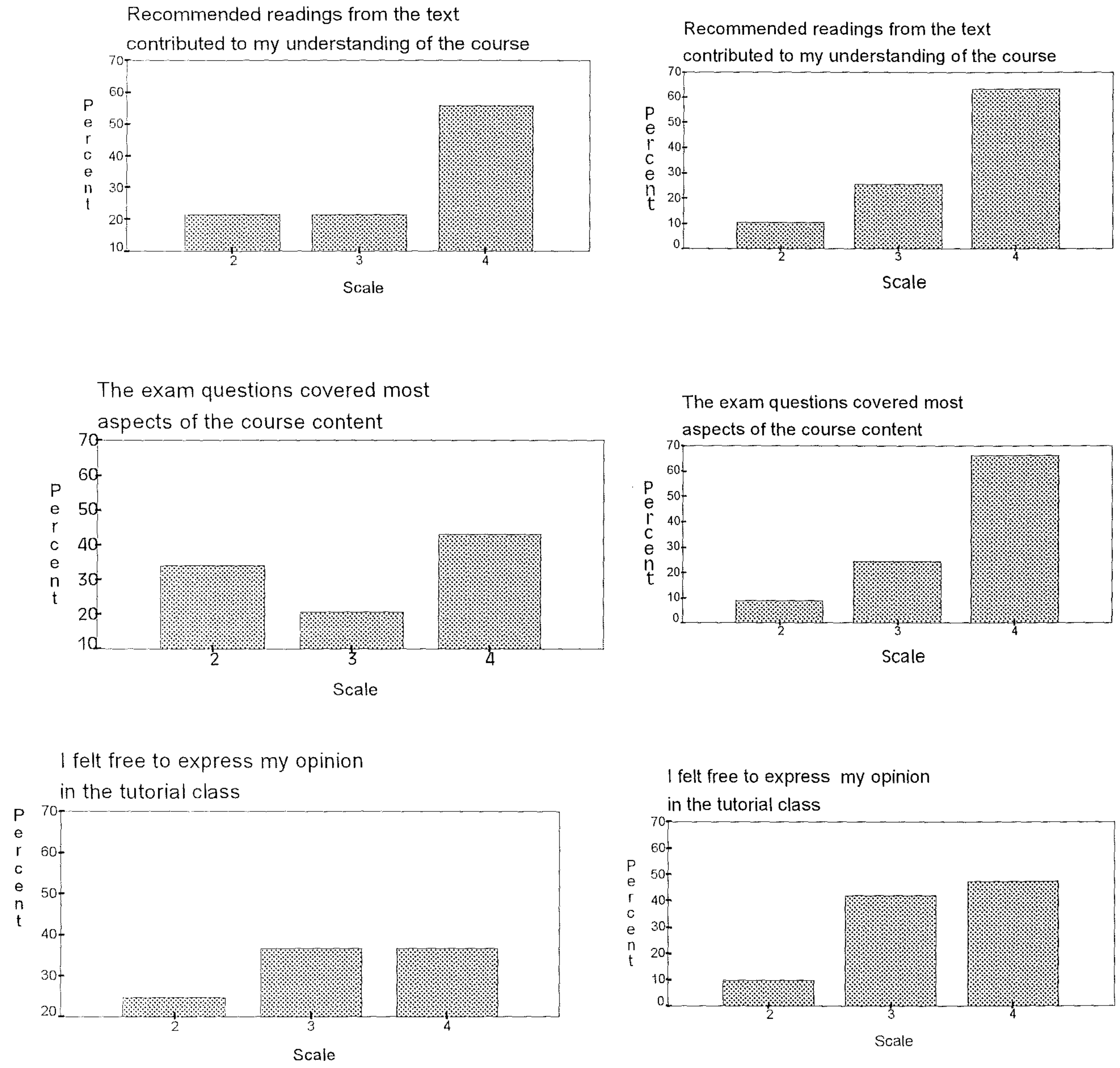
Responses on tutorials showed again an improvement in the tutorials. Three of the statements tested were highly significant while the statement on the clarity of the topic for discussion at the tutorial showed a lower significant level. All these results were again in favour of 1995/96.

The difference in response to the availability of the necessary materials during the lab sessions and the clarity of the lab procedures were significant and again in favour of 1995/96. The responses on the lab procedures were highly significant.

**FIGURE 11**

**BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN MALE STUDENTS IN 1994/95 AND 1995/96**

**1994/95** **1995/96**




**Key : 4 = Agree, 3 = Neutral,**

**2 = Disagree**

### 6.4.4 FEMALE STUDENTS

**TABLE 45**

**DIFFERENCES IN ATTITUDES BETWEEN THE FEMALE STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | FEMALE 1994/95 N = 304 | | | FEMALE 1995/96 N = 328 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Recommended readings from the text contributed to my understanding of the course | 59.5 | 27.6 | 12.8 | 72.7 | 22.4 | 4.9 | ***17.13 |
| 2. Compared to other courses, the work load for this course is very heavy | 36.5 | 37.8 | 25.7 | 48.5 | 35.6 | 16.0 | **12.66 |
| 3. The course objectives were clear to me at the beginning of the course | 38.5 | 32.2 | 29.3 | 53.7 | 30.1 | 16.3 | ***19.90 |
| 4.The pace of the course was too fast | 30.9 | 38.8 | 30.3 | 15.6 | 49.7 | 34.7 | ***21.08 |
| **ASSESSMENT** | | | | | | | |
| 5. The exam questions were reasonable in difficulty | 48.2 | 37.0 | 14.9 | 73.1 | 22.3 | 4.6 | ***44.84 |
| 6. The exam questions covered most aspects of the course content | 30.0 | 20.8 | 49.2 | 69.1 | 19.3 | 11.6 | ***122.64 |
| **TUTORIALS** | | | | | | | |
| 7.The size of the class was appropriate for the students participation | 64.4 | 22.4 | 13.2 | 80.9 | 11.1 | 8.0 | ***22.17 |

**Key : ** P < 0.01, *** P < 0.001**

**TABLE 45 CONT'D**

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**FEMALE STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | FEMALE 1994/95 N = 304 | | | FEMALE 1995/96 N = 328 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| **8**. The topics for discussion were always clear to me | 54.9 | 27.0 | 18.1 | 64.5 | 24.2 | 11.3 | *7.87 |
| 9. Each tutorial was well organised | 38.8 | 33.6 | 27.6 | 51.5 | 31.6 | 16.9 | ***14.05 |
| **10**. I felt free to express myself in the tutorial class | 34.2 | 35.5 | 30.3 | 58.4 | 27.2 | 14.4 | ***41.28 |
| **LAB WORK IN GENERAL** | | | | | | | |
| **11**. The lab sessions were well organised | 50.4 | 38.0 | 11.6 | 61.0 | 26.5 | 12.5 | *8.71 |
| **12**. The total work load for the lab sessions is very heavy | 55.4 | 33.1 | 11.6 | 33.9 | 42.5 | 23.5 | ***28.87 |
| **13**. The lab procedures were clearly explained in the lab manuals | 47.9 | 28.9 | 23.1 | 59.5 | 28.0 | 12.5 | **12.69 |
| **14**. I needed more instructions on how to write up my lab reports | 49.6 | 33.3 | 17.1 | 41.0 | 31.2 | 27.8 | **9.36 |
| **15**. The purpose of each lab session was clear to me from the beginning | 40.5 | 36.4 | 23.1 | 43.3 | 23.5 | 33.2 | **13.15 |
| **16**. My skills in interpreting the data were enhanced by the labs | 36.1 | 46.5 | 17.4 | 45.1 | 43.0 | 11.9 | *6.11 |

**Key : * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$**

Table 45 shows the difference in attitudes between the female group in 1994/95 and 1995/96. Significant differences occurred in responses to 16 out of the 23 statements tested, 9 of them very highly significant while 4 were highly significant and 3 less so.

More responses showed a significant difference between the years for the females than males, at least partly the result of differences in sample size, there being more females than males in both years. Again, nearly all significant differences were in favour of 1995/96. The exception is workload, where more females perceived the work load as heavy in the new course. As I have noted already for other groups and the class as a whole, this probably relates to continuous assessment.

The responses to the course in general were highly significant and in favour of 1995/96.

The significant difference in response to the pace of the course was highest as the females disagreed with the statement. The results were in favour of 1995/96.

The ratings of the assessment procedures were again as in the previous groups. They were highly significant and in favour of 1995/96.

The responses to the tutorials were highly significant on all statements except the one on the clarity of the topic for discussion. These results were again in favour of the 1995/96 indicating an improvement of the tutorials.

On the lab work in general, the responses to the total work load for the lab session was highly significant and in favour of 1995/96. The results indicate that the work load for the labs has been greatly reduced and more time has been made available to the students for private study.

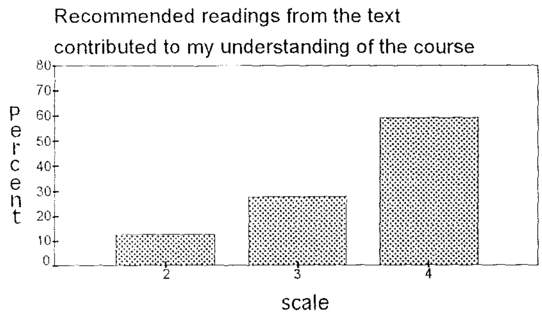
The students rated low their need for more instructions on how to write up their lab reports, the clarity of the purpose of each lab and the improvements of their skills in interpreting the data. Even though these ratings were low they showed an improvement in 1995/96 compared to 1994/95.

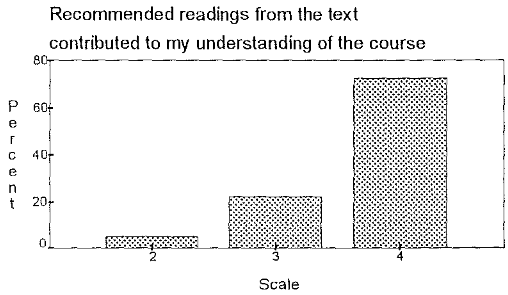
The response to the organisation of the labs was very good especially for 1995/96. The results by the female students were almost the same overall as that of the higher group.

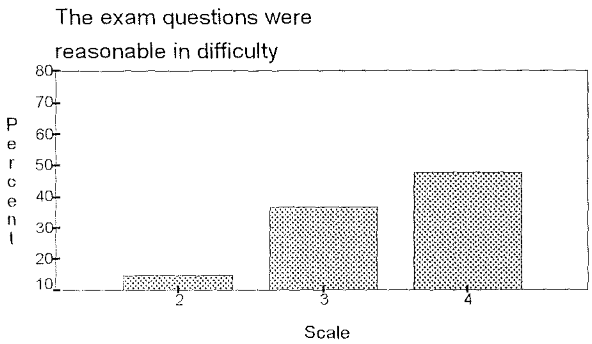
**FIGURE 12**

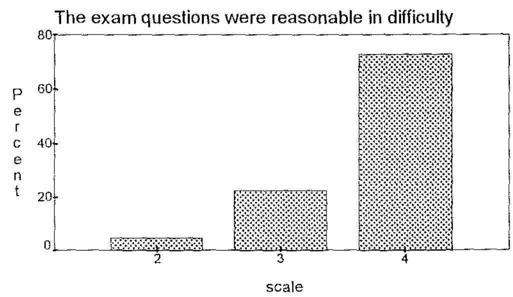
**BAR CHARTS SHOWING THE DIFFERENCES IN ATTITUDES BETWEEN FEMALE STUDENTS IN 1994/95 AND 1995/96**

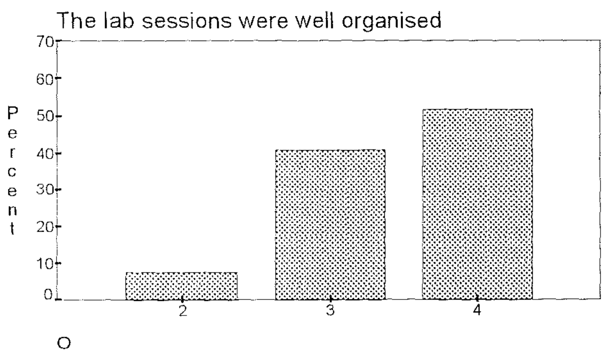
**1994/95** **1995/96**

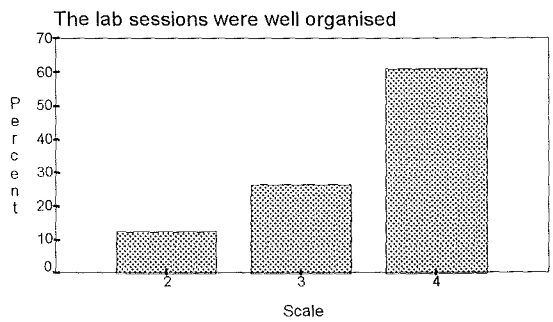



**Key : 4 = Agree, 3 = Neutral, 2 = Disagree**

### 6.4.5 OLDER STUDENTS

**TABLE 46**

**DIFFERENCES IN ATTITUDES BETWEEN THE OLDER STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | OLDER 1994/95 N = 122 | | | OLDER 1995/96 N = 66 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The course objectives were clear to me at the beginning of the course | 39.7 | 29.8 | 30.6 | 62.7 | 16.4 | 20.9 | **9.33 |
| **ASSESSMENT** | | | | | | | |
| 2. The exam questions were reasonable in difficulty | 47.9 | 37.2 | 14.9 | 77.6 | 17.9 | 4.5 | ***15.95 |
| 3. The exam questions covered most aspects of the course content | 30.8 | 26.7 | 42.5 | 61.2 | 26.9 | 11.9 | ***22.23 |
| **TUTORIALS** | | | | | | | |
| 4. The size of the class was appropriate for the students participation | 52.1 | 29.8 | 18.2 | 83.3 | 9.1 | 7.6 | ***18.06 |
| 5. The topics for discussion were always clear to me | 51.2 | 26.4 | 22.3 | 68.7 | 20.9 | 10.4 | *6.18 |
| 6. Each tutorial was well organised | 35.5 | 33.1 | 31.4 | 56.7 | 28.4 | 14.9 | **9.38 |
| 7. I felt free to express myself in the tutorial class | 39.2 | 35.0 | 25.8 | 74.6 | 16.4 | 9.0 | **21.85 |

**Key : * P < 0.05, ** P < 0.01 *** P < 0.001**

**TABLE 46 CONT'D**

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**OLDER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | OLDER 1994/95 N = 122 | | | OLDER 1995/96 N = 66 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| **LAB WORK IN GENERAL** | | | | | | | |
| **8**. The purpose of each lab session was clear to me from the beginning | 46.4 | 33.0 | 20.6 | 34.3 | 22.4 | 43.3 | **9.76 |

**Key : ** P < 0.01**

The table reveals that a significant difference occurred in response to 8 out of 23 statements, 3 very highly significant 4 highly significant and 1 less so. The responses on almost all aspects were in favour of 1995/96: the course objectives, exam difficulty, exam coverage and tutorials. However, this is the first group to show a significant difference in favour of 1994/95 concerning the clarity of purpose of the labs, though in all groups for both years, this has been an aspect in need of improvement.

### 6.4.6 YOUNGER STUDENTS

**TABLE 47**

**DIFFERENCES IN ATTITUDES BETWEEN THE YOUNGER STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | YOUNGER 1994/95 N = 365 | | | YOUNGER 1995/96 N = 424 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Recommended readings from the text contributed to my understanding of the course | 57.3 | 25.9 | 16.8 | 69.7 | 23.6 | 6.6 | ***23.02 |
| 2. Compared to other courses, the work load for this course is very heavy | 34.4 | 38.8 | 26.7 | 45.5 | 35.8 | 18.6 | **12.14 |
| 3. The course objectives were clear to me at the beginning of the course | 35.5 | 35.0 | 29.5 | 50.9 | 32.1 | 17.0 | **24.51 |
| 4.The pace of the course was too fast | 28.1 | 41.9 | 30.0 | 13.7 | 51.7 | 34.7 | ***25.26 |
| **ASSESSMENT** | | | | | | | |
| 5. The exam questions were reasonable in difficulty | 49.0 | 36.3 | 14.7 | 69.2 | 23.7 | 7.0 | ***34.62 |
| 6. The exam questions covered most aspects of the course content | 36.2 | 18.5 | 45.3 | 69.2 | 20.2 | 10.6 | ***128.90 |
| **TUTORIALS** | | | | | | | |
| 7.The size of the class was appropriate for the students participation | 67.3 | 21.3 | 11.4 | 77.9 | 12.0 | 10 .1 | **13.70 |
| 8.The topics for discussion were always clear to me | 56.8 | 28.0 | 15.2 | 66.0 | 23.2 | 10.8 | *7.39 |

TABLE 47 CONT'D

DIFFERENCES IN ATTITUDES BETWEEN THE

YOUNGER STUDENTS IN 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | YOUNGER 1994/95 N = 365 | | | YOUNGER 1995/96 N = 424 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 9. Each tutorial was well organised | 40.1 | 35.4 | 24.6 | 53.2 | 31.1 | 15.8 | ***15.91 |
| **10**. I felt free to express myself in the tutorial class | 33.7 | 36.2 | 30.1 | 60.3 | 26.1 | 13.6 | ***60.52 |
| **LAB WORK IN GENERAL** | | | | | | | |
| **11**. For every lab session, the necessary materials were always readily available | 76.7 | 13.5 | 9.8 | 84.7 | 10.6 | 4.7 | **9.22 |
| **12**. The lab sessions were well organised | 52.9 | 36.7 | 10.4 | 61.2 | 27.8 | 11.0 | *6.58 |
| **13**. The total work load for the lab sessions is very heavy | 52.2 | 32.7 | 15.2 | 35.0 | 41.5 | 23.5 | ***22.02 |
| **14**. The lab procedures were clearly explained in the lab manuals | 45.1 | 35.0 | 19.9 | 59.8 | 24.5 | 15.7 | **15.51 |
| **15**. I needed more instructions on how to write up my lab reports | 46.1 | 34.5 | 19.5 | 38.0 | 35.0 | 27.0 | *6.86 |
| **16**. The purpose of each lab session was clear to me from the beginning | 38.0 | 37.7 | 24.2 | 43.2 | 25.2 | 31.5 | ***13.41 |
| **17**. My skills in interpreting the data were enhanced by the labs | 33.4 | 49.3 | 17.2 | 44.3 | 43.6 | 12.2 | **9.53 |

**Key : * P < 0.05, ** P < 0.01, ** P < 0.001**

The table reveals that 17 out of 23 statements showed significantly different responses, 8 very highly significant, 6 highly significant and 3 less so.

The result followed the same general pattern as for the higher and the female groups. The results were all in favour of 1995/96 except statement 2 ( on work load ) as seen for several groups. For example, the recommended text, the course objectives, the exam questions - their fairness and adequate coverage, availability of the necessary materials during lab sessions, the organisation of the labs and tutorials. These all receive higher ratings in 1995/96 showing an improvement on the course.

Others receive a lower rating but still in favour of 1995/96, for example, the total work load for the lab sessions, the need for more instructions on how to write up their lab reports and clarity of the purpose of each lab, this showing a clear difference from the response of the older students.

### 6.4.7 INTENDING BIOLOGY STUDENTS

**TABLE 48**

**DIFFERENCES IN ATTITUDES BETWEEN THE INTENDING STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | INTENDING 1994/95 N = 354 | | | INTENDING 1995/96 N = 352 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Recommended readings from the text contributed to my understanding of the course | 61.1 | 24.4 | 14.5 | 71.1 | 22.0 | 6.9 | **12.70 |
| 2. Compared to other courses, the work load for this course is very heavy | 35.2 | 38.6 | 26.1 | 45.4 | 35.1 | 19.4 | *8.58 |
| 3. The course objectives were clear to me at the beginning of the course | 35.5 | 37.8 | 26.7 | 54.3 | 29.4 | 16.3 | ***26.29 |
| 4.The pace of the course was too fast | 27.3 | 40.6 | 32.1 | 13.1 | 51.3 | 35.6 | ***22.45 |
| **ASSESSMENTS** | | | | | | | |
| 5. The exam questions were reasonable in difficulty | 49.4 | 34.6 | 16.0 | 72.7 | 20.7 | 6.5 | ***41.71 |
| 6. The exam questions covered most aspects of the course content | 36.6 | 20.3 | 43.1 | 69.6 | 20.7 | 9.7 | ***110.72 |
| **TUTORIALS** | | | | | | | |
| 7. The size of the class was appropriate for the students participation | 64.0 | 23.1 | 12.9 | 79.4 | 11.2 | 9.5 | ***22.15 |
| 8. Each tutorial was well organised | 39.9 | 35.3 | 24.8 | 55.0 | 28.7 | 16.3 | ***16.96 |

**Key : * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$**

## TABLE 48

## DIFFERENCES IN ATTITUDES BETWEEN THE INTENDING STUDENTS IN 1994/95 AND 1995/96 SESSIONS

| | INTENDING 1994/95 N = 354 | | | INTENDING 19956/96 N = 352 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 9. I felt free to express myself in the tutorial class | 36.5 | 36.2 | 27.4 | 65.1 | 22.9 | 12.0 | **59.89 |

**Key : * P < 0.05, ** P < 0.01, *** P < 0.001**

Table 48 reveals that a significant difference between the intending students in 1994/95 and 1995/96 occurred in response to 9 out of 14 statements that were tested, 6 very highly significant, 2 highly significant and 1 less so.

The responses followed the same pattern as for the previous groups. The statements that showed a significant difference were all in favour of 1995/96, except statement 2 on workload.

The responses to the text and all statements on the tutorials and assessment were highly significant.

The response to work load showed that in this group, like most others, more students regarded the workload as very heavy in the new course than in the old course. However, the response on the pace of the course was in favour of the new course.

### 6.4.8 NON - INTENDING BIOLOGY STUDENTS

**TABLE 49**

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**NON - INTENDING STUDENTS IN 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | NON-INTENDING 1994/95 N = 76 | | | NON-INTENDING 1995/96 N = 109 | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Recommended readings from the text contributed to my understanding of the course | 43.6 | 34.6 | 21.8 | 65.7 | 28.7 | 5.6 | ***14.10 |
| 2. The course objectives were clear to me at the beginning of the course | 38.5 | 20.5 | 41.0 | 50.5 | 27.5 | 22.0 | *7.83 |
| **ASSESSMENTS** | | | | | | | |
| 3. The exam questions were reasonable in difficulty | 51.3 | 38.5 | 10.3 | 67.0 | 30.0 | 2.8 | *7.11 |
| 4. The exam questions covered most aspects of the course content | 28.2 | 19.2 | 52.6 | 63.3 | 22.9 | 13.8 | ***34.66 |
| **TUTORIALS** | | | | | | | |
| 5. The topics for discussion were always clear to me | 44.9 | 34.6 | 20.5 | 65.1 | 23.9 | 11.0 | *7.90 |
| 6. Each tutorial was well organised | 34.6 | 34.6 | 30.8 | 52.3 | 33.9 | 13.8 | **9.48 |
| 7. I felt free to express myself in the tutorial class | 30.8 | 32.1 | 37.2 | 54.1 | 26.6 | 19.3 | **11.51 |

**Key : * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$**

Table 49 shows the difference in attitudes between the non - intending group in 1994/95 and 1995/96. Significant differences occurred in 7 out of 14 statements tested, 2 were very highly significant. All aspects were rated in favour of 1995/96. For example, the text, assessment, organisation of the tutorials, clarity of the topic for discussion and the freedom of expression by the students at the tutorials.

## 6.5 SUMMARY OF RESULTS

The results presented in this chapter showed the differences between the old biology course in 1994/95 and the new biology course in 1995/96. The results reveal the differences in students attitudes to the old and the new courses.

From the findings of the observation of the old course and the new course, it was apparent that definite changes were effected in the course in 1995/96 in areas such as : - (1) The objectives of the course as a whole which became more specific than general. (2) The curriculum pattern becoming modular instead of broad - based. (3) The number of lectures have increased from two to three to give a better time choice. (4) The practical activities and techniques became more varied. (5) The lab manual became more elaborate and useful to the students. (6) The tutorials became more frequent and varied. (7) The assessment procedures became more varied. (8) The degree examinations now come at the end of each respective module and students are not exempted. (9) There is the guest lecture that seeks to alert the students to future employment and (10) Learning resources became more varied. All these changes are an attempt by the department to make learning more meaningful to the students.

Findings from the course in general reveal that with the changes in 1995/96 a positive impact was most probably made on the attitudes of the students. This is evident in their responses to the items of the questionnaires of this study. In general, the students ratings were more positive in 1995/96 than in 1994/95. And even in some areas where the students agreed less or disagreed in 1995/96, the responses showed an improvement in those areas. Their responses to the course in general, for example , revealed a change in their attitudes in 1995/96 that showed that an improvement has most probably been made. The students rated the text highest and this was followed by the organisation of the course then the overall rating of the biology course as very good followed by the clarity of the objectives and then their interest in the course increasing as the course progressed and finally the work load.

In the assessment procedures , the ratings were highest in 1995/96 than 1994/95 which again points to the fact that a positive impact have been made.

The responses to the lab work in general followed the same pattern. The ratings were higher in 1995/96 and showed that a definite change has taken place. The lab work stimulated their interest in the biology course and challenged the students to find out things for themselves.

With the tutorials, the ratings were again higher in 1995/96. The students felt more free to express their opinions during the tutorial class. It was clear that there was an improvement in the overall organisation of the tutorials.

On the encouragement of the students to become autonomous in their learning, the results reveal that the students are, without doubt, being encouraged in that direction, for example, in the tutorials the students felt free to express their views during the sessions, which means that they found it easy to ask for explanations on any area of difficulty that they might have had. This encouraged them to become autonomous. The labs stimulated their interest in biological science, and by their investigative nature encouraged the students to venture into the unexpected. This also challenged the students to find out things for themselves.

In only one or two aspects did the 1994/95 course came out on top in the class as a whole or in groups. The most consistent of these was over workload : it seems that more students find the workload high in the new course than in the old. As noted earlier a possible explanation is the new emphasis on continuous assessment.

Considering the differences within the groups table 50 gives a brief summary of the number of statements in which the responses of the groups were significantly different and their probability levels.

**TABLE 50**

**NUMBER OF STATEMENTS THAT WERE SIGNIFICANTLY DIFFERENT**

| Groups and Sample sizes | Total No of statements tested | No of statements that were significantly different | 5% P level | 1% P level | 0.1% P level |
|---|---|---|---|---|---|
| Higher/higher<br>N = 421 / 409 | 23 | 19 | 6 | 4 | 9 |
| Lower/Lower<br>N = 58 / 59 | 23 | 7 | 2 | 2 | 3 |
| Male/Male<br>N = 160 / 166 | 23 | 11 | 4 | 5 | 2 |
| Female/Female<br>N = 304 / 328 | 23 | 16 | 3 | 4 | 9 |
| Older/Older<br>N = 122 / 66 | 23 | 8 | 1 | 4 | 3 |
| Younger/Younger<br>N = 365 / 424 | 23 | 17 | 3 | 6 | 8 |
| Intend/Intend<br>N = 354 / 352 | 14 | 9 | 1 | 2 | 6 |
| N-Intend /N-Intend<br>N = 76 / 109 | 14 | 7 | 3 | 2 | 2 |
| TOTAL | 166 | 94 | 23<br>(24.5%) | 29<br>(30.9) | 42<br>(44.7%) |

Table 50 shows the total number of statements that were responded to by each group and also the number of statements that were significantly different and the probability at which these significant differences occurred. The results showed that more than half of the statements showed a significant difference that was in favour of 1995/96.

The differences found within the groups were highly significant and nearly all were all in favour of 1995/96 confirming that 1995/96 has indeed made an impact on the attitudes of students. Items such as the text , the course objectives, standard of the exam questions and their adequate coverage, the clarity of the tutorial topics, the organisation of the tutorials and the labs, the total work load for the lab sessions, freedom of expression by the students at the tutorials and the availability of the necessary material during the lab sessions. These were highly rated.

Those that were rated lower but still in favour of 1995/96 include; the pace of the course, the need for more instructions by the students on how to write up their lab reports, the clarity of the purpose of each lab, the enhancement of their data interpretative skills. The lesser and the greater challenges offered by the less and more investigative labs to find out things for themselves and the improvement of their problem solving skills.

The rating of these items followed the same pattern by all the groups giving an internal consistency to the results. The number of statements that were significantly different were more than those that showed no significant difference. And these were all in favour of 1995/96 indicating an improvement in the course.

Differences between the groups as shown in chapters 4 and 5 also reveal differences in student attitudes between 1994/95 and 1995/96. With respect to the students with higher entry qualifications and those with lower entry qualifications the differences in their attitudes reveal that :- (1) In areas where significant differences were found in 1994/95 (for example, the assessment procedures and the lack of being challenged enough to find out things for themselves) such differences tended to disappear with the changes in 1995/96. (2) There were areas also where the differences were not significant in 1994/95, but become significant after the changes in 1995/96, for example, workload , The lower students found the workload heavier in 1995/96 than in 1994/95 . They also felt that, with the changes, the course was not well organised.

(3) There are areas again where the differences between the two groups were significant in the two sessions , for example, the pace of the course. The lower group agreed in 1994/95 that the pace of the course was too fast while the highers disagree. In 1995/96 the highers again disagree with the statement but the lower group were almost undecided as many of them occupy the neutral position leaving only 27% to agree with the statement, hence the difference was more in 1995/96.

With the male and female comparison, it was revealed from the results that differences which existed in 1994/95 tended to disappear with the changes in 1995/96, for example, the overall rating of the biology course, the availability of the necessary materials during the lab sessions, and the lab sessions being more investigative.

An area where the difference was significant in 1995/96 was the area of the exams being seen as not being too difficult , the females agree more to the statement than the males.

The differences in attitudes between the older and younger students became significant in 1995/96 when the changes took place than when the changes had not taken place, for example, in the course objectives being clear. The older students agree more than the younger students. Also with the pace of the course being too fast, the older agree with the statement while the younger disagree. With the lab sessions being well organised, the younger students agree more while the older students agree less with the statement.

Two areas where the differences were not significant in 1995/96 but in 1994/95, are :- the workload and the size of the tutorial class.

With the intending and non - intending biology students their differences were significant in 1994/95 but not in 1995/96 in the area of the course objectives being clear. Non -

intending students disagreed with the statement while intending students agreed with it . Three areas where the differences became significant in 1995/95 and not in 1994/95 are :- Their interest in the course increasing as the course progressed. The intending students agree more than the non intending. In the area of the overall rating of the biology course as very good, the intending course students rated the course higher than the non intending course students. Also in the area of the pace of the course being too fast, the intending biology course students disagree more than the non intending students.

Hence the results showed that with the changes in 1995/96, there were changes in students attitudes. (1) There was a disappearance of the differences within the various groups of the students. (2) It appears that there were more significant differences between the groups such as older and younger and the intending and non intending biology course students. (3) In few cases the differences were significant in both sessions - 1995/96 and 1994/95.

The above differences within the various groups of the students are however only few when compared to the vast number of statements the students have agreed with or that had affected them similarly, ( see appendix A ) showing that the course had made a positive impact on the students attitudes and chapter six showed that, that impact was more in 1995/96 than in 1994/95.

Chapter 7 now looks at the student position within the Perry model with the view of further confirming the student shift towards autonomy.

# CHAPTER 7

# THE PERRY MODEL

# STUDENT ATTITUDES TO TEACHING AND LEARNING

## 7.1 INTRODUCTION

This chapter presents students' responses to the Perry model. The model offers a framework in which one can understand how students make meaning of their world, and how the students interpret and make sense of the classroom environment. The model also reveals how they view knowledge and the process of learning, how they understand the roles of the teacher and of the students in this process.

The model as earlier stated in chapter 2, represents a continuum of thinking from simplistic right and wrong patterns to a more complicated contextual view of reality. There were originally nine positions to the model, each representing a qualitatively different mode of thinking about the nature of knowledge. The nine positions are said to be found in an invariant sequence. Movement along the continuum of the model reflects increasing maturity of thought. Each position serves as a necessary building block for the position to come and each one contains the qualities of the previous ones.

The nine positions were grouped by researchers ( Finster, 1989) into four categories; dualism, multiplicity, relativism and commitment within relativism. Other researchers (Baxter - Margolda and Portefield, 1985) further regrouped these four stages into three. For this study the three categories were used, namely; dualism which is represented by the letter A, multiplicity which is represented by the letter B and relativism is represented by the letter C. Students normally progress along the Perry scheme through the university or college years, and there are conditions that facilitate this progress towards maturity or to a more complex stance. For example, students could be stimulated to confront new ideas in new ways or they could be helped to meet the appropriate challenges. Helping students to wrestle with the inadequacy of their arguments provides the support necessary to assist them meet the challenge of change (Finster, 1991).

First year university students are usually at positions 2 and 3 on the Perry model and are often dualistic in thinking while their teachers are between position 6 - 9. Hence productive teaching is at position 3 - 4 ( Finster, 1991).

The maturity end goal , that is, relativism, as described by this model, includes the facilitation of human beings who can 'reason', who possess insight as well as knowledge, who have the capacity for empathy and ethical or moral conduct, who recognise, appreciate and are not threatened by individual differences, who have developed the interpersonal skills and thinking processes necessary for living in a complex diverse society (Boud, 1981).

In this study, an attempt is being made to see if the students have been encouraged during their first year biology course towards this maturity end goal, that is, to become independent or relativistic in their thinking.

Hence, the students were given a grid where they were asked to identify their views on what they think their role as a student is, the role of the teacher, their view of knowledge and what they think their role in the examination is. They were to select four statements that best fitted their present views and their views before they came to the university. The model is therefore used in this study as an observational tool to identify the ways in which the students think. ( See grid on the next page)

## THE GRID

## MEASUREMENT OF STUDENTS ATTITUDES TO TEACHING AND LEARNING

| | | | |
|---|---|---|---|
| My job as a student is :- | **1.** To accept the information given by the lecturer without question and learn it | **2.** To accept that some responsibility rests on me for learning, but I am not sure what is expected of me about what or how to learn | **3.** To accept what is given, but to think about it critically, to check other sources for myself and to take responsibility for what and how I learn |
| I think the lecturer's job is :- | **4.** To give me all I need to know for the exams, but where there is more than one way of looking at things the lecturer should indicate clearly which way he prefers | **5.** To provide me with information but I realise that he is not the only source of information and that I can find out things for myself to supplement what the lecturer has given | **6.** To give me all I need to know for the exams and to avoid any extra non - examinable material |
| I think that knowledge is :- | **7.** A collection of unchangeable facts which are either right or wrong. I dislike uncertainties and vague statements. I am uncomfortable if I am asked to think for myself. I prefer to be given the facts | **8.** Complex and by no means black and white, but I find this exciting and stimulating. It makes me want to explore things for myself | **9.** Not just a collection of black and white facts but that there are shades of grey. Things may be right and wrong depending on the circumstances and the context. These uncertainties make me feel uncomfortable |
| My job in my exam is :- | **10.** To give back the facts I have learned as accurately as possible. I prefer questions with single clear cut answers rather than open long questions | **11.** To answer the questions including what I have found out for myself from reading or other sources. I dislike questions which force me into a fixed answer (such as multiple choice.) and prefer open questions in which I can have room to show my on thinking | **12.** To give back all I know about the topic and leave the examiner to give me credit for the relevant bits. I quite like open ended questions which allow me to show how much I know |

The statements were not arranged in order of Perry progression but were presented in random order. It was left to the students to select from each row the statement that best represented their views.

The students were also given some 'Perry statements' in the form of a Likert test to agree or disagree with and then justify their answers.

Hence it is hoped that these findings will provide an insight into:-

(1) The students' position in attitudes to teaching and learning before they came into the university.

(2) The students' position in attitudes after their first year biology course at the university.

(3) The extent to which they have moved along the Perry scheme.

(4) The extent to which the changes in the biology course made a difference to the students attitudes towards their role in learning.

The order of presentation is as follows :-

7.2 The student position before coming to the university and after one year at the university for the 1994/95 session.

7.3 The student position before coming to the university and after one year at the university for the 1995/96 session.

7.4 The difference in students position between the two sessions.

7.5 The student movements along the Perry scheme for the 1994/95 session.

7.6 The student movements along the Perry scheme for the 1995/96 session.

7.7 The difference in student movements between 1994/95 and 1995/96 session.

7.8 How they moved.

7.9 Summary of the results.

The results obtained revealed five categories of the students' position along the scheme as adopted from Finster (1991), and these are ; A, A2, B, C2 and C.

A - represents **Dualism**: this is a position where the student accepts information given by the lecturer without question and learns it. The student's role is to dispense the knowledge received. He believes that only right and wrong answers exist and that all knowledge is known. Knowledge to him is quantitative - a collection of facts. The student believes that truth exists. He wants the tests given to him to be clear - cut and objective and he expects that hard work should be rewarded.

A2 - represents **early multiplicity :** this is a position where the students perceives diversity of opinion and uncertainty. He believes that much knowledge is known, but uncertainty exists. The student also believes that truth exists but it is incomplete and there is a process to discover more. The student sees the lecturer as the source of the right way to the truth. The lecturer should model this process towards seeking the truth. The student tries to learn how to learn the truth and express himself well. He is becoming qualitative. In the examination the amount of hard work is no longer a standard. Long answers demonstrate knowledge.

B - represents **multiplicity :** this is the position where the student accepts that diversity and uncertainty exist. All opinions are equal and no one is wrong For the student, this position is therefore one where he feels insecure. He believes that the lecturer is only one authority since all opinions are equal. As a student, he believes that some form of responsibility rests on him. He is capable of independent thought and can confront and challenge the lecturer. He wants to learn how the lecturer wants him to give an answer to anything, regardless of what he (the student ) thinks. Assessment standards puzzle him because , how can one grade when there are no right answers. He is becoming good at analysis.

C2 - represents **early relativism :** this is the position where the student believes that knowledge is contextual but the lecturer must provide a guide. The lecturer should model the way he wants them to think and use evidence. He wants to learn how the lecturer wants them to think. He accepts responsibility in learning to think independently and listens to authorities. He can use supporting evidence and tries to think abstractly.

C - represents **relativism :** this is the position where the student believes that all knowledge is complex and contextual. The student finds it exciting and wants to explore things for himself. There is no absolute truth. Right and wrong answers exist only within specified contexts. Quality to him is more important than quantity. The lecturer is a source of expertise, a guide or a consultant. He wants room in an examination to express what he knows and thinks. He has a feeling of some intellectual mastery. A test to him is an opportunity for feedback and improvement and quality of answer is more important to him than the quantity of the answer.

Positions A2 and C2 are therefore regarded as transitional stages, while positions A, B and C are the main stages of the Perry model. This is so because the students were not all found to be distinctively in positions A, B and C; some were found in the transitional stages before and after their first year course at the university.

The positions of students on the Perry model were identified based on the four responses they made on the grid. A student is classified as: - (1) An A type, if he had chosen three As' or four As' (2) B type, if he has three Bs' or four Bs' (3) C type, if he has Three Cs' or Four Cs. (4) A2 type, if he has two As' in his combination. (5) C2 type, if he has two Cs' in his combination.

There were problem combinations that were difficult to classify for example, those that were classified as A2 included combinations such as :- ACAB and AABB while C2 had combinations like CCBA, CCBB and CCAA. They all seemed to be in different stages of either A2 or C2 but were classified as such because the assessment was regarded as qualitative and not quantitative. One must rely on inference since it is difficult to measure such attitudes directly.

In the presentation of these results the reaction of the whole class will be presented first, to be followed by the reactions of the various groups.

## 7.2 THE STUDENTS POSITIONS IN THE PERRY SCHEME BEFORE COMING TO THE UNIVERSITY AND AFTER ONE YEAR AT THE UNIVERSITY FOR THE 1994/95 SESSION

For this aspect of the study, the grid in part C of the biology questionnaire was used and the students' responses are shown in table 51. The results are presented in the three distinct groups of the Perry model - A, B and C. Though I had earlier classified students into 5 positions, for simplicity of statistical analysis, I have combined A and A2 and C and C2.

### 7.2.1 THE POSITION OF THE CLASS IN GENERAL

The results in table 51 are presented in percentages.

**TABLE 51**

**STUDENTS' POSITIONS BEFORE AND AFTER ONE YEAR AT UNIVERSITY FOR THE 1994/95 SESSION**

| | **Sample size ( N )** | **A** | **B** | **C** | **Chi square $X^2$** |
|---|---|---|---|---|---|
| Before coming to the university. | 386 | 43.8 | 18.9 | 37.3 | ***150.08 |
| After one year at the university. | 386 | 6.5 | 21.5 | 72.1 | |

**Key : ***P < 0.001**

Table 51 reveals that, before coming to the university the students' positions on the Perry scale were skewed towards position A. Relatively few students were found to be in position B.

The table then shows that after the students' first year at the university, there was a movement or a change in attitudes towards position C. Position A was drastically reduced in its percentage while positions B and C showed an increase. The results therefore show that the students shifted considerably towards relativistic thinking during their first year at the university. The difference between the students' positions before and after one year at the university was very significant as indicated by the high Chi square value.

### 7.2.2 THE GROUPS - THEIR POSITION BEFORE COMING TO THE UNIVERSITY

The responses of the students to the grid according to their various groups is shown in table 52. The results are shown in percentages but the Chi square was calculated from the frequency numbers.

**TABLE 52**

**THE POSITIONS OF THE GROUPS BEFORE COMING TO THE UNIVERSITY - 1994/95**

| THE GROUPS | Sample size (N) | A | B | C | Chi square $X^2$ |
|---|---|---|---|---|---|
| HIGHER | 340 | 43.9 | 19.7 | 36.4 | 1.94 |
| LOWER | 46 | 41. 3 | 13.0 | 45.7 | |
| MALE | 114 | 40.9 | 18.3 | 40.9 | 1.19 |
| FEMALE | 272 | 45.7 | 19.3 | 35.0 | |
| OLDER | 122 | 34.8 | 14.1 | 51.1 | **9.94 |
| YOUNGER | 264 | 46.9 | 20.2 | 32.9 | |
| INTENDING | 326 | 44.1 | 19.8 | 36.1 | 0.80 |
| NON - INTENDING | 60 | 38.6 | 19.3 | 42.1 | |

**Key : ** $P < 0.01$**

Deductions from table 52 are that the same general pattern as for the whole group was repeated in the various sub - groups with some slight differences. Most groups were skewed towards position A (dualism).

With respect to the lower and higher, the lower students showed a greater tendency towards relativism than the highers but the difference was not significant.

There was no significant difference between the males and the females though the males however showed a slightly greater tendency towards relativism than the females.

The older students were clearly more relativistic than the younger students. This was the only statistically significant difference between the subgroups. A possible explanation for this difference could be that before they came to the university their thinking patterns have become more established towards the relativistic stance through their various experiences.

The table also shows that the non - intending biology students were slightly more relativistic than the intending students but the difference was not significant.

The table therefore showed that all groups, except the older student sub - group and possibly the non - intending biology subgroup followed the basic pattern found for the class as a whole, that is, a population skewed towards position A.

### 7.2.3 THE GROUPS - THEIR POSITION AFTER ONE YEAR AT UNIVERSITY FOR 1994/95 SESSION

The responses of the students from the grid are shown in table 53.

**TABLE 53**

**THE POSITIONS OF THE GROUPS AFTER ONE YEAR AT THE UNIVERSITY - 1994/95**

| | Sample size ( N ) | A | B | C | Chi square $X^2$ |
|---|---|---|---|---|---|
| **HIGHER** | 340 | 7.0 | 23.0 | 70.0 | * 7.40 |
| **LOWER** | 46 | 2.2 | 8.7 | 89.1 | |
| **MALE** | 114 | 10.4 | 20.9 | 68.7 | 5.06 |
| **FEMALE** | 272 | 4.3 | 22.8 | 72.8 | |
| **OLDER** | 122 | 1.1 | 18.5 | 80.4 | * 7.25 |
| **YOUNGER** | 264 | 8.2 | 22.6 | 69.2 | |
| **INTENDING** | 326 | 7.3 | 21.2 | 71.5 | 1.12 |
| **NON - INTENDING** | 60 | 3.5 | 21.1 | 75.4 | |

**Key : * $P < 0.05$**

Table 53 shows that after one year at University, all sub groups are skewed towards position C, reversing the positions found before coming to university (Table 52). Between sub - groups, some significant differences can be seen.

The table shows that the 'lower' students after their first year at the university were significantly more relativistic than the 'highers'. The 'lower' students had a very low percentage at position B - the uncertain stage. This is a very interesting result and open to several possible interpretations. Being new to the subject, the 'lowers' may have found that the university approach to teaching biology had a major effect on how they learned it. Or the difference might stem from the fact that the 'highers', with their greater background knowledge in biology, might not have felt highly challenged by the course as many of the aspects of the course would be a repetition for them. However, the 'lowers' did have a higher proportion at C than the 'highers' before coming to university.

As regards the male and female students the results showed no significant difference between the two groups after their first year course. The two groups have therefore been similarly affected by the course.

The results also showed that older students after one year had a more relativistic or independent position than the younger students. Their percentage at B - the uncertain stage was very low. The difference between the two groups was significant. However, these were the groups that differed before coming to university, and the shift towards C in the older group is of a similar order to the younger group.

There was no significant difference between the intending and the non - intending students after their first year at the university. The course affected them similarly.

The results therefore showed that at the end of their first year course, the students showed a greater tendency towards independent thinking than when they first started. Some of the groups were affected similarly like the males and females, intending and non - intending students while others had differences between them, for example, the highers and the lowers, older and the younger students.

## 7.3 THE STUDENTS' POSITIONS IN THE PERRY SCHEME BEFORE COMING TO THE UNIVERSITY AND AFTER ONE YEAR AT THE UNIVERSITY FOR THE 1995/96 SESSION

For this aspect of the study, the grid in part C of the biology questionnaire for the 1995/96 was used and the students responses are shown in table 54.

### 7.3.1 THE POSITION OF THE CLASS IN GENERAL

**TABLE 54**

**STUDENTS POSITIONS BEFORE AND AFTER ONE YEAR AT UNIVERSITY FOR THE 1995/96 SESSION**

| | **Sample size ( N )** | **A** | **B** | **C** | **Chi square $X^2$** |
|---|---|---|---|---|---|
| Before coming to the university. | 396 | 38.9 | 23.7 | 37.4 | ***169.86 |
| After one year at the university. | 396 | 3.8 | 19.4 | 76.8 | |

**Key : ***P < 0.001**

Table 54 shows that there was a marked difference between the students' positions before coming to the university and after their first year at the university. Before coming to the university, a slightly higher percentage of the students were at position A than at position C. After their first year at the university the students positions showed a considerable shift towards position C : the percentages of students at both positions A and B were reduced , A greatly so.

### 7.3.2 THE GROUPS - THEIR POSITION BEFORE COMING TO THE UNIVERSITY FOR THE 1995/96 SESSION

The responses of the students from the grid are shown in table 55.

**TABLE 55**

**THE POSITIONS OF THE GROUPS BEFORE COMING TO THE UNIVERSITY - 1995/96**

| | Sample size ( N ) | A | B | C | Chi square $X^2$ |
|---|---|---|---|---|---|
| HIGHER | 355 | 42.1 | 24.8 | 33.1 | ** 23.28 |
| LOWER | 41 | 12.2 | 17.1 | 70.7 | |
| MALE | 155 | 44.2 | 13.2 | 42.6 | ** 11.92 |
| FEMALE | 241 | 36.5 | 28.9 | 34.6 | |
| OLDER | 66 | 16.7 | 14.3 | 69.0 | ** 20.35 |
| YOUNGER | 330 | 41.5 | 24.9 | 33.6 | |
| INTENDING | 304 | 39.5 | 24.2 | 36.3 | .11 |
| NON - INTENDING | 92 | 37.5 | 25.0 | 37.5 | |

**Key : ** $P < 0.01$**

Table 55 shows that the general pattern for the whole group was repeated in the various sub-groups, with some exceptions. Both the 'lower' and the 'older' groups had a high proportion at position C. In this year, significant differences were found between highers and lowers, males and females and older and youngers. A comparison with Table 52 shows that these differences were similar to those found in 1994/95, but somewhat more emphatic, leading to statistical significance in two more cases.

### 7.3.3 THE GROUPS - THEIR POSITION AFTER ONE YEAR AT UNIVERSITY FOR 1995/96 SESSION

The responses of the students from the grid are shown in table 56.

**TABLE 56**

**THE POSITIONS OF THE GROUPS AFTER ONE YEAR AT THE UNIVERSITY - 1995/96**

| | Sample size ( N ) | A | B | C | Chi square $X^2$ |
|---|---|---|---|---|---|
| **HIGHER** | 355 | 4.0 | 20.5 | 75.5 | 3.66 |
| **LOWER** | 41 | 0.0 | 12.2 | 87.8 | |
| **MALE** | 129 | 7.0 | 20.2 | 72.9 | 5.51 |
| **FEMALE** | 241 | 2.3 | 19.2 | 78.6 | |
| **OLDER** | 66 | 2.4 | 4.8 | 92.9 | * 7.04 |
| **YOUNGER** | 330 | 4.0 | 21.2 | 74.9 | |
| **INTENDING** | 304 | 2.8 | 17.4 | 79.7 | ** 9.54 |
| **NON - INTENDING** | 92 | 8.0 | 27.3 | 64.8 | |

**Key : * P < 0.05**

**** P < 0.01**

Table 56 shows that there was a strong movement towards position C by most of the students after their first year course. Between the 'highers' and the 'lowers', a larger percentage of lowers were at position C but the difference was not significant in this case (unlike in session 1994/95 - Table 53 ). Part of the reason for the lack of a significant difference is that such a high proportion of the lowers ( 70.7%) were at C before coming to University, so few were left to move position.

There was no significant difference between Perry distributions for males and females after a year at University. However, since the females started with a significantly higher proportion at A and B, they have moved more to C than the males.

The relative distributions for older and younger students remained essentially as they were at the start, with both groups shifting towards C by similar amounts.

The most significant difference between sub-groups in this session was between intending and non-intending students. Intending students moved significantly more to C than did non-intendings. This is a particularly interesting finding since the two groups were not distinguishable at the start, and such a difference did not occur in session 1994/95.

## 7.4 THE DIFFERENCES IN STUDENTS POSITIONS BETWEEN 1994/95 AND 1995/96 SESSIONS

The students positions on the Perry scale showed the following differences between the 1994/95 and 1995/96 sessions.

**TABLE 57**

**THE DIFFERENCE IN STUDENTS' POSITIONS**

| YEAR | Sample size (N) | A | B | C | Chi square $X^2$ |
|---|---|---|---|---|---|
| **Before coming to University** | | | | | |
| **1994/95** | 386 | 43.8 | 18.9 | 37.3 | |
| **1995/96** | 396 | 38.9 | 23.7 | 37.4 | 3.27 |
| | | | | | |
| **After one year at University** | | | | | |
| **1994/95** | 386 | 6.5 | 21.5 | 72.1 | |
| **1995/96** | 396 | 3.8 | 19.4 | 76.8 | 3.76 |

Table 57 shows that the starting distribution was not significantly different.

In both sessions, the proportions of students at position at C was lower before they came to the university. This means that more of the students were dualistic in thinking before coming to the university.

After one year at the university, the difference between the distributions was again not significant but there was a slightly greater shift towards position C in the class of 1995/96 than in 1994/95.

## 7.5 STUDENTS' MOVEMENT ALONG THE PERRY SCHEME

From the students' responses in the grid, the following types of movements were identified; **positive, negative and unchanged.** A positive movement is any movement along the Perry scheme in the direction of position C. A negative movement is any movement along the Perry scheme away from position C, that is, in the direction of position A. Unchanged are those that did not show any movement at all from what they were before coming to the university and after first year at the university.

### 7.5.1 STUDENTS' MOVEMENT IN 1994/95 SESSION.

#### 7.5.1.1 MOVEMENT OF THE CLASS IN GENERAL

The movement of the whole class as identified from the students responses in the grid is shown in table 58. Since students in position C at the start of the year cannot move further in the relativistic direction during the year, I have shown not only all classes of movements but also the percentages of types of movement with those who were C at the start, and who did not change, excluded.

**TABLE 58**

**MOVEMENT OF THE CLASS ALONG THE PERRY SCHEME**

| TYPE OF MOVEMENT | % | % without those that remain unchanged at position C |
|---|---|---|
| POSITIVE | 59.1 | 71.2 |
| NEGATIVE | 5.7 | 7.1 |
| UNCHANGED | 35.2 | 19.9 |

### 7.5.1.2 MOVEMENT OF THE GROUPS ALONG THE PERRY SCHEME - 1994/95

The movements of the various groups along the Perry scheme as identified from their responses in the grid are shown in table 59.

**TABLE 59**

**GROUP MOVEMENT ALONG THE PERRY SCHEME - 1994/95**

| THE GROUPS | Sample size (N) | POS | NEG | UNCH | Chi square $X^2$ |
|---|---|---|---|---|---|
| HIGHER | 340 | 58.5 | 5.8 | 35.8 | 0.59 |
| LOWER | 46 | 63.0 | 4.3 | 32.6 | |
| MALE | 114 | 50.4 | 7.0 | 42.6 | 4.23 |
| FEMALE | 272 | 62.6 | 5.1 | 32.3 | |
| OLDER | 122 | 50.0 | 5.4 | 44.6 | 4.59 |
| YOUNGER | 264 | 62.0 | 5.8 | 32.2 | |
| INTENDING | 326 | 59.4 | 6.6 | 34.0 | 2.69 |
| NON - INTENDING | 60 | 56.1 | 1.87 | 42.1 | |

**POS** = Positive movement, **NEG** = Negative movement, **UNCH** = Unchanged.

The results from Table 59 show, as for the class as a whole, that in all sub- groups, the vast majority of students who changed moved in a positive direction. In the comparisons between subgroups, no significant differences occurred in the distribution of movements.

### 7.5.2 STUDENTS' MOVEMENT IN 1995/96 SESSION

#### 7.5.2.1 MOVEMENT OF THE CLASS IN GENERAL

The movement of the whole class as identified from the students responses in the grid is shown in table 60. As in table 58, a column is included to show the data excluding those who were C at the start and who did not change.

**TABLE 60**

**MOVEMENT OF THE CLASS ALONG THE PERRY SCHEME**

| TYPE OF MOVEMENT | % | % without those that remain unchanged at position C |
|---|---|---|
| POSITIVE | 62.5 | 83.8 |
| NEGATIVE | 3.5 | 4.7 |
| UNCHANGED | 34.0 | 11.5 |

#### 7.5.2.2 MOVEMENT OF THE GROUPS ALONG THE PERRY SCHEME - 1995/96

The movements of the various groups along the Perry scheme as identified from their responses in the grid is shown in table 61.

**TABLE 61**

**MOVEMENT OF THE GROUPS ALONG THE PERRY SCHEME - 1995/96**

| THE GROUPS | Sample size (N) | POS | NEG | UNCH | Chi square $X^2$ |
|---|---|---|---|---|---|
| HIGHER | 355 | 63.8 | 3.2 | 33.0 | * 6.23 |
| LOWER | 41 | 50.0 | 10.0 | 40.0 | |
| MALE | 155 | 52.7 | 7.0 | 40.3 | ** 10.03 |
| FEMALE | 241 | 66.9 | 2.3 | 30.8 | |
| OLDER | 66 | 38.1 | 0.0 | 61.9 | ** 16.57 |
| YOUNGER | 330 | 65.0 | 4.2 | 30.8 | |
| INTENDING | 304 | 65.6 | 2.5 | 31.9 | ** 13.18 |
| NON - INTENDING | 92 | 48.3 | 9.2 | 42.5 | |

**Key : * $P < 0.05$, ** $P < 0.01$**

The results from Table 61 show, as for the class as a whole, that in all subgroups, the vast majority of students who changed moved in a positive direction. In this case, significant differences occurred in all the subgroup comparisons. A greater proportion of positive compared to negative movements or no change occurred in 'highers' compared to 'lowers', females compared to males, younger compared to older and intending compared to non-intending. These differences need to be interpreted with caution. In some sub-groups for example, older students, the proportion who started at C and remained at C is very high, giving an overall result of little change - but we would not expect them to revert to A or B.

## 7.6 THE DIFFERENCES IN STUDENTS' MOVEMENT BETWEEN 1994/95 AND 1995/96 SESSIONS

### TABLE 62

### THE DIFFERENCE IN STUDENTS MOVEMENT

| YEAR | Sample size (N) | POS | NEG | UNCH | Chi square $X^2$ |
|---|---|---|---|---|---|
| **Including all those that started at position C** | | | | | |
| **1994/95** | **386** | 59.1 | 5.7 | 35.2 | |
| **1995/96** | **396** | 62.1 | 3.5 | 34.0 | 2.51 |
| **Excluding all those that started at position C and remained unchanged** | | | | | |
| **1994/95** | **312** | 71.2 | 7.1 | 19.9 | |
| **1995/96** | **296** | 83.8 | 4.7 | 11.5 | ** 9.39 |

**Key : * P < 0.01**

The results show that when we compare all movements for the two sessions, although positive movement are slightly higher in session 1995/96 than in 1994/95, the difference in distribution was not significant. However, when we exclude all those who began the years at C and remained unchanged, the difference between 1995/96 and 1994/95 becomes highly significant with higher proportion of positive movements achieved during the new course.

## 7.7 HOW THEY MOVED

From the responses of the students with respect to what they were before they came into the university and after their first year course at the university the actual movements made were identified and classified as either positive, negative or unchanged. These different types of movements and their respective percentages are shown in tables 63, 64 and 65 for both 1994/95 and 1995/96 sessions.

**TABLE 63**

**POSITIVE MOVEMENTS IN 1994/95 AND 1995/96**

| | 1994/95<br>N = 228 | 1995/96<br>N = 248 |
|---|---|---|
| TYPE OF MOVEMENTS | % | % |
| A - A2 | 3.0 | 0.4 |
| A - B | 20.9 | 13.8 |
| A - C | 43.8 | 47.7 |
| A2 - B | 2.6 | 1.7 |
| B - C | 19.6 | 25.1 |
| C2 - C | 10.4 | 11.2 |

Table 63 shows that a high proportion of the positive movements were at A - C for both sessions, somewhat more in 1995/96 than in 1994/95.

**TABLES 64**

**NEGATIVE MOVEMENTS IN 1994/95 AND 1995/96**

| | **1994/95**<br><br>**N = 22** | **1995/96**<br><br>**N = 14** |
|---|---|---|
| **TYPES OF MOVEMENTS** | **%** | **%** |
| A2 - A | 4.4 | * - |
| B - A | 3.1 | 6.7 |
| B - A2 | 8.7 | 6.7 |
| C2 - A | 8.7 | * - |
| C - B | 43.4 | 73.3 |
| C - C2 | 21.7 | 13.3 |

* These movements did not occur in 1995/96 session.

Table 64 shows the highest proportion of negative movements for both sessions were at C- B. However, the total sample size of negative movements was small. It is noticeable that very few students ( none in 1995/96) moved from C - A.

**TABLE 65**

**GROUPS THAT REMAINED UNCHANGED IN 1994/95 AND 1995/96**

| | **1994/95** N = 136 | **1995/96** N = 135 |
|---|---|---|
| | **%** | **%** |
| A - A | 9.1 | 7.7 |
| B - B | 12.9 | 18.8 |
| C - C | 80.0 | 73.7 |

Table 65 shows that well over half of the students that remained unchanged were at position C. The percentage of the students that remained unchanged at C was higher in 1994/95 than in 1995/96.

## 7. 8 PERRY STATEMENTS

In order to further confirm the direction of the students movements, the students were given three Perry statements. The students were asked to agree or disagree with each of the statements and give their reasons. The three statements were classified into the main groups of the Perry model: that is A (dualism), B (multiplicity) and C (relativism ). This was given in 1994/95 only. In 1995/96 there was no time available to present it to the students. Their responses are shown in table 66.

**TABLE 66**

**A COMPARISON BETWEEN STUDENTS RESPONSES TO PERRY STATEMENTS AND THE GRID IN 1994/95 SESSION**

| | Sample Size (N) | A | B | C | Chi square $X^2$ |
|---|---|---|---|---|---|
| | | % | % | % | |
| **The Perry statements** | 491 | 6.1 | 21.9 | 72.1 | 0.06 |
| **The grid** | 491 | 6.5 | 21.5 | 72.1 | |

The results shows that there is no significant difference between the two distributions. Hence the Perry statements results agreed with the grid results.

The Perry statements are shown below with some selected reasons that the students gave to justify their answers.

### 7.8.2 REASONS FOR AGREEING OR DISAGREEING WITH EACH STATEMENT

The statement A : - ***A good thing about science is the fact that everything is so clear cut either right or wrong.***

## Agree

(1) There are no ifs and buts, you just have to learn the facts.

(2) It gives me an opportunity to attain high marks and to show my understanding without waffle.

(3) Science is clear cut, hence it enables me to avoid confusion.

(4) Most things are clear cut, but not all. I prefer clear cut things.

## Disagree

(1) Sometimes it is better to be able to consider things from a different perspective and hypothesise. This encourages learning.

(2) Science expands as would our thoughts, so it cannot be clear cut.

(3) Science cannot be clear cut because there is constant investigation and revision of current beliefs and theories.

(4) If everything is clear cut there will be no intrigue.

Statement B : - ***There seems to be so many ways of looking at scientific subjects I feel confused about what is right and wrong.***

## Agree

(1) Sometimes there are so many solutions to one question that is confusing to know which solution is best.

(2) Sometimes I don't know exactly how to approach an idea.

(3) There are lots of different ways of looking at scientific subjects and I sometimes find it difficult to adjust my previous opinions.

(4) There are many arguments in science that contradict each other and this is confusing.

## Disagree

(1) The different ways of looking at science makes it more interesting.

(2) You must be able to isolate a position and make up your mind.

(3) It is always good to explore other ideas and not just to stick to what you know.

(4) Ambiguity in a subject makes you ask questions and this is helpful in finding the facts.

Statement C : - ***When I meet a new idea in a course I try to relate it to things I have met on other parts of the course.***

### Agree

(1) All competent people relate the new knowledge to the old.

(2) Part of the point of holding knowledge is for its ability to be applied to other situations. It loses its practical value if it is not related to anything else.

(3) Knowledge is continuously being built up by this type of linkage.

(4) The new idea interrelates with the old and this aids understanding.

### Disagree

(1) Every subject is unique.

(2) I treat each new idea differently.

(3) I prefer to keep topics separately so as to avoid confusion.

(4) I just learn what I am taught.

The students that disagree with statement A and B and agree with C can be classed as relativistic in their thinking, while those that agree with statement A are dualistic and those that agree with statement B were multiplistic in their thinking.

These statements thus confirm that the Perry groupings do exist among the students. I have given only a selection from a very large number of justifying statements made by the students. These statements are particularly interesting as they show a clear awareness of the students attitudes to learning and to learning science in particular.

## 7.9 SUMMARY OF RESULTS

The results in this chapter reveal the attitudes of the students towards teaching and learning of their first year biology course as defined by the Perry model. The results show that before coming to the university the largest grouping of the students were dualistic in thinking which means that as students they see their role as that of receiving what the lecturer gives them without much question and to give out what they have received. In this situation they see the lecturer as the only authority. They are therefore not able or willing to take responsibility for what they learn and how they learn it.

After the first year at university a change became evident in the students' attitudes as their responses indicate a strong shift from a dualistic stance to a relativistic one. This trend was similar for both 1994/95 and 1995/96 sessions. This shows that the students have started to take responsibility for their own learning rather than expecting the lecturer to provide all the information.

In the 1994/95 session, before coming to the university, the differences between the sub-groups were not significant except for the older and younger group. Most groups were skewed towards dualism. After their first year at university all the groups were skewed towards the relativistic position. The differences were significant for some groups and not for others, showing that some groups were similarly affected, for example the males and females, intending and non-intending students.

In the 1995/96 session, before coming to the university, the differences were highly significant between the groups, with the exception of the intending and non - intending group. The 'lower' and 'older' had high initial proportions at position C. After their first year at the university all the groups were skewed towards the relativistic position. The differences were significant for some groups and not for others showing that some groups were similarly affected , for example the males and females, higher and lower students.

When types of movements were analysed, and the results for the two years compared, a highly significant difference emerged. In both years, the majority of movements were positive, towards position C. Although there were slightly more positive movements in 1995/96 than in 1994/95, the distributions were not significantly different. However, when those starting off the year at position C ( and who therefore can move no further in a positive direction ) were excluded, session 1995/96 was significantly different from

1994/95, with a higher proportion of positive movements. This constitutes evidence that the changes in the course did make a difference in students attitudes to their learning producing a shift towards the relativistic stance which is associated with a higher degree of autonomy.

In conclusion, the results from the Perry model study gave a further confirmation that the students during their first year biology course were being encouraged to become autonomous in their learning and this encouragement was more evident in 1995/96 than in 1994/95.

Biology is one of the three courses the students study. Their attitudes to teaching and learning biology are likely to be highly influenced by the way the course is presented; however the overall university experience will have an influence too.

## 7.10 REFLECTIONS ON THE PERRY MODEL

The findings have shown that students are undergoing changes in their perception and approach to their study while at university. This shows that many students entering the university with the impression that science is clear cut and factual, might change the impression as they progress through the course, although some students maintain this opinion till the end of the course. The students perception of the lecturers also generally changes from being authority figures who know everything about their subject to people who might not know all the answers. The students also start to take responsibility for their own learning as they progress through university rather than expecting the lecturer to provide all the information. This will include wanting to undertake more individual study and to work with other students.

As students become more responsible for their learning they become more active in attempting to relate any new information into topics or subjects on their course. With these changing perceptions of the subject areas and the role of themselves and the lecturer, within the learning environment, students preferences for teaching, assessment and study methods also change.

A knowledge of Perry scheme of intellectual development is useful in describing the behaviours of students and also in suggesting ideas, encouraging and supporting students to develop more relativistic ways of thinking. Assumptions can be made as to the relative Perry positions of the average students of each year and classes can be taught accordingly. However a knowledge of where individual students are, or where the majority of a class of students are, could be considered preferable particularly if the effects of different instructional methods are to be monitored

Awareness of the students' position might be important when planning a lab practical so that a learning environment which challenges and supports students could be provided to encourage and promote progression through the Perry scheme (Finster, 1990).

Identifying students' position can be problematic because individuals exhibit behaviours characteristics of different stages, perhaps responding dualistically to one learning context and relativistically in another (Finster, 1991). Baxter- Margolda and Porterfield (1985) have highlighted the importance of developing measures which can allow students to justify their responses.

The findings from this study suggested that the grid and the statements are providing information pertaining to a student's stage of intellectual development. The grid and the statements can be completed within a short time and can therefore be used to monitor changes in attitudes in large number of students. The instrument may not accountedly measure absolute attitude, but they can monitor atttittude change.

The first few months of a students' university experience might be considered to set the trend for the subsequent years as a student adapts to the new learning environment. If the students enter the university with a relativistic approach to their learning, as seemed to be the case of the first year students in 1995/96, then it would seem important that lecturers consider ways in which this approach might be maintained throughout the duration of their course by the use of appropriate instructional methods if the aim of the course is to encourage students to develop relativistic thinking.

A change from a more traditional lecturer role to that of a facilitator in order to maintain a more active approach could prove demanding and problematic to some lecturers, particularly on courses which have more content bound syllabi (Collier, 1985). Hence there is need for incentives for lecturers with heavy teaching and research workloads to change their teaching. It will also require that the new lecturers should be trained to teach in a way in which they will become involved in their students thinking (Clarke, 1991). This training will also equip them with the teaching methods that will encourage the students to become more relativistic in their thinking.

Students responded to the existence of uncertainty by feeling confused, and panicing The confusion then led to acceptance . According to Riegel (1973) this feeling of acceptance is a small development towards relativism.

Dualistic students are deaf to external cues available within the learning environment while multiplists seek out cues from the lecturers and direct their learning accordingly. Relativists are seen as cue conscious students who want to demonstrate a more personalised approach to their learning rather than being specifically lecturer directed (Miller and Parlett, 1974).

The transition from school to university requires the student to make a rapid adjustment in his way of life and in his approach to learning and his first year at the university is therefore a critical period (Hale, 1964). This is the time when they will be re-evaluating their value systems and developing an idea of self. Widick *et al.* (1975) have described how students' intellectual and identity development can occur in parallel at university and that the university environment provides suitable challenges which facilitate this process. An openness or receptivity for change seems to be a determining factor in whether or not students reach a stage of relativism (Widick, 1977; Perry,1981) with an additional willingness to learn and to develop at a personal level rather than just obtain a qualification. A lack of necessity or desirė to make the transition to relativism therefore might in part explain why not all first year students tested in this project had reached a stage of relativism. Finster (1989) found that a group of students did not appear to make a transition to relativism, preferring to remain at the earlier stages of intellectual development .This is supported by the findings in this study.

If in a department the recall of factual information is emphasised in the course assessments, students can be encouraged to remain at a stage where they actively cue seek from the lecturers and direct their learning towards a high level of achievement but at a lower intellectual level.

# CHAPTER 8

# SUMMARY AND RECOMMENDATIONS

## 8.1 SUMMARY

The research was designed to determine student attitudes to teaching strategies aimed at encouraging autonomous learning in university level biology.

As it has been stated in chapter one, a students' attitude is a characteristic that is not directly observable but which can be presumed as underlying and in part accountable for, an observed pattern of behaviour. An attitude is a student's disposition to respond to an educational situation in a certain predictable manner that is relatively stable. A learner is not merely a cognitive entity, but, he exhibits affective or emotional states in his motivations, attitudes, personality, anxieties, intentions and beliefs all of which influence his learning in both direct and indirect ways. Attitudes may lead to a rejection of new ideas or facilitate the acceptance of new ones. Hence attitudes may influence or even determine the learning which occurs in the classroom. This realisation has led to the need for inculcating the appropriate attitudes in students and is held by many to be one of the main functions of an organised system of education (Lewis ,1974).

Hence one of the two - fold tasks of the university has been that of preparation of students for the learned professions by immersing them in subjects which, while being desirable in view of their future professions, are at the same time intellectually stimulating and broadly educative. The other is ensuring the advancement of knowledge.

Students are now more in number and are more diversified in their social and educational background and this presents a challenge to university teachers who aim at teaching their subjects in such a way that not only serves as a basis for professional skill but also stimulates and broadens the mind.

Hence the need for university teaching to combine training for professional life with the development of the students minds - the ability of students to think for themselves becomes very necessary.

Consequently the promotion of independent learning or the ability to think for oneself has become central to the whole enterprise of the higher education. Independent learning is necessary in students because of its unique characteristics and value to the student. A student who has become autonomous will be able to exercise freedom of choice after rational reflection and conduct his life without having his mind made up by others. This leads to the development of self confidence. Therefore, because of the importance of independent learning, there is the need to provide a learning environment that will offer the learner the freedom and encourage the right attitude to practice the skill. There is also the need for effective teaching strategies that will facilitate this type of learning.

The Undergraduate Teaching Unit of the IBLS in Glasgow University decided to look into the teaching programme of the first year biology course and effect changes where necessary. Their main objective was to be able to cater for each student as a unique individual and to ensure the achievement of a personal best in terms of academic progress and independence of mind.

Changes in the level 1 biology course which were brought about were intended to encourage the students to become more autonomous in their learning. The research examines such changes to see what effect they might have had on the students. The students responses reveal the following areas where the course has made an impact on their attitudes.

### 8.1.1 THE BIOLOGY COURSE IN GENERAL

With a student population of over 700, administration takes up considerable time and interchange of information about a student's progress become more laborious. The students' responses however have shown that the biology course was well organised and hence rated the biology course as a whole as very good. This results indicates that students were presented with materials in a way that made learning very meaningful to them. They rated the text for the biology course as very good. This shows that the text had good coverage of the syllabus, suitability of language, coherence and a continuous development of ideas.

The clarity of the objectives of the course was rated very high, which means that the students knew exactly what was expected of them in the course.

The interest of the students in the course increased as the course progressed and their feelings were motivated and challenged by the course. In this respect the course was rated as good but there was still room for improvement. The students considered the workload as heavy in 1995/96 session despite the reductions in content. This might indicate the existence of a new pressure from the continuous assessment. This aspect might need some re-examination. The majority of the students felt that the pace of the course was not too fast.

### 8.1.2 ASSESSMENT PROCEDURES

In this study, students responses to the assessment procedures revealed that the exam questions were fair and were of the right standard. The students were more satisfied by the area of coverage of the exam questions in 1995/96 than in 1994/95. However, students were divided in both years on whether the methods of assessment measured their competence. Also opinion was very mixed on the quality of feedback students received on their assessment. According to Cox (1994) it is important to provide feedback on coursework as quickly as possible while the work done is fresh in the students' minds.

### 8.1.3 ASSIGNMENTS

Assignments provided the best opportunity for feedback on what students are learning from the course and also for reinforcing the teaching by positive comments and correction on the students' performance. Hence constructive criticisms are important.

From the study, the students rated as very good some aspects of the assignments such as promptness of return and relevance, however the majority of the students felt that they did not get valuable comments on assignments. Hence the need to look into this area specifically.

### 8.1.4 LABORATORY WORK IN GENERAL

The laboratory activities were varied especially in 1995/96. These tasks were carefully chosen to amplify and deepen the student knowledge of the subject matter and to give them some degree of autonomy.

The results from the study reveal that the labs were fulfilling one of their primary functions of helping the students to understand some of the lecture topics. Also the result showed that the necessary materials were always readily available, supervision of students was effective, labs were well organised, lab procedures were clear, students felt encouraged to think for themselves and the total workload for the labs was less in 1995/96. The clarity of the purpose of the labs and feedback received from the labs were rated low. Hence there might be the need to look into these two aspects.

### 8.1.5 TUTORIALS

Tutorials are student - centred activities where students are given the opportunity to air their views and are helped with any difficulties they might have from the lectures. Ideas are discussed and exercises on particular skills are performed. Eckstein (1979) explained that tutorials are suitable for accompanying a course of lectures to give an opportunity for students to clarify uncomprehended points left over from the lectures. Ogborn (1977) affirmed that this is the main and often the only acknowledge purpose of the tutorials. The lecturers acts only as facilitators.

From the study, it was apparent that tutorials have made a positive impact on the attitudes of the students and this impact was significantly greater on all counts in 1995/96. The results showed that the students are now becoming more active during tutorial sessions and are able to air their views and find help with difficulties they may have without any problems.

The topic to be discussed at the tutorials was clear and the size of the tutorial class was appropriate. There seemed to be some interpersonal distances among the students during the tutorial sessions.

The Teaching Assistants drew attention to the need to set up a tutorial system specific to lecture materials which will deal with students' difficulties in this area.

### 8.1.6 STUDY PROJECT ON AIDS

Cornwall (1981) emphasised on the need to introduce small components of independence into courses that are not purely designed for independent learning, thereby leading students into greater autonomy as early as possible during a course of study.

The attitudes and expectations of students are firmly established quite soon after they enter the university, and so there is a need for early introduction of autonomy which will enable them to cope with such skills in the later years of study.

The results from the students showed that the study projects on AIDS has succeeded in encouraging them to become autonomous in their learning by encouraging them to carry out their studies independently and to think for themselves. But the students did not find these projects enjoyable probably because they were too time consuming and the feedback was not satisfactory.

### 8.1.7 THE SUB - GROUPS

Within the sub - groups examined differences in attitudes occurred during the courses. The characteristics that were probably responsible for these differences were also identified. For the higher and lower group, the differences in their attitudes arose from the difference in their educational background. The higher group had a greater background knowledge in biology while the lower group had a little or no background in biology.

With regards to the male and female group the main characteristic that was probably responsible for the differences in their attitudes was their preference for biology. Another characteristic difference was the males' appearing to be more confident in their performances in the course than the females. Also the males exhibited a greater liking for abstraction than the females.

For the older and younger groups, the main characteristics that were probably responsible for the differences in their attitudes included; commitments (for example, family), previous experiences, study habits, a critical tendency. There was for the older group an unrealistic expectation of course structure and teaching methods, poor study habits, commitment and previous experience while the younger group showed recent study experiences, good learning techniques, lack of commitment and experience.

With respect to the intending and non - intending course, the main characteristics that probably brought about the differences between the groups is the lack of interest in biology by the non - intending group.

### 8.1.8 THE PERRY MODEL

The model as stated earlier in chapter 3 is an observational tool used to identify the ways in which students think or behave. The model provided evidence that the changes in the course did make a difference in students attitudes to their learning producing a shift towards the relativistic stance which is associated with a higher degree of autonomy.

On the basis of these results, it is clear that the department has demonstrated a sense of duty, a determination, a desire and a willingness to ensure that learning becomes more meaningful to the students and that an attitude of independence is encouraged.

The results also showed that the changes made in the biology course made a considerable impact on the students attitudes that lead to satisfaction in learning. This was clearly shown in the responses of the students in the 'new' course as compared to the 'old' course. The students were more positive in the new course than the old course (see chapter 6).

## 8.2 RECOMMENDATIONS

### 8.2.1 THE BIOLOGY COURSE IN GENERAL

The findings of this study have revealed that the changes made in the biology course had made a positive impact on the attitudes of the students to their learning. The study also revealed that these changes have also encouraged the students to become autonomous in their learning.

However there are some areas that will require re-examination so as to ensure their effectiveness in making learning more meaningful to the students. Such areas will include those that have not made a satisfactory impact on the students attitudes. Based on such areas therefore the following recommendations are made :-

(1) There is still the need for the provision of more challenging activities that will increase the interest of the students in the biology course.

(2) The workload is still being perceived as heavy by the students. There is the need to review the continuous assessments to ensure its practicability.

(3) Re-examination of the assessment procedures is still necessary - especially the validity; whether they measure what they are supposed to measure.

(4) Students should have valuable feedback on their learning. Marked assignments should be returned with valuable comments. Instructions on the assignments need to be made more clear to the students.

(5) There is need for more investigative labs. They encouraged the development of problem solving and interpretative skills and consequent autonomy in learning

(6) There is the need to re-emphasise the purpose of the labs at the beginning of each session so that the students will be able to assess their achievement at the end of the lab. This encourages their learning.

(7) Prelab activities should assume a greater importance thus ensuring greater understanding in the lab. These activities highlight essential ideas of the labwork, introducing new principles or concepts, clarifying the purpose of the lab and pointing out pitfalls.

(8) The processes being used to ensure immediate student feedback after the labs should again be re-examined.

(9) Films/video should be shown to the students at a time when they are less likely to be too tired to benefit from it.

(10) Tutors at the tutorials should again be reminded of the need to continue to act as much as possible as members of the class.

(11) The use of teaching aids during lectures should again be re-emphasised as they enhanced students understanding.

(12) Lectures should, as much as possible encourage the students to investigate the subject more and to enable them to transfer what they have learn to new situations.

(13) Projects, such as AIDS, should be carefully assessed in order to ensure an effective feedback to the students.

(14) During tutorials students should be encouraged to know the names of their colleagues in order to improve interpersonal relationships.

### 8.2. 2 THE SUB - GROUPS

With regards to the different characteristics within the groups which affect their attitudes to the course. The following recommendations are made:

#### 8.2.2.1 HIGHER AND LOWER STUDENTS

(1) There should be more challenging activities for the higher group so that they do not lose interest.

(2) There should also be remedial programmes for the lower group,. for example, seminars could be arranged to assist them with any difficulties they may have, once in a while.

In an attempt to ensure uniformity in attainment among this group of students in class, differentiation in teaching based on varying entry qualifications could be used.

Hale (1964) suggested that the Lower group could be kept in the same class and given extra tuition or they could be separated and assigned to a different course or to different stream in the same course which proceeds more slowly than that containing the higher group

These two methods are not mutually exclusive. All students could attend the same lectures but could be separated according to ability or attainment when grouped for tutorials. Hale pointed out that there has been opposition to the idea of separating the lower group from the higher group on the ground that the lower group benefit from the presence of the higher group in any class in which students take part in discussion. The problem is not an easy one as the interest of the higher and the lower students may not be altogether reconcilable.

### 8.2.2.2 MALE AND FEMALE STUDENTS

More challenging activities are needed that will satisfy the quest for abstraction in the males and also provide an improvement in the same for the females. This will increase the interest of the males in biology.

### 8.2.2.3 OLDER AND YOUNGER STUDENTS

(1) For the older groups, there is need for pre- course counselling in order to lessen their unrealistic expectations of teaching methods.

(2) The older group will also require a pre-course intensive induction on study skills.

(3) The younger group will require more challenging activities.

### 8.2.2.4 INTENDING AND NON - INTENDING STUDENTS

(1) The intending and the non-intending group will require more challenging activities.

(2) The non-intending group might need some remedial programmes to assist them with any difficulty they might have with the course.

### 8.2.2.5 THE PERRY MODEL

(1) There might be the need to identify the students' positions on the Perry scheme so that each student can be properly assisted.

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# APPENDIX A

## DETAILED RESULTS OF THE GROUP RESPONSES

## 1994/95 - THE COURSE IN GENERAL

## HIGHER AND LOWER

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| The course content was well organsied | 64.5 | 29.2 | 6.3 | 60.0 | 36.7 | 3.3 | 1.92 |
| The course objectives were clear to me at the begining of the course | 36.4 | 34.2 | 29.4 | 31.7 | 38.3 | 30.0 | 0.57 |
| My interest in the c course increased as the course progressed | 48.1 | 35.9 | 16.0 | 48.3 | 33.3 | 18.3 | 0.27 |
| Recommended readings from the text contributed to my understanding of the course | 56.8 | 26.9 | 16.3 | 68.3 | 20.0 | 11.7 | 2.87 |
| Compared to other courses the work load for this course is very heavy | 35.9 | 37.1 | 26.9 | 44.1 | 37.3 | 18.6 | 2.30 |
| Overall, I will rate the biology course as very heavy | **69.8** | **26.3** | **3.9** | **60.0** | **25.0** | **15.0** | ****12.94** |
| The pace of the course was too fast | **26.0** | **41.7** | **32.3** | **46.7** | **30.0** | **23.3** | ****10.99** |
| **1995/96** | | | | | | | |
| The course content was well organsied | **69.0** | **24.8** | **6.2** | **55.9** | **25.4** | **18.6** | ****11.65** |
| The course objectives were clear to me at the begining of the course | 54.1 | 29.7 | 16.3 | 44.1 | 28.8 | 27.1 | 4.45 |
| My interest in the c course increased as the course progressed | 47.0 | 36.3 | 16.7 | 54.2 | 30.5 | 15.3 | 1.11 |
| Recommended readings from the text contributed to my understanding of the course | 71.5 | 21.8 | 6.7 | 61.0 | 33.2 | 6.8 | 3.21 |
| Compared to other courses the work load for this course is very heavy | **46.4** | **33.5** | **20.1** | **55.9** | **37.3** | **6.8** | ***6.17** |
| Overall, I will rate the biology course as very heavy | 66.4 | 25.7 | 7.9 | 61.0 | 30.5 | 8.5 | 0.69 |
| The pace of the course was too fast | **13.4** | **50.5** | **36.1** | **27.1** | **59.3** | **13.6** | ****15.13** |

## THE COURSE IN GENERAL - AREAS THE TWO GROUPS AGREED SEPARATELY IN 1994/95 AND 1995/96

## HIGHER AND LOWER

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | N | **D** | **A** | N | **D** | |
| I learnt a great deal of factual material form this course | 82.1 | 14.0 | 3.9 | 77.1 | 13.1 | 9.8 | 4.29 |
| The different parts of the course well integrated | 50.2 | 42.0 | 7.7 | 59.0 | 32.8 | 8.2 | 1.92 |
| Lectures relate to my existing knowledge and experiences | **63.2** | **29.3** | **7.6** | **22.0** | **50.8** | **27.1** | ****42.25** |
| I felt motivated and challenged to learn in this course | 47.3 | 38.6 | 14.0 | 44.3 | 37.7 | 18.0 | 0.71 |
| The course co - ordination was poor | 6.8 | 33.8 | 59.4 | 6.6 | 42.6 | 50.8 | 1.86 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The course in general was well organised | 79.5 | 15.5 | 5.0 | 72.9 | 18.6 | 8.5 | 1.75 |
| The course co - ordination was good | 50.4 | 41.5 | 8.2 | 47.5 | 44.1 | 8.5 | 0.18 |
| I felt challenged in this course to find out things for myself | **38.0** | **40.3** | **21.7** | **55.9** | **33.9** | **10.2** | ***8.11** |
| I have more time in this course for private study | 17.9 | 46.3 | 35.8 | 7.0 | 49.1 | 43.9 | 4.55 |

## 1994/95 - THE COURSE IN GENERAL

### MALE AND FEMALE

| | Male | | | Female | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| The course content was well organsied | 70.3 | 24.5 | 5.2 | 62.5 | 30.9 | 6.6 | 2.77 |
| The course objectives were clear to me at the begining of the course | 34.0 | 35.3 | 30.8 | 38.5 | 32.2 | 29.3 | 0.93 |
| My interest in the c course increased as the course progressed | **39.7** | **41.5** | **18.6** | **52.6** | **31.3** | **16.1** | ***7.14** |
| Recommended readings from the text contributed to my understanding of the course | **56.4** | **21.8** | **21.8** | **59.5** | **27.8** | **12.8** | ***6.76** |
| Compared to other courses the work load for this course is very heavy | 40.4 | 34.0 | 25.6 | 36.5 | 37.8 | 25.7 | 0.83 |
| Overall, I will rate the biology course as very heavy | **57.7** | **34.0** | **8.3** | **73.9** | **22.1** | **4.0** | ****13.13** |
| The pace of the course was too fast | 26.3 | 42.3 | 31.4 | 30.9 | 38.8 | 30.3 | 1.12 |
| **1995/96** | | | | | | | |
| The course content was well organsied | 65.5 | 23.6 | 10.9 | 68.2 | 26.3 | 5.5 | 4.81 |
| The course objectives were clear to me at the begining of the course | 50.3 | 30.3 | 19.4 | 53.7 | 30.1 | 16.3 | 0.86 |
| My interest in the c course increased as the course progressed | 41.2 | 41.2 | 17.6 | 51.1 | 32.1 | 16.8 | 4.85 |
| Recommended readings from the text contributed to my understanding of the course | **64.0** | **25.6** | **10.4** | **72.7** | **22.4** | **4.9** | ***6.48** |
| Compared to other courses the work load for this course is very heavy | 45.5 | 32.7 | 21.8 | 48.5 | 35.6 | 6.0 | 2.57 |
| Overall, I will rate the biology course as very heavy | 64.6 | 25.0 | 10.4 | 66.2 | 26.8 | 7.1 | 1.16 |
| The pace of the course was too fast | 15.2 | 53.9 | 30.9 | 15.6 | 49.7 | 34.7 | 0.87 |

## THE COURSE IN GENERAL - AREAS THE TWO GROUPS AGREED SEPARATELY IN 1994/95 AND 1995/96

## MALE AND FEMALE

| | MALE | | | FEMALE | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| I learnt a great deal of factual material form this course | **79.1** | **12.0** | **8.9** | **83.3** | **14.1** | **2..6** | ***9.08** |
| The different parts of the course well integrated | 53.2 | 38.0 | 8.9 | 51.8 | 40.7 | 7.5 | 0.45 |
| Lectures relate to my existing knowledge and experiences | 53.8 | 34.6 | 11.5 | 60.1 | 30.9 | 9.0 | 1.83 |
| I felt motivated and challenged to learn in this course | **38.6** | **44.3** | **17.1** | **52.1** | **34.8** | **13.1** | ***7.64** |
| The course co - ordination was poor | 8.2 | 31.0 | 60.8 | 6.6 | 36.4 | 57.1 | 1.53 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The course in general was well organised | 78.8 | 13.9 | 7.3 | 78.6 | 16.8 | 4.6 | 2.02 |
| The course co - ordination was good | 47.9 | 42.4 | 9.7 | 51.1 | 41.5 | 7.4 | 0.96 |
| I felt challenged in this course to find out things for myself | 38.8 | 35.2 | 26.1 | 41.3 | 40.4 | 18.3 | 4.06 |
| I have more time in this course for private study | 18.3 | 44.5 | 37.2 | 15.6 | 46.9 | 37.4 | 0.60 |

**1994/95 - THE COURSE IN GENERAL**

**OLDER AND YOUNGER**

| | **Older** | | | **Younger** | | | **$X^2$** |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The course content was well organsied | 63.3 | 30.0 | 6.7 | 64.7 | 39.8 | 5.5 | 0.24 |
| The course objectives were clear to me at the begining of the course | 39.7 | 29.8 | 30.6 | 35.5 | 35.0 | 29.5 | 1.20 |
| My interest in the c course increased as the course progressed | 40.5 | 35.5 | 24.0 | 51.2 | 34.7 | 14.1 | *7.58 |
| Recommended readings from the text contributed to my understanding of the course | 62.0 | 24.8 | 13.2 | 57.3 | 25.9 | 16.8 | 1.12 |
| Compared to other courses the work load for this course is very heavy | 47.5 | 31.7 | 20.8 | 34.4 | 38.8 | 26.7 | *6.58 |
| Overall. I will rate the biology course as very heavy | 62.3 | 26.4 | 8.3 | 69.6 | 26.2 | 4.1 | 3.22 |
| The pace of the course was too fast | 32.2 | 34.7 | 33.1 | 28.1 | 41.9 | 30.0 | 1.96 |
| **1995/96** | | | | | | | |
| The course content was well organsied | 70.2 | 17.9 | 11.9 | 66.7 | 26.5 | 6.8 | 3.83 |
| The course objectives were clear to me at the begining of the course | **62.7** | **16.4** | **20.9** | **50.8** | **32.2** | **16.9** | ***6.89** |
| My interest in the c course increased as the course progressed | 47.8 | 31.3 | 20.9 | 47.7 | 35.9 | 16.4 | 1.02 |
| Recommended readings from the text contributed to my understanding of the course | **70.2** | **22.4** | **7.5** | **69.6** | **23.8** | **6.6** | ***8.12** |
| Compared to other courses the work load for this course is very heavy | 61.2 | 26.9 | 11.9 | 45.4 | 35.8 | 18.8 | 5.89 |
| Overall. I will rate the biology course as very heavy | 59.7 | 25.4 | 14.9 | 66.4 | 26.5 | 7.1 | 4.77 |
| The pace of the course was too fast | **26.9** | **47.8** | **25.4** | **13.6** | **51.8** | **34.6** | ***8.20** |

## THE COURSE IN GENERAL - AREAS THE TWO GROUPS AGREED SEPARATELY IN 1994/95 AND 1995/96

### OLDER AND YOUNGER

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| I learnt a great deal of factual material form this course | **70.5** | **18.9** | **10.7** | **85.8** | **11.8** | **2.5** | ****19.55** |
| The different parts of the course well integrated | 53.3 | 40.2 | 6.6 | 51.0 | 40.8 | 8.2 | 0.43 |
| Lectures relate to my existing knowledge and experiences | 55.0 | 35.0 | 10.0 | 59.3 | 30.5 | 10.2 | 0.87 |
| I felt motivated and challenged to learn in this course | **44.3** | **34.4** | **21.3** | **48.5** | **39.5** | **12.1** | ***6.40** |
| The course co - ordination was poor | 9.8 | 33.6 | 56.6 | 7.2 | 34.8 | 58.0 | 2.42 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The course in general was well organised | 67.2 | 25.4 | 7.5 | 80.3 | 14.6 | 5.2 | 6.06 |
| The course co - ordination was good | 42.4 | 45.5 | 12.1 | 51.1 | 41.4 | 7.5 | 2.56 |
| I felt challenged in this course to find out things for myself | **59.7** | **26.9** | **13.4** | **37.3** | **40.6** | **22.1** | ****12.07** |
| I have more time in this course for private study | 10.6 | 42.4 | 47.0 | 17.4 | 46.8 | 35.8 | 3.77 |

**1994/95 - THE COURSE IN GENERAL**

**INTENDING AND NON - INTENDING**

| | **Intending** | | | **Non - Intending** | | | **$X^2$** |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The course content was well organsied | 65.8 | 28.8 | 5.4 | 62.8 | 30.8 | 6.4 | 0.29 |
| The course objectives were clear to me at the begining of the course | 35.5 | 37.8 | 26.7 | 38.5 | 20.5 | 41.0 | **10.12 |
| My interest in the c course increased as the course progressed | 48.9 | 35.2 | 15.9 | 44.9 | 34.6 | 20.5 | 1.03 |
| Recommended readings from the text contributed to my understanding of the course | 61.1 | 24.4 | 14.5 | 43.6 | 34.6 | 21.8 | *8.05 |
| Compared to other courses the work load for this course is very heavy | 35.2 | 38.6 | 26.1 | 47.4 | 30.8 | 21.8 | 4.08 |
| Overall, I will rate the biology course as very heavy | 70.7 | 24.4 | 4.8 | 57.1 | 35.1 | 7.8 | 5.46 |
| The pace of the course was too fast | 27.3 | 40.6 | 32.1 | 29.5 | 39.7 | 30.8 | 0.16 |
| **1995/96** | | | | | | | |
| The course content was well organsied | 65.9 | 25.6 | 8.5 | 74.3 | 19.3 | 6.4 | 2.70 |
| The course objectives were clear to me at the begining of the course | 54.1 | 29.6 | 16.2 | 50.5 | 27.5 | 22.0 | 1.91 |
| My interest in the c course increased as the course progressed | **51.7** | **33.8** | **14.5** | **33.9** | **36.7** | **29.4** | ****15.95** |
| Recommended readings from the text contributed to my understanding of the course | 70.9 | 22.2 | 6.8 | 65.7 | 28.7 | 5.6 | 1.99 |
| Compared to other courses the work load for this course is very heavy | 45.3 | 35.0 | 19.7 | 55.1 | 32.1 | 12.8 | 4.01 |
| Overall, I will rate the biology course as very heavy | **69.1** | **24.6** | **6.3** | **50.5** | **33.0** | **16.5** | ****16.55** |
| The pace of the course was too fast | **13.1** | **51.4** | **35.5** | **21.3** | **52.8** | **25.9** | ***6.04** |

## THE COURSE IN GENERAL - AREAS THE TWO GROUPS AGREED SEPARATELY IN 1994/95 AND 1995/96

## INTENDING AND NON - INTENDING

| | **Intending** | | | **Non - Intending** | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| I learnt a great deal of factual material form this course | 83.7 | 12.1 | 4.2 | 73.1 | 19.2 | 7.7 | 4.88 |
| The different parts of the course well integrated | 53.8 | 39.4 | 6.8 | 50.0 | 41.0 | 9.0 | 0.65 |
| Lectures relate to my existing knowledge and experiences | 59.1 | 31.4 | 9.4 | 54.6 | 28.6 | 16.9 | 3.65 |
| I felt motivated and challenged to learn in this course | **52.1** | **36.1** | **11.8** | **32.1** | **47.4** | **20.5** | ****11.08** |
| The course co - ordination was poor | 6.2 | 35.8 | 58.0 | 9.0 | 32.1 | 59.0 | 1.00 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The course in general was well organised | 78.1 | 15.3 | 6.5 | 82.6 | 14.7 | 2.8 | 1.74 |
| The course co - ordination was good | 50.1 | 40.7 | 9.1 | 46.3 | 47.2 | 6.5 | 1.25 |
| I felt challenged in this course to find out things for myself | 40.3 | 38.9 | 20.7 | 36.7 | 37.6 | 25.7 | 2.34 |
| I have more time in this course for private study | 17.7 | 47.1 | 35.1 | 13.8 | 42.2 | 44.0 | 2.98 |

## ASSESSMENT

## HIGHER AND LOWER

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The examination questions were reasonable in difficulty | 48.0 | 37.6 | 14.4 | 51.7 | 33.3 | 15.0 | 0.41 |
| The methods of assessments used in the course measure my competency | **33.7** | **42.1** | **24.2** | **23.3** | **36.7** | **40.0** | ***7.09** |
| The examination questions covered most aspects of the course content | 34.9 | 20.7 | 44.4 | 31.7 | 21.7 | 46.7 | 0.24 |
| I did not get a valuable feedback on my learning as I progressed | 31.1 | 43.1 | 25.7 | 25.4 | 52.5 | 22.0 | 1.86 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The examination questions were reasonable in difficulty | 70.9 | 22.2 | 6.9 | 66.1 | 27.1 | 6.8 | 5.08 |
| The methods of assessments used in the course measure my competency | 41.8 | 37.9 | 20.3 | 33.9 | 40.7 | 25.4 | 1.54 |
| The examination questions covered most aspects of the course content | 68.3 | 21.0 | 10.7 | 67.8 | 20.3 | 11.9 | 0.07 |
| I did get a valuable feedback on my learningas I progressed | 38.7 | 39.9 | 21.5 | 37.3 | 33.9 | 28.8 | 1.74 |

## ASSESSMENT

## MALE AND FEMALE

| | Male | | | Female | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The examination questions were reasonable in difficulty | 51.0 | 34.8 | 14.2 | 48.2 | 37.0 | 14.9 | 0.32 |
| The methods of assessments used in the course measure my competency | 30.8 | 38.5 | 30.8 | 34.9 | 41.2 | 23.9 | 2.55 |
| The examination questions covered most aspects of the course content | **43.9** | **21.3** | **34.8** | **30.0** | **20.8** | **49.2** | ****10.42** |
| I did not get a valuable feedback on my learning as I progressed | 31.0 | 41.3 | 27.7 | 30.0 | 45.3 | 24.7 | 0.79 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The examination questions were reasonable in difficulty | **64.9** | **24.2** | **10.9** | **73.1** | **22.3** | **4.6** | ***6.42** |
| The methods of assessments used in the course measure my competency | 41.2 | 35.2 | 23.6 | 39.8 | 40.7 | 19.6 | 1.78 |
| The examination questions covered most aspects of the course content | 66.7 | 24.2 | 9.1 | 69.1 | 19.3 | 11.6 | 2.05 |
| I did get a valuable feedback on my learningas I progressed | **43.6** | **30.3** | **26.1** | **36.4** | **43.1** | **20.5** | ***7.65** |

## ASSESSMENT

## OLDER AND YOUNGER

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The examination questions were reasonable in difficulty | 47.9 | 37.2 | 14.9 | 49.0 | 36.3 | 14.7 | 0.05 |
| The methods of assessments used in the course measure my competency | 27.5 | 42.5 | 30.0 | 34.6 | 40.7 | 24.7 | 2.45 |
| The examination questions covered most aspects of the course content | 30.8 | 26.7 | 42.5 | 36.2 | 18.5 | 45.3 | 3.82 |
| I did not get a valuable feedback on my learning as I progressed | **28.6** | **36.1** | **35.3** | **30.6** | **46.7** | **22.8** | ***7.78** |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The examination questions were reasonable in difficulty | 77.6 | 17.9 | 4.5 | 69.3 | 23.7 | 7.0 | 4.06 |
| The methods of assessments used in the course measure my competency | 37.3 | 37.3 | 25.4 | 40.6 | 39.0 | 20.4 | 0.87 |
| The examination questions covered most aspects of the course content | 61.2 | 26.9 | 11.9 | 69.2 | 20.2 | 10.6 | 1.88 |
| I did get a valuable feedback on my learningas I progressed | 35.8 | 40.3 | 23.9 | 39.2 | 38.5 | 22.3 | 0.28 |

## ASSESSMENT

## INTENDING AND NON - INTENDING

| | Intending | | | Non - Intending | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The examination questions were reasonable in difficulty | 49.4 | 34.6 | 16.0 | 51.0 | 38.5 | 10.5 | 1.73 |
| The methods of assessments used in the course measure my competency | 35.1 | 40.3 | 24.6 | 29.9 | 37.7 | 32.5 | 2.14 |
| The examination questions covered most aspects of the course content | 36.6 | 20.3 | 43.1 | 28.7 | 19.2 | 52.1 | 2.57 |
| I did not get a valuable feedback on my learning as I progressed | 27.8 | 45.6 | 26.7 | 37.7 | 35.1 | 27.3 | 3.68 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The examination questions were reasonable in difficulty | 72.7 | 20.7 | 6.5 | 67.0 | 30.3 | 2.8 | 1.46 |
| The methods of assessments used in the course measure my competency | 41.2 | 38.1 | 20.7 | 40.4 | 36.7 | 22.9 | 0.24 |
| The examination questions covered most aspects of the course content | 69.6 | 20.7 | 9.7 | 63.3 | 22.8 | 13.8 | 1.99 |
| I did get a valuable feedback on my learningas I progressed | 39.8 | 38.2 | 22.0 | 39.4 | 36.7 | 23.9 | 0.15 |

# 1995/96 - ASSIGNMENTS

## HIGHER AND LOWER

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| Marked assignments were returned promptly | 74.2 | 16.3 | 9.6 | 77.6 | 13.8 | 8.6 | 0.32 |
| The assignments were related to the biology course | 69.1 | 20.6 | 10.3 | 74.1 | 22.4 | 3.5 | 2.80 |
| Adequate time was allowed for completing the assignments | 59.1 | 21.9 | 19.0 | 50.0 | 34.5 | 15.5 | 4.50 |
| The written assignments increased my understanding of the biology course | 49.8 | 30.4 | 19.9 | 62.1 | 22.4 | 15.5 | 3.10 |
| The instructions for the assignment were very clear | 42.5 | 32.6 | 24.9 | 41.4 | 34.5 | 24.1 | 0.08 |
| **MALE / FEMALE** | | | | | | | |
| Marked assignments were returned with valuable comments | 22.2 | 34.0 | 43.8 | 24.1 | 27.6 | 48.3 | 0.94 |
| Marked assignments were returned promptly | 73.2 | 16.5 | 10.4 | 75.8 | 15.3 | 8.9 | 0.44 |
| The assignments were related to the biology course | 69.9 | 20.9 | 9.2 | 70.2 | 20.6 | 9.2 | 0.01 |
| Adequate time was allowed for completing the assignments | 62.4 | 19.4 | 18.2 | 56.0 | 25.4 | 18.7 | 2.48 |
| The written assignments increased my understanding of the biology course | 54.3 | 24.4 | 21.3 | 49.7 | 31.9 | 18.4 | 3.03 |
| The instructions for the assignment were very clear | 45.7 | 32.9 | 21.3 | 40.3 | 32.9 | 26.8 | 1.83 |
| Marked assignments were returned with valuable comments | 24.4 | 37.8 | 37.8 | 21.2 | 31.6 | 47.2 | 3.96 |

**1995/96 - ASSIGNMENTS**

**OLDER AND YOUNGER**

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| Marked assignments were returned promptly | 77.3 | 15.2 | 7.6 | 74.4 | 16.0 | 9.6 | 0.35 |
| The assignments were related to the biology course | 72.7 | 21.2 | 6.1 | 69.8 | 20.5 | 9.7 | 0.89 |
| Adequate time was allowed for completing the assignments | 55.2 | 26.9 | 17.9 | 58.7 | 22.8 | 18.5 | .55 |
| The written assignments increased my understanding of the biology course | 56.1 | 25.8 | 18.2 | 50.6 | 29.9 | 19.5 | 0.71 |
| The instructions for the assignment were very clear | 40.9 | 39.4 | 19.7 | 42.5 | 31.8 | 25.7 | 1.85 |
| Marked assignments were returned with valuable comments | 28.8 | 21.2 | 50.0 | 21.2 | 35.5 | 43.3 | 5.56 |
| **INT / NON-INT** | | | | | | | |
| Marked assignments were returned promptly | 75.9 | 14.7 | 9.5 | 74.3 | 18.3 | 7.3 | 1.18 |
| The assignments were related to the biology course | 69.5 | 20.7 | 9.8 | 73.1 | 16.7 | 10.2 | 0.84 |
| Adequate time was allowed for completing the assignments | 60.3 | 22.0 | 17.7 | 52.3 | 26.6 | 21.1 | 2.19 |
| The written assignments increased my understanding of the biology course | 51.0 | 30.9 | 18.1 | 21.1 | 51.9 | 25.0 | 23.2 |
| The instructions for the assignment were very clear | 43.5 | 32.9 | 23.6 | 41.3 | 32.1 | 26.6 | 0.41 |
| Marked assignments were returned with valuable comments | 22.4 | 33.9 | 43.7 | 19.3 | 33.9 | 64.8 | 0.56 |

**1994/95 - THE LABORATORY WORK IN GENERAL**

**HIGHER AND LOWER**

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| For every lab session the necessary materials were always readily available | 77.6 | 12.7 | 9.7 | 73.1 | 15.4 | 11.5 | 0.51 |
| The lab sessions helped me to understand some of the topics covered in lectures | 68.8 | 22.1 | 9.1 | 68.6 | 19.6 | 11.8 | 0.46 |
| The lab sessions were well organised | 53.2 | 35.6 | 11.2 | 57.7 | 26.9 | 15.4 | 1.84 |
| The total work load for the lab sessions was very heavy | 52.9 | 33.8 | 13.3 | 46.2 | 30.8 | 23.1 | 3.41 |
| The lab work stimulated my interest in biological science | 48.6 | 35.3 | 16.0 | 44.2 | 30.8 | 25.0 | 2.56 |
| The lab procedures were clearly explained in the manuals | 46.5 | 32.9 | 20.5 | 48.1 | 28.8 | 23.1 | 0.39 |
| I needed more instructions on how to write up my lab reports | 45.1 | 34.0 | 20.9 | 42.3 | 34.6 | 23.1 | 0.19 |
| The purpose of each lab session was very clear to me at the beginning of the lab | 40.5 | 36.0 | 23.6 | 38.5 | 40.4 | 21.2 | 0.40 |
| My skills in interpreting the data were enhanced by the lab | 33.7 | 48.6 | 17.6 | 32.7 | 44.2 | 23.1 | 0.92 |

# 1995/96 - THE LABORATORY WORK IN GENERAL

## HIGHER AND LOWER

| | IHigher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| For every lab session the necessary materials were always readily available | 85.2 | 10.0 | 4.8 | 84.5 | 10.3 | 5.2 | 0.02 |
| The lab sessions helped me to understand some of the topics covered in lectures | 70.3 | 17.6 | 12.1 | 66.1 | 20.3 | 13.6 | 0.44 |
| The lab sessions were well organised | 61.3 | 25.9 | 12.8 | 52.5 | 33.9 | 13.6 | 1.91 |
| The total work load for the lab sessions was very heavy | 34.5 | 41.4 | 24.1 | 41.4 | 43.1 | 15.5 | 2.32 |
| The lab work stimulated my interest in biological science | 58.5 | 29.0 | 12.5 | 41.8 | 40.0 | 18.2 | 5.54 |
| The lab procedures were clearly explained in the manuals | 59.4 | 24.7 | 15.9 | 47.5 | 28.8 | 23.7 | 3.49 |
| I needed more instructions on how to write up my lab reports | 36.2 | 35.2 | 28.6 | 51.7 | 27.6 | 20.7 | 5.25 |
| The purpose of each lab session was very clear to me at the beginning of the lab | 43.0 | 25.7 | 31.4 | 40.7 | 18.6 | 40.7 | 2.48 |
| My skills in interpreting the data were enhanced by the lab | 43.3 | 44.5 | 12.1 | 47.5 | 37.3 | 15.3 | 1.22 |

**1994/95 - THE LABORATORY WORK IN GENERAL**

**AREAS THE TWO GROUPS AGREED SEPARATELY**

**HIGHER AND LOWER**

| | **Higher** | | | **Lower** | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| In some practical sessions, I was only following the instructions just like a recipe | 65.8 | 23.6 | 10.6 | 65.4 | 28.8 | 5.8 | 1.56 |
| In some lab sessions I found it difficult to make any deductions | 60.7 | 27.2 | 12.1 | 65.4 | 19.2 | 15.4 | 1.64 |
| The lab work added reality to the lecture material | 61.2 | 18.5 | 10.3 | 57.7 | 26.9 | 15.4 | 1.19 |
| It was easy to follow the lab manual because it was well organised | 44.6 | 39.7 | 15.8 | 34.6 | 40.4 | 25.0 | 3.29 |
| I would prefer immediate feedback on how well I have done in my lab work | 35.9 | 40.1 | 24.0 | 50.0 | 23.1 | 26.9 | 5.98 |
| The lab work trained me to interpret data | 29.6 | 50.2 | 20.2 | 23.1 | 51.9 | 25.0 | 1.18 |
| I dislike practicals that requires me to think for myself | 10.6 | 23.9 | 65.6 | 17.3 | 21.2 | 61.5 | 2.03 |
| Almost every week I read the appropriate section of the lab manual before coming to the practical | 22.1 | 27.2 | 50.8 | 34.6 | 28.8 | 36.5 | 0.55 |
| The deatils demanded in the lab manuals are far too much | 22.1 | 39.9 | 38.1 | 23.1 | 34.6 | 42.3 | 0.47 |
| The use of films/videos added considerable assistance to my understanding of the labs | 31.8 | 35.5 | 32.7 | 34.6 | 26.9 | 38.5 | 1.50 |

**1995/96 - THE LABORATORY WORK IN GENERAL**

**AREAS THE TWO GROUPS AGREED SEPARATELY**

**HIGHER AND LOWER**

| | **Higher** | | | **Lower** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The apparatus used during the lab sessions were not difficult to handle | 88.1 | 9.3 | 2.6 | 86.2 | 2.6 | 11.2 | 0.57 |
| The demonstratorsoffered effective supervision | 73.3 | 17.9 | 8.8 | 72.4 | 19.0 | 8.6 | 0.04 |
| the labwork encouraged me to think for myself | 55.7 | 34.3 | 10.0 | 62.1 | 31.0 | 6.9 | 1.03 |
| My ability to observe things carefully was improved by the labs | 52.1 | 39.3 | 8.6 | 50.0 | 36.2 | 3.8 | 1.68 |
| The lab work improved my ability to draw conclusions on the things that I observe | 52.0 | 38.1 | 9.8 | 44.4 | 40.7 | 14.8 | 1.77 |
| I can now do similar lab work without much instruction | 49.5 | 35.5 | 15.0 | 55.2 | 29.3 | 15.5 | 0.89 |
| The labwork helped me to develop my problem solving skills | 47.4 | 40.5 | 12.1 | 41.4 | 46.6 | 12.1 | 0.85 |
| The lab sessions were mainly investigative | 42.8 | 47.6 | 9.6 | 48.2 | 40.7 | 11.1 | 0.91 |
| The preparations I did before coming to each lab session helped me to understand what I was doing | 39.2 | 41.1 | 19.6 | 50.0 | 37.9 | 12.1 | 3.14 |
| I felt challenged to find out things for myself | 35.7 | 43.8 | 20.5 | 43.1 | 41.4 | 15.5 | 1.46 |
| I had immediate feedback on how well I have done in my lab work | 31.3 | 36.8 | 32.0 | 41.4 | 36.2 | 22.4 | 3.12 |
| Not enough time was given to complete each lab session | **21.9** | **23.1** | **55.0** | **34.5** | **27.6** | **37.5** | ***6.68** |

**1994/95 - THE LABORATORY WORK IN GENERAL**

**MALE AND FEMALE**

| | **Male** | | | **Female** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| For every lab session the necessary materials were always readily available | **67.1** | **20.1** | **12.8** | **82.6** | **9.1** | **8.3** | ****13.06** |
| The lab sessions helped me to understand some of the topics covered in lectures | 64.9 | 24.3 | 10.8 | 71.0 | 20.3 | 8.7 | 1.59 |
| The lab sessions were well organised | 59.7 | 28.9 | 11.4 | 50.4 | 38.0 | 11.6 | 3.73 |
| The total work load for the lab sessions was very heavy | 45.6 | 34.9 | 19.5 | 55.4 | 33.1 | 11.6 | 5.73 |
| The lab work stimulated my interest in biological science | 45.0 | 32.9 | 22.1 | 50.4 | 35.5 | 14.1 | 4.28 |
| The lab procedures were clearly explained in the manuals | **42.3** | **40.9** | **16.8** | **47.9** | **28.9** | **23.1** | ***6.42** |
| I needed more instructions on how to write up my lab reports | **37.7** | **34.9** | **27.4** | **49.6** | **33.3** | **17.1** | ***7.53** |
| The purpose of each lab session was very clear to me at the beginning of the lab | 38.9 | 36.2 | 24.8 | 40.5 | 36.4 | 23.1 | 0.17 |
| My skills in interpreting the data were enhanced by the lab | 30.4 | 50.9 | 18.7 | 36.1 | 46.5 | 17.4 | 1.33 |

1995/96 - THE LABORATORY WORK IN GENERAL

MALE AND FEMALE

| | Male | | | Female | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| For every lab session the necessary materials were always readily available | 82.3 | 11.0 | 6.7 | 85.6 | 10.7 | 3.7 | 2.27 |
| The lab sessions helped me to understand some of the topics covered in lectures | 66.3 | 19.3 | 14.5 | 70.7 | 17.7 | 11.6 | 1.20 |
| The lab sessions were well organised | 57.8 | 28.9 | 13.3 | 61.0 | 26.5 | 12.5 | 0.46 |
| The total work load for the lab sessions was very heavy | 38.8 | 40.6 | 20.6 | 34.0 | 42.5 | 23.5 | 1.24 |
| The lab work stimulated my interest in biological science | 51.6 | 35.4 | 13.0 | 57.5 | 28.9 | 13.5 | 2.17 |
| The lab procedures were clearly explained in the manuals | **54.8** | **19.9** | **25.3** | **59.5** | **28.0** | **12.5** | ****14.07** |
| I needed more instructions on how to write up my lab reports | 34.5 | 40.6 | 24.9 | 41.0 | 31.2 | 27.8 | 4.36 |
| The purpose of each lab session was very clear to me at the beginning of the lab | 39.2 | 27.7 | 33.1 | 43.3 | 23.5 | 33.2 | 1.24 |
| My skills in interpreting the data were enhanced by the lab | 41.8 | 44.2 | 13.9 | 45.1 | 43.0 | 11.9 | 0.68 |

1994/95 - THE LABORATORY WORK IN GENERAL

AREAS THE TWO GROUPS AGREED SEPARATELY

MALE AND FEMALE

| | Male | | | Female | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| In some practical sessions, I was only following the instructions just like a recipe | 66.4 | 21.5 | 12.1 | 65.6 | 25.3 | 9.1 | 1.36 |
| In some lab sessions I found it difficult to make any deductions | **51.7** | **28.9** | **19.5** | **66.9** | **24.8** | **8.3** | ****13.32** |
| The lab work added reality to the lecture material | 61.7 | 26.8 | 11.4 | 60.6 | 29.0 | 10.4 | 0.27 |
| It was easy to follow the lab manual because it was well organised | 45.3 | 38.5 | 16.2 | 42.1 | 40.1 | 17.8 | 0.39 |
| I would prefer immediate feedback on how well I have done in my lab work | **40.5** | **28.4** | **31.1** | **36.5** | **44.0** | **19.5** | ****11.40** |
| The lab work trained me to interpret data | 22.8 | 56.4 | 20.8 | 32.6 | 46.7 | 20.7 | 4.80 |
| I dislike practicals that requires me to think for myself | **13.4** | **16.8** | **69.8** | **9.5** | **28.9** | **65.6** | ***7.85** |
| Almost every week I read the appropriate section of the lab manual before coming to the practical | 20.1 | 24.2 | 55.7 | 26.7 | 29.5 | 43.8 | 1.58 |
| The deatils demanded in the lab manuals are far too much | 29.8 | 43.0 | 36.2 | 24.4 | 36.8 | 38.8 | 1.45 |
| The use of films/videos added considerable assistance to my understanding of the labs | 36.5 | 31.1 | 32.4 | 29.3 | 36.0 | 34.7 | 2.24 |

## 1995/96 - THE LABORATORY WORK IN GENERAL

## AREAS THE TWO GROUPS AGREED SEPARATELY

## MALE AND FEMALE

| | Male | | | Female | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| The apparatus used during the lab sessions were not difficult to handle | **84.2** | **10.9** | **4.9** | **89.9** | **8.9** | **1.2** | ***6.79** |
| The demonstratorsoffered effective supervision | 77.6 | 15.2 | 7.3 | 70.6 | 19.9 | 9.5 | 2.68 |
| the labwork encouraged me to think for myself | 54.6 | 35.2 | 10.3 | 56.0 | 33.3 | 10.7 | 0.16 |
| My ability to observe things carefully was improved by the labs | 49.7 | 40.6 | 9.7 | 52.3 | 38.2 | 9.5 | 0.31 |
| The lab work improved my ability to draw conclusions on the things that I observe | 46.6 | 39.1 | 14.3 | 52.8 | 38.9 | 8.3 | 4.51 |
| I can now do similar lab work without much instruction | 46.7 | 35.8 | 17.6 | 51.1 | 34.9 | 14.1 | 1.34 |
| The labwork helped me to develop my problem solving skills | 42.4 | 43.0 | 14.6 | 48.3 | 40.7 | 11.0 | 2.09 |
| The lab sessions were mainly investigative | 40.0 | 46.9 | 13.1 | 45.4 | 46.6 | 8.0 | 3.58 |
| The preparations I did before coming to each lab session helped me to understand what I was doing | 34.8 | 43.3 | 22.0 | 43.3 | 39.9 | 16.9 | 3.78 |
| I felt challenged to find out things for myself | 36.4 | 38.8 | 24.9 | 35.5 | 46.5 | 18.0 | 4.00 |
| I had immediate feedback on how well I have done in my lab work | 31.7 | 33.5 | 34.8 | 32.4 | 38.2 | 29.4 | 1.69 |
| Not enough time was given to complete each lab session | 26.1 | 22.4 | 51.5 | 22.3 | 24.2 | 53.5 | 0.87 |

**1994/95 - THE LABORATORY WORK IN GENERAL**

**OLDER AND YOUNGER**

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| For every lab session the necessary materials were always readily available | 77.3 | 11.3 | 11.3 | 76.7 | 13.5 | 9.8 | 0.44 |
| The lab sessions helped me to understand some of the topics covered in lectures | 63.5 | 25.0 | 11.5 | 71.0 | 20.3 | 8.8 | 1.88 |
| The lab sessions were well organised | 58.8 | 26.8 | 14.4 | 52.9 | 36.7 | 10.4 | 3.58 |
| The total work load for the lab sessions was very heavy | 50.5 | 36.1 | 13.4 | 52.2 | 32.7 | 15.2 | 0.45 |
| The lab work stimulated my interest in biological science | 45.4 | 36.1 | 18.6 | 49.5 | 34.0 | 16.5 | 0.53 |
| The lab procedures were clearly explained in the manuals | 49.5 | 28.9 | 21.6 | 45.1 | 35.0 | 19.9 | 1.24 |
| I needed more instructions on how to write up my lab reports | 42.7 | 32.3 | 25.0 | 46.1 | 34.5 | 19.5 | 1.35 |
| The purpose of each lab session was very clear to me at the beginning of the lab | 46.4 | 33.0 | 20.6 | 38.1 | 37.7 | 24.2 | 2.13 |
| My skills in interpreting the data were enhanced by the lab | 37.5 | 42.7 | 19.8 | 33.5 | 49.3 | 17.2 | 1.28 |

**1995/96 - THE LABORATORY WORK IN GENERAL**

**OLDER AND YOUNGER**

| | **Older** | | | **Younger** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| For every lab session the necessary materials were always readily available | 83.6 | 11.9 | 4.5 | 84.7 | 10.6 | 4.7 | 0.11 |
| The lab sessions helped me to understand some of the topics covered in lectures | 58.2 | 23.9 | 17.9 | 71.0 | 17.3 | 11.7 | 4.55 |
| The lab sessions were well organised | **50.7** | **25.4** | **23.9** | **61.2** | **27.8** | **11.0** | ***8.76** |
| The total work load for the lab sessions was very heavy | 38.8 | 43.3 | 17.9 | 35.0 | 41.5 | 23.5 | 1.07 |
| The lab work stimulated my interest in biological science | 42.2 | 39.1 | 18.8 | 57.7 | 29.8 | 12.5 | 5.55 |
| The lab procedures were clearly explained in the manuals | 44.8 | 31.3 | 23.9 | 59.8 | 24.5 | 15.7 | 5.67 |
| I needed more instructions on how to write up my lab reports | 44.8 | 29.9 | 25.4 | 38.0 | 35.0 | 27.0 | 1.18 |
| The purpose of each lab session was very clear to me at the beginning of the lab | 34.3 | 22.4 | 43.3 | 43.2 | 25.2 | 31.5 | 3.69 |
| My skills in interpreting the data were enhanced by the lab | 41.8 | 43.3 | 14.9 | 44.3 | 43.6 | 12.2 | 0.43 |

## 1994/95 - THE LABORATORY WORK IN GENERAL

## AREAS THE TWO GROUPS AGREED SEPARATELY

## OLDER AND YOUNGER

| | **Older** | | | **Younger** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| In some practical sessions, I was only following the instructions just like a recipe | 75.3 | 19.6 | 5.2 | 62.8 | 25.3 | 11.8 | 5.91 |
| In some lab sessions I found it difficult to make any deductions | 55.7 | 32.0 | 12.4 | 63.0 | 24.6 | 12.5 | 2.15 |
| The lab work added reality to the lecture material | 60.8 | 24.7 | 14.4 | 61.1 | 29.4 | 9.5 | 2.25 |
| It was easy to follow the lab manual because it was well organised | 45.8 | 36.5 | 17.7 | 42.8 | 40.1 | 17.2 | 0.41 |
| I would prefer immediate feedback on how well I have done in my lab work | 40.6 | 33.3 | 26.0 | 37.8 | 38.9 | 23.3 | 0.96 |
| The lab work trained me to interpret data | 28.9 | 51.5 | 9.6 | 29.3 | 49.8 | 20.9 | 0.11 |
| I dislike practicals that requires me to think for myself | 8.3 | 17.5 | 74.2 | 12.5 | 25.9 | 61.6 | 5.09 |
| Almost every week I read the appropriate section of the lab manual before coming to the practical | **36.1** | **27.8** | **36.1** | **20.5** | **27.3** | **52.5** | ****11.73** |
| The deatils demanded in the lab manuals are far too much | **21.7** | **28.9** | **49.5** | **23.2** | **42.4** | **34.3** | ***7.92** |
| The use of films/videos added considerable assistance to my understanding of the labs | **48.5** | **29.9** | **21.6** | **26.7** | **35.8** | **37.5** | ****17.00** |

**1995/96 - THE LABORATORY WORK IN GENERAL**

**AREAS THE TWO GROUPS AGREED SEPARATELY**

**OLDER AND YOUNGER**

| | **Older** | | | **Younger** | | | **$X^2$ Chi square** |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The apparatus used during the lab sessions were not difficult to handle | 92.5 | 6.0 | 1.5 | 87.3 | 10.1 | 2.6 | 1.49 |
| The demonstratorsoffered effective supervision | 70.2 | 17.9 | 11.9 | 73.5 | 18.1 | 8.5 | 0.88 |
| the labwork encouraged me to think for myself | 61.2 | 28.4 | 10.5 | 54.7 | 34.7 | 10.6 | 1.14 |
| My ability to observe things carefully was improved by the labs | 50.8 | 37.3 | 11.9 | 51.4 | 39.4 | 9.2 | 0.54 |
| The lab work improved my ability to draw conclusions on the things that I observe | 44.4 | 11.2 | 44.4 | 51.5 | 37.8 | 10.6 | 2.28 |
| I can now do similar lab work without much instruction | 44.8 | 38.8 | 16.4 | 50.5 | 34.5 | 15.0 | 0.76 |
| The labwork helped me to develop my problem solving skills | 41.8 | 44.8 | 13.4 | 47.0 | 41.1 | 12.0 | 0.63 |
| The lab sessions were mainly investigative | 50.8 | 38.1 | 11.1 | 42.4 | 48.1 | 9.5 | 2.21 |
| The preparations I did before coming to each lab session helped me to understand what I was doing | 50.8 | 34.3 | 14.9 | 38.7 | 42.0 | 19.3 | 3.52 |
| I felt challenged to find out things for myself | 46.3 | 34.3 | 19.4 | 34.0 | 45.5 | 20.4 | 4.11 |
| I had immediate feedback on how well I have done in my lab work | 37.3 | 37.3 | 25.4 | 31.3 | 36.7 | 32.0 | 1.48 |
| Not enough time was given to complete each lab session | **46.3** | **23.9** | **29.9** | **20.0** | **23.5** | **56.6** | ****24.85** |

**1995/96 - THE LABORATORY WORK IN GENERAL**

**INTENDING AND NON - INTENDING**

| | **Intending** | | | **Non - Intending** | | | **$X^2$ Chi square** |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| For every lab session the necessary materials were always readily available | 84.5 | 9.8 | 5.8 | 84.4 | 12.8 | 2.8 | 2.23 |
| The lab sessions helped me to understand some of the topics covered in lectures | 70.2 | 18.8 | 11.1 | 65.1 | 17.4 | 17.4 | 3.05 |
| The lab sessions were well organised | **61.7** | **23.9** | **14.5** | **61.5** | **35.8** | **8.3** | ***7.36** |
| The total work load for the lab sessions was very heavy | **32.9** | **40.9** | **26.3** | **45.0** | **40.4** | **14.7** | ***8.17** |
| The lab work stimulated my interest in biological science | **60.6** | **27.8** | **11.6** | **39.8** | **39.8** | **20.4** | ****14.86** |
| The lab procedures were clearly explained in the manuals | 58.2 | 25.6 | 16.2 | 60.6 | 22.0 | 17.4 | 0.58 |
| I needed more instructions on how to write up my lab reports | 38.3 | 35.4 | 26.3 | 42.2 | 30.3 | 27.5 | 1.02 |
| The purpose of each lab session was very clear to me at the beginning of the lab | 42.0 | 25.3 | 32.7 | 41.3 | 22.0 | 36.7 | 0,78 |
| My skills in interpreting the data were enhanced by the lab | **44.7** | **44.4** | **10.8** | **40.4** | **39.4** | **20.2** | ***6.43** |

**1995/96 - THE LABORATORY WORK IN GENERAL**

**AREAS THE TWO GROUPS AGREED SEPARATELY**

**INTENDING AND NON - INTENDING**

| | **Intending students** | | | **Non - Intending students** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The apparatus used during the lab sessions were not difficult to handle | 89.1 | 8.3 | 2.6 | 84.4 | 12.8 | 2.8 | 2.07 |
| The demonstrators offered effective supervision | 72.1 | 18.3 | 9.6 | 75.2 | 16.5 | 8.3 | 0.37 |
| the labwork encouraged me to think for myself | 57.7 | 32.3 | 10.0 | 48.6 | 38.5 | 12.8 | 2.83 |
| My ability to observe things carefully was improved by the labs | 53.4 | 37.1 | 9.4 | 46.8 | 44.0 | 9.2 | 1.73 |
| The lab work improved my ability to draw conclusions on the things that I observe | 52.8 | 37.1 | 10.2 | 43.0 | 45.8 | 11.2 | 3.21 |
| I can now do similar lab work without much instruction | **53.1** | **34.0** | **12.9** | **38.5** | **40.4** | **21.1** | ***8.33** |
| The labwork helped me to develop my problem solving skills | 47.7 | 39.1 | 13.1 | 39.4 | 50.5 | 10.1 | 4.41 |
| The lab sessions were mainly investigative | 42.7 | 46.5 | 10.8 | 44.9 | 46.7 | 8.4 | 0.53 |
| The preparations I did before coming to each lab session helped me to understand what I was doing | 42.0 | 40.0 | 18.0 | 34.9 | 43.1 | 22.0 | 1.99 |
| I felt challenged to find out things for myself | 37.7 | 42.0 | 20.3 | 32.1 | 46.8 | 21.1 | 1.19 |
| I had immediate feedback on how well I have done in my lab work | 30.4 | 38.1 | 31.5 | 36.7 | 34.9 | 28.4 | 1.53 |
| Not enough time was given to complete each lab session | 21.4 | 23.4 | 55.1 | 30.3 | 21.1 | 48.6 | 3.62 |

**1994/95 - COMPARISON OF THE LESS AND THE MORE INVESTIGATIVE LABORATORIES HIGHER AND LOWER STUDENTS**

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| This lab session challenged me to find out things for myself | 55.4 | 34.2 | 10.4 | 50.0 | 41.7 | 8.3 | 1.07 |
| The time allowed for tthis lab session was adequate | 50.5 | 29.2 | 20.3 | 50.0 | 31.3 | 18.8 | 0.11 |
| The manual for this lab was very clear and straightforward | 50.8 | 35.2 | 14.0 | 40.8 | 36.7 | 22.4 | 2.90 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 41.5 | 42.1 | 16.5 | 35.4 | 43.8 | 20.8 | 0.87 |
| This lab session was mainly investigative | 39.4 | 49.8 | 10.8 | 42.9 | 38.8 | 18.4 | 3.26 |
| There was too much of a cook-book approach in this lab | 23.2 | 43.5 | 33.3 | 16.7 | 52.1 | 31.3 | 1.53 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| This lab session challenged me to find out things for myself | **51.7** | **31.5** | **16.7** | **70.0** | **22.0** | **8.0** | ***6.07** |
| The time allowed for tthis lab session was adequate | 43.5 | 23.3 | 33.1 | 50.0 | 24.0 | 26.0 | 1.10 |
| The manual for this lab was very clear and straightforward | 49.4 | 35.1 | 15.5 | 62.0 | 24.0 | 14.0 | 3.00 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 31.1 | 41.2 | 27.7 | 36.0 | 40.0 | 24.0 | 0.55 |
| This lab session was mainly investigative | 66.7 | 24.4 | 9.0 | 70.0 | 16.0 | 14.0 | 2.50 |
| There was too much of a cook-book approach in this lab | 19.3 | 45.6 | 35.1 | 10.0 | 54.0 | 36.0 | 2.74 |

## 1994/95 - COMPARISON OF THE LESS AND THE MORE INVESTIGATIVE LABORATORIES

## MALE AND FEMALE STUDENTS

| | **Male** | | | **Female** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| This lab session challenged me to find out things for myself | **46.4** | **40.0** | **13.6** | **58.8** | **33.0** | **8.2** | ***6.18** |
| The time allowed for tthis lab session was adequate | 47.5 | 35.3 | 17.3 | 52.4 | 25.4 | 22.3 | 4.45 |
| The manual for this lab was very clear and straightforward | 43.6 | 38.6 | 17.9 | 52.4 | 33.9 | 13.7 | 2.88 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 39.3 | 41.4 | 19.3 | 40.8 | 43.3 | 15.9 | 0.72 |
| This lab session was mainly investigative | **32.1** | **52.9** | **15.0** | **44.6** | **45.9** | **9.4** | ***6.63** |
| There was too much of a cook-book approach in this lab | 26.6 | 45.3 | 28.1 | 21.0 | 43.8 | 35.2 | 2.59 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| This lab session challenged me to find out things for myself | 54.9 | 29.2 | 16.0 | 52.8 | 32.0 | 15.2 | 0.34 |
| The time allowed for tthis lab session was adequate | 38.5 | 28.0 | 33.6 | 47.4 | 21.1 | 31.5 | 3.48 |
| The manual for this lab was very clear and straightforward | 47.2 | 36.8 | 16.0 | 53.0 | 31.7 | 15.2 | 1.30 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 36.1 | 37.5 | 26.4 | 28.9 | 43.5 | 27.6 | 2.30 |
| This lab session was mainly investigative | 65.5 | 23.9 | 10.6 | 67.3 | 24.0 | 8.7 | 0.35 |
| There was too much of a cook-book approach in this lab | 19.4 | 39.6 | 41.0 | 16.5 | 50.9 | 32.6 | 4.58 |

# 1994/95 - THE COMPARISON OF THE LESS AND THE MORE INVESTIGATTIVE LABORATORIES

## OLDER AND YOUNGER STUDENTS

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| This lab session challenged me to find out things for myself | 54.9 | 37.4 | 7.7 | 54.2 | 34.9 | 10.9 | 0.84 |
| The time allowed for tthis lab session was adequate | 58.9 | 28.9 | 12.2 | 48.2 | 28.5 | 23.3 | 5.53 |
| The manual for this lab was very clear and straightforward | 54.4 | 31.1 | 14.4 | 47.4 | 37.2 | 15.4 | 1.45 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 37.7 | 46.2 | 16.1 | 41.2 | 41.2 | 17.6 | 0.70 |
| This lab session was mainly investigative | 48.4 | 42.9 | 8.8 | 37.3 | 50.4 | 12.3 | 3.64 |
| There was too much of a cook-book approach in this lab | 24.2 | 40.7 | 35.2 | 22.6 | 45.2 | 32.2 | 0.59 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| This lab session challenged me to find out things for myself | 52.2 | 31.1 | 16.7 | 54.2 | 30.6 | 15.3 | 0.14 |
| The time allowed for tthis lab session was adequate | 38.9 | 24.4 | 36.7 | 46.2 | 23.3 | 30.6 | 1.66 |
| The manual for this lab was very clear and straightforward | 61.8 | 25.8 | 12.4 | 47.6 | 36.1 | 16.3 | 5.52 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 33.0 | 39.6 | 27.5 | 31.3 | 41.7 | 27.1 | 0.14 |
| This lab session was mainly investigative | 69.3 | 19.3 | 11.4 | 66.3 | 24.9 | 8.8 | 1.46 |
| There was too much of a cook-book approach in this lab | 20.9 | 47.3 | 31.9 | 17.1 | 45.8 | 37.1 | 1.09 |

## 1995/96 - COMPARISON OF THE LESS AND THE MORE INVESTIGATIVE LABORATORIES

## HIGHER AND LOWER STUDENTS

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The time allowed for tthis lab session was adequate | 66.9 | 21.4 | 11.7 | 75.0 | 16.1 | 8.9 | 1.48 |
| The manual for this lab was very clear and straightforward | 57.8 | 28.4 | 13.8 | 55.4 | 35.7 | 8.9 | 1.85 |
| This lab session was mainly investigative | 43.6 | 37.7 | 18.7 | 55.4 | 33.9 | 10.7 | 3.50 |
| This lab session challenged me to find out things for myself | 40.7 | 36.6 | 22.7 | 40.0 | 36.4 | 23.6 | 0.02 |
| This lab enabled me to use my own initiative | 28.6 | 42.0 | 29.4 | 33.9 | 42.9 | 23.2 | 1.13 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 27.7 | 45.6 | 26.7 | 26.8 | 57.1 | 16.1 | 3.59 |
| The tasks given in this lab were overwhelming | 10.2 | 38.1 | 51.7 | 14.3 | 44.6 | 41.1 | 2.42 |
| There was too much of a cook-book approach in this lab | 24.8 | 44.2 | 31.1 | 34.6 | 41.8 | 23.6 | 2.74 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| The time allowed for tthis lab session was adequate | 63.1 | 18.5 | 18.5 | 58.6 | 25.9 | 15.5 | 1.84 |
| The manual for this lab was very clear and straightforward | 64.4 | 23.6 | 11.9 | 63.8 | 24.1 | 12.1 | 0.01 |
| This lab session was mainly investigative | 60.7 | 30.9 | 8.4 | 62.1 | 27.6 | 10.4 | 0.43 |
| This lab session challenged me to find out things for myself | 62.1 | 27.2 | 10.7 | 63.2 | 28.1 | 8.8 | 0.21 |
| This lab enabled me to use my own initiative | 56.0 | 34.2 | 9.8 | 63.8 | 27.6 | 8.6 | 1.29 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 47.0 | 40.3 | 12.7 | 41.4 | 51.7 | 6.9 | 3.38 |
| The tasks given in this lab were overwhelming | **11.9** | **38.2** | **49.9** | **24.1** | **43.1** | **32.8** | ***9.10** |
| There was too much of a cook-book approach in this lab | **22.2** | **46.9** | **30.9** | **36.8** | **31.8** | **31.6** | ***7.07** |

# 1995/96 - COMPARISON OF THE LESS AND THE MORE INVESTIGATIVE LABORATORIES

## MALE AND FEMALE STUDENTS

| | Male | | | Female | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The time allowed for tthis lab session was adequate | 64.0 | 23.0 | 13.0 | 69.9 | 19.4 | 10.7 | 1.74 |
| The manual for this lab was very clear and straightforward | 52.2 | 32.3 | 15.5 | 59.7 | 27.5 | 12.8 | 2.48 |
| This lab session was mainly investigative | 44.1 | 37.9 | 18.0 | 45.1 | 37.0 | 17.9 | 0.05 |
| This lab session challenged me to find out things for myself | 39.4 | 35.0 | 25.6 | 40.2 | 38.3 | 21.5 | 1.13 |
| This lab enabled me to use my own initiative | 36.7 | 46.0 | 27.3 | 30.6 | 40.0 | 29.4 | 1.62 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 30.4 | 47.8 | 21.7 | 26.3 | 45.9 | 27.8 | 2.29 |
| The tasks given in this lab were overwhelming | 14.5 | 38.9 | 46.6 | 9.1 | 39.1 | 51.9 | 2.75 |
| There was too much of a cook-book approach in this lab | 30.6 | 43.1 | 26.3 | 23.4 | 44.4 | 32.2 | 3.42 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| The time allowed for tthis lab session was adequate | 59.2 | 20.7 | 20.1 | 63.6 | 19.4 | 17.0 | 1.03 |
| The manual for this lab was very clear and straightforward | 63.0 | 25.5 | 11.5 | 64.9 | 22.8 | 12.3 | 0.45 |
| This lab session was mainly investigative | 55.2 | 35.8 | 9.1 | 63.8 | 27.9 | 8.4 | 3.63 |
| This lab session challenged me to find out things for myself | **56.7** | **28.0** | **15.2** | **65.8** | **26.5** | **7.7** | ***7.63** |
| This lab enabled me to use my own initiative | 53.3 | 35.2 | 11.5 | 59.3 | 31.7 | 9.0 | 1.78 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 42.7 | 43.9 | 13.4 | 47.8 | 40.1 | 12.1 | 1.17 |
| The tasks given in this lab were overwhelming | 15.2 | 41.2 | 43.6 | 12.9 | 37.2 | 49.9 | 1.73 |
| There was too much of a cook-book approach in this lab | **33.1** | **42.9** | **23.9** | **19.1** | **46.2** | **34.8** | ****13.36** |

# 1995/96 - COMPARISON OF THE LESS AND THE MORE INVESTIGATIVE LABORATORIES OLDER AND YOUNGER STUDENTS

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The time allowed for tthis lab session was adequate | 70.8 | 18.5 | 10.8 | 67.6 | 20.9 | 11.5 | 0.28 |
| The manual for this lab was very clear and straightforward | 60.0 | 24.6 | 15.4 | 56.6 | 29.7 | 13.7 | 0.74 |
| This lab session was mainly investigative | 55.4 | 30.8 | 13.9 | 43.0 | 38.5 | 18.5 | 3.49 |
| This lab session challenged me to find out things for myself | 40.6 | 37.5 | 21.9 | 40.0 | 37.1 | 23.0 | 0.04 |
| This lab enabled me to use my own initiative | **41.5** | **38.5** | **20.0** | **27.3** | **42.7** | **30.0** | ***6.07** |
| The lab work helped me to develop helped me to developmy skills in problem solving | **38.5** | **46.2** | **15.4** | **25.9** | **46.8** | **27.3** | ***6.34** |
| The tasks given in this lab were overwhelming | **20.0** | **33.8** | **46.2** | **9.1** | **40.3** | **50.0** | ***7.11** |
| There was too much of a cook-book approach in this lab | 33.8 | 43.1 | 23.1 | 24.5 | 44.0 | 31.5 | 3.22 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| The time allowed for tthis lab session was adequate | 57.6 | 24.2 | 18.2 | 62.9 | 19.1 | 18.0 | 1.01 |
| The manual for this lab was very clear and straightforward | 57.6 | 27.3 | 15.2 | 65.4 | 23.1 | 11.5 | 1.60 |
| This lab session was mainly investigative | 56.9 | 32.3 | 10.8 | 61.6 | 30.2 | 8.3 | 0.70 |
| This lab session challenged me to find out things for myself | 61.5 | 32.3 | 6.2 | 62.8 | 26.4 | 10.8 | 1.96 |
| This lab enabled me to use my own initiative | 57.6 | 28.8 | 13.6 | 57.1 | 33.7 | 9.2 | 1.57 |
| The lab work helped me to develop helped me to developmy skills in problem solving25.9 | 45.5 | 45.5 | 9.1 | 46.3 | 40.7 | 13.0 | 1.03 |
| The tasks given in this lab were overwhelming | **24.2** | **36.4** | **39.4** | **12.0** | **39.1** | **48.0** | ***7.48** |
| There was too much of a cook-book approach in this lab | 35.4 | 40.0 | 24.6 | 21.9 | 46.0 | 32.1 | 5.76 |

## 1995/96 - COMPARISON OF THE LESS AND THE MORE INVESTIGATIVE LABORATORIES INTENDING AND NON - INTENDING

| | Intending | | | Non - Intending | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **THE LESS INVESTGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The time allowed for tthis lab session was adequate | 67.2 | 22.4 | 10.5 | 67.0 | 15.5 | 17.5 | 5.01 |
| The manual for this lab was very clear and straightforward | 56.5 | 30.4 | 13.0 | 58.3 | 27.2 | 14.6 | 0.46 |
| This lab session was mainly investigative | 47.1 | 34.9 | 18.0 | 37.9 | 42.7 | 19.4 | 2.91 |
| This lab session challenged me to find out things for myself | 41.4 | 38.0 | 20.0 | 34.0 | 34.0 | 32.0 | 5.94 |
| This lab enabled me to use my own initiative | 31.6 | 41.2 | 27.2 | 20.4 | 43.7 | 35.9 | 5.60 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 28.1 | 46.7 | 25.2 | 23.3 | 48.5 | 26.2 | 1.00 |
| The tasks given in this lab were overwhelming | 9.0 | 40.0 | 51.0 | 15.5 | 39.8 | 44.7 | 3.89 |
| There was too much of a cook-book approach in this lab | 26.7 | 43.1 | 30.2 | 25.2 | 45.6 | 29.1 | 0.22 |
| **THE MORE INVESTIGATIVE LAB** | | | | | | | |
| The time allowed for tthis lab session was adequate | 62.8 | 19.8 | 17.5 | 64.2 | 16.0 | 19.8 | 0.87 |
| The manual for this lab was very clear and straightforward | 63.5 | 23.9 | 12.5 | 67.9 | 23.6 | 8.5 | 1.40 |
| This lab session was mainly investigative | 59.6 | 31.2 | 9.2 | 64.2 | 28.3 | 7.6 | 0.75 |
| This lab session challenged me to find out things for myself | 61.4 | 28.0 | 10.6 | 65.1 | 24.5 | 10.4 | 0.54 |
| This lab enabled me to use my own initiative | 56.0 | 33.1 | 10.9 | 61.3 | 31.1 | 7.6 | 1.39 |
| The lab work helped me to develop helped me to developmy skills in problem solving | 46.3 | 40.6 | 13.1 | 44.3 | 46.2 | 9.4 | 1.60 |
| The tasks given in this lab were overwhelming | 11.4 | 41.3 | 47.3 | 17.9 | 33.0 | 49.1 | 4.16 |
| There was too much of a cook-book approach in this lab | 26.1 | 412.7 | 31.2 | 18.9 | 50.0 | 31.1 | 2.71 |

## TUTORIALS

## HIGHER AND LOWER STUDENTS

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The size of the tutorial class was appropriate for effective student participation | 63.2 | 23.9 | 12.9 | 61.7 | 25.0 | 13.3 | 0.05 |
| The topic discussed at the tutorials was always very clear to me | 56.3 | 27.3 | 16.4 | 44.3 | 29.5 | 26.2 | 4.79 |
| Each tutorial was well organised | **39.9** | **35.3** | **24.8** | **26.7** | **35.0** | **38.3** | ***6.01** |
| I felt free to express opinion in the tutorial class | 35.2 | 37.1 | 27.7 | 31.7 | 31.7 | 36.7 | 2.09 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The size of the tutorial class was appropriate for effective student participation | 78.2 | 11.7 | 10.1 | 79.3 | 12.1 | 8.6 | 0.12 |
| The topic discussed at the tutorials was always very clear to me | 66.2 | 23.3 | 10.5 | 67.2 | 19.0 | 13.8 | 0.95 |
| Each tutorial was well organised | 53.2 | 31.0 | 15.8 | 58.6 | 29.3 | 12.1 | 0.78 |
| I felt free to express opinion in the tutorial class | 61.2 | 25.5 | 13.3 | 70.7 | 17.2 | 12.1 | 2.21 |

**TUTORIALS**

**MALE AND FEMALE STUDENTS**

| | **Male** | | | **Female** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The size of the tutorial class was appropriate for effective student participation | 60.6 | 26.5 | 12.9 | 64.4 | 22.4 | 13.2 | 0.92 |
| The topic discussed at the tutorials was always very clear to me | 55.2 | 29.9 | 14.9 | 54.9 | 27.0 | 18.1 | 0.91 |
| Each tutorial was well organised | 40.0 | 35.5 | 24.5 | 38.8 | 33.6 | 27.6 | 0.53 |
| I felt free to express opinion in the tutorial class | 37.4 | 37.4 | 25.2 | 34.2 | 35.5 | 30.3 | 1.34 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The size of the tutorial class was appropriate for effective student participation | 74.0 | 12.7 | 13.3 | 80.9 | 11.1 | 8.0 | 4.11 |
| The topic discussed at the tutorials was always very clear to me | 69.7 | 20.6 | 9.7 | 64.5 | 24.2 | 11.3 | 1.31 |
| Each tutorial was well organised | 57.6 | 29.1 | 13.3 | 51.5 | 31.6 | 16.9 | 1.85 |
| I felt free to express opinion in the tutorial class | 69.7 | 20.0 | 10.3 | 58.4 | 27.2 | 14.4 | 5.95 |

## TUTORIALS

## OLDER AND YOUNGER STUDENTS

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The size of the tutorial class was appropriate for effective student participation | **52.1** | **29.8** | **18.2** | **67.3** | **21.3** | **11.4** | ****9.29** |
| The topic discussed at the tutorials was always very clear to me | 51.2 | 26.4 | 22.3 | 56.8 | 28.0 | 15.2 | 3.24 |
| Each tutorial was well organised | 35.5 | 33.1 | 31.4 | 40.1 | 35.4 | 24.6 | 2.22 |
| I felt free to express opinion in the tutorial class | 39.2 | 35.0 | 25.8 | 33.6 | 36.4 | 30.0 | 1.39 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The size of the tutorial class was appropriate for effective student participation | 83.3 | 9.1 | 7.6 | 77.9 | 12.9 | 10.1 | 1.01 |
| The topic discussed at the tutorials was always very clear to me | 68.7 | 20.9 | 10.4 | 66.0 | 23.2 | 10.8 | 0.21 |
| Each tutorial was well organised | 56.7 | 28.4 | 14.9 | 53.2 | 31.1 | 15.8 | 0.30 |
| I felt free to express opinion in the tutorial class | 74.6 | 16.4 | 9.0 | 60.3 | 26.1 | 13.6 | 5.04 |

**TUTORIALS**

**INTENDING AND NON - INTENDING**

| | **Intending** | | | **Non - Intending** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| **1994/95 SESSION** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The size of the tutorial class was appropriate for effective student participation | 64.0 | 23.1 | 12.9 | 60.3 | 25.6 | 14.1 | 0.39 |
| The topic discussed at the tutorials was always very clear to me | 58.6 | 25.7 | 15.7 | 44.9 | 34.6 | 20.5 | 4.86 |
| Each tutorial was well organised | 39.9 | 35.3 | 24.8 | 34.6 | 34.6 | 30.8 | 1.35 |
| I felt free to express opinion in the tutorial class | 36.5 | 36.2 | 27.4 | 30.8 | 32.1 | 37.2 | 3.01 |
| | | | | | | | |
| **1995/96 SESSION** | | | | | | | |
| The size of the tutorial class was appropriate for effective student participation | 79.4 | 11.2 | 9.5 | 75.0 | 13.9 | 11.1 | 0.95 |
| The topic discussed at the tutorials was always very clear to me | 66.0 | 22.9 | 11.1 | 65.5 | 23.9 | 11.0 | 0.05 |
| Each tutorial was well organised | 55.0 | 28.7 | 16.3 | 52.3 | 33.9 | 13.8 | 1.24 |
| I felt free to express opinion in the tutorial class | 65.1 | 22.9 | 12.0 | 54.1 | 26.6 | 1`9.3 | 5.30 |

1995/96 - TUTORIALS

HIGHER AND LOWER STUDENTS

| | Higher | | | Lower | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| The lecturer had a friendly attitude towards the students | 84.0 | 12.4 | 3.6 | 87.9 | 5.2 | 6.9 | 3.81 |
| The lecturer had a thorough knowledge of the subject matter | 83.6 | 12.9 | 3.6 | 87.9 | 6.9 | 5.2 | 1.95 |
| The lecturer encouraged the students to use their own initiative | 65.7 | 27.1 | 7.1 | 73.7 | 32.8 | 3.5 | 1.82 |
| A relaxed atmosphere existed during the tutorial session | 63.1 | 21.9 | 15.0 | 75.9 | 13.8 | 10.3 | 3.65 |
| The tutorials helped me to understand some of the topics covered in the lectures | 60.2 | 23.8 | 16.0 | 75.9 | 13.8 | 10.3 | 5.32 |
| I was always encouraged to contribute during the tutorial session | 57.1 | 26.1 | 16.9 | 63.8 | 20.7 | 15.5 | 1.00 |
| The lecturer acted as a member of the group rather than as a leader | 47.1 | 22.4 | 30.5 | 60.3 | 15.5 | 24.1 | 3.63 |
| During the tutorials some of the difficulties encountered during the lectures are cleared up | 48.3 | 31.9 | 19.8 | 51.7 | 36.2 | 12.1 | 2.01 |
| The tutor clearly explained how the topic discussed relate to the rest of the course | 40.6 | 41.1 | 18.4 | 48.3 | 32.8 | 19.0 | 1.61 |
| New materials were always covered during the tutorial session | 31.2 | 42.1 | 26.7 | 34.5 | 41.4 | 24.1 | 0.31 |
| I knew the names of every one in my tutorial group | 28.2 | 14.8 | 57.0 | 15.5 | 12.1 | 72.4 | 5.37 |
| I looked forward to tutorial sessions | **19.1** | **38.3** | **42.6** | **34.5** | **36.2** | **29.3** | ***8.07** |
| Tutorials stimulated my interest in the biology course | 27.6 | 44.8 | 27.6 | 31.0 | 46.6 | 22.4 | 0.75 |
| **1994/95 SESSION** | | | | | | | |
| The essay writing has improved my style and fluency of writing | 15.8 | 34.8 | 49.4 | 18.3 | 25.0 | 56.7 | 2.25 |

**1995/96 - TUTORIALS**

**MALE AND FEMALE STUDENTS**

| | **Male** | | | **Female** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The lecturer had a friendly attitude towards the students | 87.3 | 7.9 | 4.9 | 82.9 | 13.8 | 3.4 | 4.10 |
| The lecturer had a thorough knowledge of the subject matter | 84.9 | 12.1 | 3.0 | 83.5 | 12.2 | 4.3 | 0.47 |
| The lecturer encouraged the students to use their own initiative | 62.4 | 32.1 | 5.5 | 67.8 | 25.2 | 7.1 | 2.84 |
| A relaxed atmosphere existed during the tutorial session | 66.1 | 20.0 | 13.9 | 63.9 | 21.4 | 14.7 | 0.22 |
| The tutorials helped me to understand some of the topics covered in the lectures | 57.6 | 24.8 | 17.6 | 63.3 | 22.0 | 14.7 | 1.56 |
| I was always encouraged to contribute during the tutorial session | 57.6 | 23.0 | 19.4 | 57.8 | 26.0 | 16.2 | 1.03 |
| The lecturer acted as a member of the group rather than as a leader | 50.9 | 16.4 | 32.7 | 48.6 | 23.9 | 27.5 | 4.01 |
| During the tutorials some of the difficulties encountered during the lectures are cleared up | 47.3 | 35.8 | 17.0 | 49.2 | 30.9 | 19.9 | 1.38 |
| The tutor clearly explained how the topic discussed relate to the rest of the course | 40.2 | 40.2 | 19.5 | 41.6 | 40.4 | 18.0 | 0.18 |
| New materials were always covered during the tutorial session | 35.2 | 38.2 | 26.7 | 30.0 | 44.0 | 26.0 | 1.84 |
| I knew the names of every one in my tutorial group | 26.8 | 13.4 | 59.8 | 26.9 | 15.3 | 57.8 | 0.33 |
| I looked forward to tutorial sessions | 24.8 | 37.0 | 38.2 | 18.7 | 38.2 | 43.1 | 2.72 |
| Tutorials stimulated my interest in the biology course | 29.5 | 41.1 | 29.5 | 27.0 | 46.6 | 26.4 | 1.35 |
| **1994/95 SESSION** | | | | | | | |
| The essay writing has improved my style and fluency of writing | 21.3 | 31.6 | 47.1 | 14.1 | 32.9 | 53.0 | 3.07 |

# 1995/96 - TUTORIALS

## OLDER AND YOUNGER STUDENTS

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| | A | N | D | A | N | D | |
| The lecturer had a friendly attitude towards the students | 86.6 | 9.0 | 4.5 | 84.1 | 12.2 | 3.8 | 0.64 |
| The lecturer had a thorough knowledge of the subject matter | 82.1 | 10.4 | 7.5 | 28.4 | 12.4 | 3.3 | 2.84 |
| The lecturer encouraged the students to use their own initiative | 64.2 | 29.9 | 6.0 | 66.1 | 27.3 | 6.6 | 0.20 |
| A relaxed atmosphere existed during the tutorial session | 73.1 | 13.4 | 13.4 | 63.1 | 22.3 | 14.6 | 3.10 |
| The tutorials helped me to understand some of the topics covered in the lectures | 71.6 | 16.4 | 11.9 | 59.9 | 23.9 | 16.2 | 3.41 |
| I was always encouraged to contribute during the tutorial session | 61.2 | 26.9 | 11.9 | 57.0 | 24.9 | 18.1 | 1.53 |
| The lecturer acted as a member of the group rather than as a leader | 61.2 | 19.4 | 19.4 | 47.4 | 21.8 | 30.8 | 4.94 |
| During the tutorials some of the difficulties encountered during the lectures are cleared up | 55.2 | 32.8 | 11.9 | 47.7 | 32.4 | 20.0 | 2.66 |
| The tutor clearly explained how the topic discussed relate to the rest of the course | 50.8 | 32.8 | 16.4 | 39.8 | 41.4 | 18.8 | 2.93 |
| New materials were always covered during the tutorial session | 37.3 | 40.3 | 22.4 | 31.0 | 42.3 | 26.8 | 1.20 |
| I knew the names of every one in my tutorial group | 20.9 | 14.9 | 64.2 | 27.8 | 14.6 | 57.7 | 1.44 |
| I looked forward to tutorial sessions | **38.8** | **31.3** | **29.9** | **18.1** | **38.7** | **43.2** | ****15.24** |
| Tutorials stimulated my interest in the biology course | 34.3 | 43.3 | 22.4 | 26.7 | 45.2 | 28.1 | 1.95 |
| **1994/95 SESSION** | | | | | | | |
| The essay writing has improved my style and fluency of writing | 12.4 | 31.4 | 56.2 | 18.0 | 34.0 | 48.1 | 3.91 |

1995/96 - TUTORIALS

INTENDING AND NON - INTENDING STUDENTS

| | **Intending** | | | **Non - Intending** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The lecturer had a friendly attitude towards the students | 85.4 | 10.9 | 3.7 | 80.7 | 14.7 | 4.6 | 1.41 |
| The lecturer had a thorough knowledge of the subject matter | 82.9 | 12.9 | 4.3 | 84.4 | 11.9 | 3.7 | 0.16 |
| The lecturer encouraged the students to use their own initiative | 66.6 | 26.9 | 6.6 | 61.5 | 31.2 | 7.3 | 0.96 |
| A relaxed atmosphere existed during the tutorial session | 66.9 | 20.0 | 13.1 | 58.7 | 22.0 | 19.3 | 3.15 |
| The tutorials helped me to understand some of the topics covered in the lectures | 60.9 | 23.1 | 16.0 | 59.6 | 23.9 | 16.5 | 0.05 |
| I was always encouraged to contribute during the tutorial session | 58.0 | 24.3 | 17.7 | 52.3 | 29.4 | 18.3 | 1.34 |
| The lecturer acted as a member of the group rather than as a leader | **52.0** | **19.7** | **28.3** | **38.5** | **27.5** | **34.0** | ***6.34** |
| During the tutorials some of the difficulties encountered during the lectures are cleared up | 49.7 | 32.9 | 17.4 | 45.9 | 31.2 | 22.0 | 1.67 |
| The tutor clearly explained how the topic discussed relate to the rest of the course | 42.4 | 39.3 | 18.3 | 38.5 | 37.6 | 23.9 | 1.64 |
| New materials were always covered during the tutorial session | 32.9 | 41.7 | 25.4 | 30.3 | 41.3 | 28.4 | 0.46 |
| I knew the names of every one in my tutorial group | 28.4 | 14.6 | 57.0 | 22.0 | 14.7 | 63.3 | 1.81 |
| I looked forward to tutorial sessions | 22.6 | 34.9 | 42.6 | 31.6 | 26.2 | 42.2 | 42.2 |
| Tutorials stimulated my interest in the biology course | 29.6 | 44.5 | 25.9 | 23.9 | 41.3 | 34.9 | 3.57 |
| **1994/95 SESSION** | | | | | | | |
| The essay writing has improved my style and fluency of writing | 15.7 | 34.5 | 49.9 | 17.9 | 28.2 | 53.8 | 1.16 |

**1995/96 - STUDY PROJECT ON AIDS**

**HIGHER AND LOWER STUDENTS**

| | **Higher** | | | **Lower** | | | **$X^2$ Chi square** |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The study project on AIDS has enhanced my ability to carry out my my studies independently | 51.6 | 27.0 | 21.5 | 59.3 | 25.4 | 15.3 | 1.61 |
| The project work encouraged me to think for myself | 50.8 | 31.5 | 17.7 | 52.5 | 25.4 | 22.0 | 1.20 |
| My investigative skills were greatly improved by the project work | **35.8** | **39.1** | **25.1** | **54.2** | **25.4** | **20.3** | ***7.69** |
| My ability to integrate data has been enhanced by the project work | **29.4** | **48.7** | **22.0** | **45.8** | **30.5** | **23.7** | ***8.19** |
| The project work has given me the a chance in my university career to be creative | 26.8 | 41.6 | 31.6 | 32.2 | 35.6 | 32.2 | 1.02 |
| The project work has been the most enjoyable aspect of my course | **17.0** | **29.7** | **53.3** | **28.8** | **35.6** | **35.6** | ***7.71** |
| **MALE AND FEMALE** | MALE | | | FEMALE | | | $x^2$ |
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The study project on AIDS has enhanced my ability to carry out my my studies independently | **44.2** | **30.9** | **24.9** | **57.5** | **24.5** | **18.0** | ***7.84** |
| The project work encouraged me to think for myself | 47.3 | 29.7 | 23.0 | 52.9 | 31.2 | 15.9 | 3.81 |
| My investigative skills were greatly improved by the project work | 32.1 | 40.0 | 27.9 | 41.9 | 35.5 | 22.6 | 4.56 |
| My ability to integrate data has been enhanced by the project work | 33.3 | 41.2 | 25.5 | 30.6 | 48.9 | 20.5 | 2.89 |
| The project work has given me the a chance in my university career to be creative | 32.9 | 35.4 | 31.7 | 25.1 | 42.8 | 32.1 | 3.94 |
| The project work has been the most enjoyable aspect of my course | 18.2 | 30.3 | 51.5 | 18.4 | 31.9 | 49.7 | 0.17 |

**1995/96 - STUDY PROJECT ON AIDS**

**OLDER AND YOUNGER STUDENTS**

| | **Older** | | | **Younger** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The study project on AIDS has enhanced my ability to carry out my my studies independently | 61.2 | 26.9 | 11.9 | 51.6 | 26.8 | 21.6 | 3.66 |
| The project work encouraged me to think for myself | 47.8 | 32.8 | 19.4 | 51.4 | 30.5 | 18.1 | 0.31 |
| My investigative skills were greatly improved by the project work | 47.8 | 31.3 | 20.9 | 37.1 | 38.0 | 24.9 | 2.79 |
| My ability to integrate data has been enhanced by the project work | 41.8 | 40.3 | 17.9 | 29.8 | 47.4 | 22.8 | 3.89 |
| The project work has given me the a chance in my university career to be creative | 34.8 | 36.4 | 28.8 | 26.5 | 41.1 | 32.4 | 1.98 |
| The project work has been the most enjoyable aspect of my course | 22.4 | 37.3 | 40.3 | 17.6 | 30.4 | 52.0 | 3.18 |
| **INTEND AND NON - INTEND** | **Intending** | | | **Non - Intending** | | | $x^2$ |
| | **A** | **N** | **D** | **A** | **N** | **D** | |
| The study project on AIDS has enhanced my ability to carry out my my studies independently | 55.4 | 26.1 | 18.5 | 47.7 | 26.6 | 25.7 | 3.08 |
| The project work encouraged me to think for myself | 52.0 | 31.0 | 17.0 | 48.6 | 27.5 | 23.9 | 2.58 |
| My investigative skills were greatly improved by the project work | 42.1 | 35.5 | 22.4 | 32.1 | 36.7 | 31.2 | 4.70 |
| My ability to integrate data has been enhanced by the project work | 34.1 | 44.0 | 21.9 | 25.7 | 50.5 | 23.9 | 2.73 |
| The project work has given me the a chance in my university career to be creative | 30.2 | 39.3 | 30.5 | 22.9 | 40.4 | 36.7 | 2.57 |
| The project work has been the most enjoyable aspect of my course | 18.8 | 32.5 | 48.7 | 20.2 | 26.6 | 53.2 | 1.34 |

## 1995/96 - THE TWO LECTURES

## HIGHER AND LOWER STUDENTS

| | **Higher** | | | **Lower** | | | **$X^2$** Chi square |
|---|---|---|---|---|---|---|---|
| **MITOSIS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The teaching aids used in this lecture improved my learning | 45.9 | 42.1 | 12.0 | 52.6 | 36.8 | 10.5 | 0.91 |
| This lecture stimulated my interest in the biology course | **42.5** | **39.8** | **17.8** | **61.4** | **29.8** | **8.8** | ***7.75** |
| This lecture encouraged me to investigate this subject more | 33.2 | 40.1 | 26.7 | 49.1 | 31.6 | 19.3 | 5.63 |
| This lecture enabled me to transfer the knowledge I received to new situations | **32.7** | **40.6** | **26.7** | **49.1** | **33.3** | **17.5** | ***6.21** |
| This lecture encouraged me to think critically | **31.7** | **47.6** | **20.7** | **52.6** | **33.3** | **14.0** | ***9.73** |
| **ORGANELLES** | | | | | | | |
| The teaching aids used in this lecture improved my learning | 32.0 | 58.1 | 9.9 | 39.3 | 48.2 | 12.5 | 1.97 |
| This lecture stimulated my interest in the biology course | 33.0 | 48.2 | 18.8 | 41.1 | 44.6 | 14.3 | 1.62 |
| This lecture encouraged me to investigate this subject more | **25.4** | **48.1** | **26.6** | **44.6** | **33.9** | **21.4** | ***9.26** |
| This lecture enabled me to transfer the knowledge I received to new situations | 23.4 | 50.2 | 26.3 | 35.7 | 44.6 | 19.6 | 4.17 |
| This lecture encouraged me to think critically | **19.1** | **59.9** | **21.0** | **41.1** | **42.9** | **16.0** | ****14.06** |

1995/96 - THE TWO LECTURES

MALE AND FEMALE STUDENTS

| | Male | | | Female | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **MITOSIS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The teaching aids used in this lecture improved my learning | 47.6 | 39.2 | 13.3 | 45.7 | 43.5 | 10.9 | 1.11 |
| This lecture stimulated my interest in the biology course | 39.2 | 41.0 | 19..9 | 48.0 | 37.2 | 14.9 | 3.98 |
| This lecture encouraged me to investigate this subject more | 38.0 | 38.0 | 24.1 | 33.5 | 39.0 | 27.0 | 1.03 |
| This lecture enabled me to transfer the knowledge I received to new situations | **28.9** | **39.2** | **31.9** | **37.6** | **40.4** | **22.1** | ***6.62** |
| This lecture encouraged me to think critically | 40.4 | 39.8 | 19.9 | 32.3 | 48.4 | 19.3 | 3.87 |
| **ORGANELLES** | | | | | | | |
| The teaching aids used in this lecture improved my learning | 32.7 | 53.3 | 13.9 | 32.0 | 59.6 | 8.5 | 3.91 |
| This lecture stimulated my interest in the biology course | 33.3 | 50.3 | 16.4 | 33.7 | 47.7 | 18.7 | 0.49 |
| This lecture encouraged me to investigate this subject more | 30.3 | 43.0 | 26.7 | 26.3 | 47.5 | 26.3 | 1.13 |
| This lecture enabled me to transfer the knowledge I received to new situations | **22.4** | **44.8** | **32.7** | **25.6** | **52.5** | **21.9** | ***6.75** |
| This lecture encouraged me to think critically | 23.6 | 53.3 | 23.0 | 20.3 | 60.9 | 18.8 | 2.63 |

## 1995/96 - THE TWO LECTURES

## OLDER AND YOUNGER STUDENTS

| | Older | | | Younger | | | $X^2$ Chi square |
|---|---|---|---|---|---|---|---|
| **MITOSIS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The teaching aids used in this lecture improved my learning | 46.9 | 39.1 | 14.1 | 46.2 | 42.5 | 11.3 | 0.52 |
| This lecture stimulated my interest in the biology course | 57.8 | 28.1 | 14.1 | 43.1 | 40.0 | 16.9 | 5.01 |
| This lecture encouraged me to investigate this subject more | **50.0** | **32.8** | **17.2** | **32.7** | **39.9** | **27.4** | ***7.62** |
| This lecture enabled me to transfer the knowledge I received to new situations | 34.4 | 40.6 | 25.0 | 34.7 | 39.9 | 25.5 | 0.04 |
| This lecture encouraged me to think critically | 46.9 | 37.5 | 15.6 | 33.3 | 46.7 | 20.0 | 4.54 |
| **ORGANELLES** | | | | | | | |
| The teaching aids used in this lecture improved my learning | 31.7 | 55.6 | 12.7 | 32.3 | 57.7 | 10.0 | 0.44 |
| This lecture stimulated my interest in the biology course | 40.6 | 45.3 | 14.1 | 32.5 | 49.1 | 18.4 | 1.87 |
| This lecture encouraged me to investigate this subject more | **48.4** | **35.9** | **15.6** | **24.5** | **47.5** | **28.0** | ****16.41** |
| This lecture enabled me to transfer the knowledge I received to new situations | 25.0 | 48.4 | 26.6 | 24.5 | 50.1 | 25.4 | 0.07 |
| This lecture encouraged me to think critically | 26.6 | 56.3 | 17.2 | 20.7 | 58.7 | 20.7 | 1.29 |

**1995/96 - THE TWO LECTURES**

**INTENDING AND NON - INTENDING**

| | **Intending** | | | **Non - Intending** | | | **$X^2$ Chi square** |
|---|---|---|---|---|---|---|---|
| **MITOSIS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The teaching aids used in this lecture improved my learning | 48.7 | 40.7 | 10.6 | 39.6 | 47.2 | 13.2 | 2.74 |
| This lecture stimulated my interest in the biology course | 47.1 | 38.0 | 14.9 | 41.5 | 37.7 | 20.8 | 2.31 |
| This lecture encouraged me to investigate this subject more | 36.7 | 37.0 | 26.4 | 31.1 | 45.3 | 23.6 | 2.40 |
| This lecture enabled me to transfer the knowledge I received to new situations | 35.2 | 39.8 | 24.9 | 32.1 | 44.3 | 23.6 | 0.70 |
| This lecture encouraged me to think critically | 34.7 | 46.7 | 18.6 | 37.7 | 39.6 | 22.6 | 1.79 |
| **ORGANELLES** | | | | | | | |
| The teaching aids used in this lecture improved my learning | 34.6 | 54.8 | 10.7 | 26.9 | 65.4 | 7.7 | 3.72 |
| This lecture stimulated my interest in the biology course | **37.9** | **44.0** | **18.1** | **22.9** | **59.0** | **18.1** | ***9.19** |
| This lecture encouraged me to investigate this subject more | **31.1** | **42.4** | **26.5** | **19.1** | **55.2** | **25.7** | ***7.12** |
| This lecture enabled me to transfer the knowledge I received to new situations | **26.8** | **48.1** | **25.1** | **17.1** | **61.0** | **21.9** | ***5.99** |
| This lecture encouraged me to think critically | 23.9 | 55.6 | 20.5 | 18.1 | 62.9 | 19.0 | 2.03 |

APPENDIX B - 1994/95 SESSION

## UNIVERSITY OF GLASGOW

## CENTRE FOR SCIENCE EDUCATION

## BIOLOGY STUDENT EVALUATION OF TEACHING & LEARNING

**This questionnaire is seeking information about your experience in the Biology 1 Course. Please red the statements carefully and answer each question accurately. Your responses are anonymous and will help us in our future planning.**

**PART A GENERAL INFORMATION**

(i) Please state your highest previous biology qualification. ------------------------------

(ii) Year of birth ---------------------------------------------(iii) Sex M/F (Delete One)

(iv) State your intended course for further study. ------------------------------------------

**PART B BIOLOGY TEACHING**

**Pleas indicate the extent to which you agree or disagree with each of the following statements by encircling the appropriate number.**

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

**SECTION 1 THE COURSE IN GENERAL**

| | | |
|---|---|---|
| 1. | The different parts of the course were well organised | 5 4 3 2 1 |
| 2. | I felt motivated and challenged to learn in this course | 5 4 3 2 1 |
| 3. | The course co-ordination was poor | 5 4 3 2 |
| 4. | I learnt a great deal of factual material from this course. | 5 4 3 2 1 |
| 5. | The course content was well organised. | 5 4 3 2 1 |

| | | |
|---|---|---|
| 6. | My interest in the course increased as the course progressed. | 5 4 3 2 1 |
| 7. | The course objectives were clear to me at the beginning of the course. | 5 4 3 2 1 |
| 8 | Recommended readings from the course contributed to my understanding of the course. | 5 4 3 2 1 |
| 9. | Compared to other courses the work load for this course is very heavy. | 5 4 3 2 1 |
| 10. | Lectures relate to my existing knowledge and experiences. | 5 4 3 2 1 |
| 11. | The pace of the course was too fast. | 5 4 3 2 1 |
| 12. | Overall I will rate the biology course as very good. | 5 4 3 2 1 |

**SECTION II ASSESSMENT PROCEDURES**

| | | |
|---|---|---|
| 13. | The methods of assessment used in the course measure my competence | 5 4 3 2 1 |
| 14. | The examination questions covered most aspects of the course content. | 5 4 3 2 1 |
| 15. | The questions were reasonable in length and difficulty. | 5 4 3 2 1 |
| 16. | I did not get a valuable feedback on my learning as I progressed. | 5 4 3 2 1 |

**SECTION III TUTORIALS**

| | | |
|---|---|---|
| 17. | The essay writing practice has improved my style and fluency of writing. | 5 4 3 2 1 |
| 18. | Each tutorial was well organised. | 5 4 3 2 1 |
| 19. | The size of the tutorial class was appropriate for students participation. | 5 4 3 2 1 |
| 20. | I felt free to express my opinion in the tutorial group. | 5 4 3 2 1 |
| 21. | The topics for discussion were always clear to me. | 5 4 3 2 1 |

**PART D**

**Please indicate the extent to which you agree or disgree with these statements below.**

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

| | | |
|---|---|---|
| 1. | I think it is the responsibility of the lecturer to give me all the information I need to pass the exams. | 5 4 3 2 1 |

2. Sometimes there seems to be so many ways of looking at the course, that I feel confused about what is right and wrong. 5 4 3 2 1

3. Sometimes I find that I learn more about a subject by discussing it with other students than I do by sitting and revising at home. 5 4 3 2 1

4. There isn't any point in a course including things which will not be in the exam. 5 4 3 2 1

5. If I read something which does not agree with what I have been told in lectures, I prefer to stick with the lecturer's point of view. 5 4 3 2 1

6. If I had the choice of written comments or a specific mark at the end of a piece of coursework, I would choose the comments. 5 4 3 2 1

7. It is a waste of time to work on problems which have no possibility of producing a clear cut unambiguous answer. 5 4 3 2 1

8. I feel uncomfortable when I am left to make up my own mind about a subject, not knowing how the lecturer feels. 5 4 3 2 1

9. I enjoy undertaking tasks where the lecturer doesn't specify exactly what has to be done and it is left to me to decide. 5 4 3 2 1

10. A good thing about learning science is the fact that everything is so clear cut. 5 4 3 2 1

11. The worst thing about a vague assignment is that you don't know exactly what the lecturer requires from you. 5 4 3 2 1

12. I like exams which gives me an opportunity to show I have ideas of my own. 5 4 3 2 1

13. the only fair problem exercises are the ones which are exactly like those we have already done in class. 5 4 3 2 1

14. I sometime choose a topic or a way of answering an exam question which I know the lecturer likes, in order to get higher marks. 5 4 3 2 1

15. It's good when a number of lecturers are teaching a course because you get not just one but a variety of opinions. 5 4 3 2 1

PART E

Indicate with a tick in the boxes provided if you AGREE (A) or DISAGREE (D) with the following statements. Justify your answers in a sentence or two.

| **A** | **B** | A good thing about science is thet fact that everything is so clear - cut either right or wrong. ***Justify your decision.***------------------------------------------ |
|---|---|---|

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| A | B | There sometimes seems to be so many ways of looking at scientific subjects, I feel confused about what is right and wrong. ***Justify your decision.***--------------- |
|---|---|---|

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| A | B | When I meet a new idea in a course I try to relate it to things I have met in other parts of the course. ***Justify your decision***.----------------------------------- |
|---|---|---|
| | | ---------------------------------------------------------------------------------------- |
| | | ---------------------------------------------------------------------------------------- |
| | | ---------------------------------------------------------------------------------------- |
| | | ---------------------------------------------------------------------------------------- |

**ANY GENERAL COMMENTS ON THE COURSE?**

Thank you for your co-operation

**APPENDIX B - 1994/95 SESSION**

**UNIVERSITY OF GLASGOW**

**CENTRE FOR SCIENCE EDUCATION**

**BIOLOGY STUDENT QUESTIONNAIRE**

**This questionnaire is seeking information about your experience of the biology laboratory course. Please go through the statements and indicate your reaction by encircling the appropriate number in part B and C. Part A is on general information about you, while part D is for any additional comments you might have on the laboratory course.**

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

## PART A GENERAL INFORMATION

**(1) Please state your highest biology qualification ---------------------------------------**

**------------------------------------------------------------------------------------------------------------**

**(ii) Year of birth ---------------------------------------------- (iii) Sex M/F ( Delete One)**

## PART B THE LABORATORY WORK IN GENERAL

| | | |
|---|---|---|
| 1. | The purpose of each lab session was clear to me from the beginning. | 5 4 3 2 1 |
| 2. | The lab sessions helped me to understand some of the topics covered in the lecture course. | 5 4 3 2 1 |
| 3. | The lab procedures were clearly explained in the manuals. | 5 4 3 2 1 |
| 4. | My skills in interpreting data were enhanced by the labs. | 5 4 3 2 1 |
| 5. | In some practical sessions I was only following the instructions just like a recipe. | 5 4 3 2 1 |
| 6. | The lab sessions were well organised. | 5 4 3 2 1 |
| 7. | The lab work added reality to the lecture material. | 5 4 3 2 1 |
| 8. | The lab work trained me to interpret data. | 5 4 3 2 1 |
| 9. | In some lab sessions I found it difficult to make any decision. | 5 4 3 2 1 |
| 10. | It was easy to follow the lab manual because it was well organised. | 5 4 3 2 1 |
| 11. | I needed more instructions on how to write up my lab reports | 5 4 3 2 1 |
| 12. | The lab work stimulated my interest in the biological science. | 5 4 3 2 1 |
| 13. | For every lab session the necessary materials were always readily available. | 5 4 3 2 1 |
| 14. | The total work load for the lab session is very heavy. | 5 4 3 2 1 |
| 15. | I would prefer immediate feedback on how well I have done | 5 4 3 2 1 |

in my lab work

| | | |
|---|---|---|
| 16. | I dislike practicals that requires me to think for myself. | 5 4 3 2 1 |
| 17 | The details demanded in the lab manuals are far too much. | 5 4 3 2 1 |
| 18. | Almost every week, I read the appropriate part of the lab manuals before coming to the practicals. | 5 4 3 2 1 |
| 19. | The use of films/ videos added considerable assistance to my understanding of the labs. | 5 4 3 2 1 |

**PART C THIS SECTION ASKS YOU TO COMPARE TWO OF THE LABORATORIES**

| **QUESTIONS** | | **IMMUNOLOGY** | **MAMMALIAN SKULLS** |
|---|---|---|---|
| 20. | The time allotted for this lab session was adequate. | 5 4 3 2 1 | 5 4 3 2 1 |
| 21. | This lab session challenged me to find out things for myself. | 5 4 3 2 1 | 5 4 3 2 1 |
| 22. | This lab work helped me to develop my skills in problem solving. | 5 4 3 2 1 | 5 4 3 2 1 |
| 23 | .There was too much of a cook book approach in this lab. | 5 4 3 2 1 | 5 4 3 2 1 |
| 24. | This lab session was mainly investigative. | 5 4 3 2 1 | 5 4 3 2 1 |
| 25. | The manual for this lab was very clear and straightforward. | 5 4 3 2 1 | 5 4 3 2 1 |

**PART D THIS SECTION ASKS FOR YOUR COMMENTS**

26. What in your opinion are the best features of the present laboratory?.

27. What do you think are the worst features of the present laboratory?

28. What changes to the present lab sessions could you suggest?

*Thank you very much for answering this questionnaire. Please return it as directed*

## APPENDIX B - 1995/96 SESSION

**UNIVERSITY OF GLASGOW**

**CENTRE FOR SCIENCE EDUCATION**

**BIOLOGY STUDENT EVALUATION OF TEACHING AND LEARNING**

**This questionnaire is seeking information about your experience in the Biology 1 course. Please read the statements carefully and answer each question accurately. Part A is on general information about you and Part B is on the Biology course in general , while Part C is for any additional information that you might have on the course. All your responses are anonymous and will help the Institute in its future planning.**

**PART A GENERAL INFORMATION**

**(i). Please state your highest previous Biology qualification--------------------------------**

**-----------------------------------------------------------------------------------------------**

**(ii). Date of Birth-------------------------------------------------------------------------------**

**(iii). Place of Birth-----------------------------------------------------------------------------**

**(iv). Sex M/F (Circle the correct one)**

**(v). State your intended course for further studies-----------------------------------------**

**PART B BIOLOGY TEACHING**

**Please indicate the extent to which you agree or disagree with each of the following statements by encircling the appropriate number.**

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

*SECTION 1 THE COURSE IN GENERAL*

| | |
|---|---|
| 1. The course in general was well organised | 5 4 3 2 1 |
| 2. The content of each module was well organised | 5 4 3 2 1 |
| 3. My interest in the course increased as the course progressed. | 5 4 3 2 1 |
| 4.I felt challenged in this course to find out things for myself | 5 4 3 2 1 |
| 5. The course co-ordination was good | 5 4 3 2 1 |
| 6. The objectives of each module were very clear to me. | 5 4 3 2 1 |
| 7. The recommended readings from the text contributed to my understanding the course. | 5 4 3 2 1 |
| 8. Compared to other courses the total workload for this course is very heavy. | 5 4 3 2 1 |
| 9. I have more time in this course for private study. | 5 4 3 2 1. |
| 10. The pace of the course was too fast | 5 4 3 2 1 |
| 11. Overall I would rate the Biology course as very good. | 5 4 3 2 1 |

*SECTION II ASSESSMENT*

12. The method of assessment used in the course measured my competence. 5 4 3 2 1

13. The examination questions were reasonable in difficulty 5 4 3 2 1

14. The exam questions covered most aspects of the course reasonably well. 5 4 3 2 1

15. I did get valuable feedback on my learning as I progressed. 5 4 3 2 1

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Agree.**

*SECTION III PROJECT*

16. The study project on AIDS has enhanced my ability to carry out my studies independently. 5 4 3 2 1

17. My investigative skills were greatly improved by the project work. 5 4 3 2 1

18. The project work has been the most enjoyable aspect of my course. 5 4 3 2 1

19. The project work encouraged me to think for myself. 5 4 3 2 1

20. The project work has given me a chance in my University career to be creative. 5 4 3 2 1

21. My ability to integrate data has been enhanced by the project work. 5 4 3 2 1

**PART C STUDENTS ATTITUDES TO TEACHING AND LEARNING.**

22. The statements in the grid on this page are about your views of knowledge and learning. There are five rows of statements. In each row choose **ONE** statement which ***best fits your present views*** and circle the number of that statement.

| | | | |
|---|---|---|---|
| My job as a student is :- | **1**. To accept the information given by the lecturer without question and learn it. | **2.** To accept that some responsibility rests on me for learning, but I am not sure what is expected of me about what or how to learn. | **3.** To accept what is given, but to think about it critically, to check other sources for myself and to take responsibility for what and how I learn. |
| I think the lecturer's job is :- | **4**. To give me all I need to know for the exams, but where there is more than one way of looking at things the lecturer should indicate clearly which way he prefers. | **5.** To provide me with information but I realise that he is not the only source of information and that I can find out things for myself to supplement what the lecturer has given. | **6.** To give me all I need to know for the exams and to avoid any extra non - examinable material. |
| I think that knowledge is:- | **7**.A collection of unchangeable facts which are either right or wrong.I dislike uncertainties and vague statements. I am uncomfortable if I am asked to think for myself.I prefer to be given the facts. | **8**. Complex and by no means black and white, but I find this exciting and stimulating. It makes me want to explore things for myself. | **9**. Not just a collection of black and white facts but that there are shades of grey. Things may be right and wrong depending on the circumstances and the context. These uncertainties make me feel uncomfortable. |
| My job in my exam is :- | **10**.To give back the facts I have learned as accurately as possible . I prefer questions with single clear cut answers rather than open long questions. | **11.** To answer the questions including what I have found out for myself from reading or other sources. I dislike questions which force me into a fixed answer(such as multiple choice.) and prefer open questions in which I can have room to show my on thinking. | **12**. To give back all I know about the topic and leave the examiner to give me credit for the relevant bits. I quite like open ended questions which allow me to show how much I know. |

23. ***Before you came to University*** you may have held other views than those you hold now. Please go back to the grid and select a box from each row which best represent ***your views then***. Just give ***the four box numbers*** here.

| | | | |
|---|---|---|---|
| | | | |

**PART D THIS SECTION ASKS YOU TO COMPARE TWO OF THE LECTURES YOU ATTENDED**

| STATEMENTS | MITOSIS & MEIOSIS | EUKARYOTIC CELL ORGANELLES & CELL DIVISION. |
|---|---|---|
| 24. This lecture stimulated my interest in the biology course. | 5 4 3 2 1 | 5 4 3 2 1 |
| 25. The teaching aids used in this lecture improved my learning.. | 5 4 3 2 1 | 5 4 3 2 1 |
| 26.This lecture encouraged me to think critically. | 5 4 3 2 1 | 5 4 3 2 1 |
| 27. This lecture enabled me to transfer the knowledge I received to life situations. | 5 4 3 2 1 | 5 4 3 2 1 |
| 28. This lecture encouraged me to investigate this subject more. | 5 4 3 2 1 | 5 4 3 2 1 |

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**PART E THE LABORATORY**

**Please indicate the extent to which you agree or disagree with each of the following statements by encircling the appropriate number.**

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

| | |
|---|---|
| 29. The purpose of each lab session was very clear to me at the beginning of the lab. | 5 4 3 2 1 |
| 30. The lab sessions helped me to understand some of the topics covered in lectures. | 5 4 3 2 1 |
| 31. The lab procedures were clearly explained in the manuals. | 5 4 3 2 |
| 32. The lab sessions were well organised. | 5 4 3 2 1 |

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

| | |
|---|---|
| 33. My skills in interpreting data were improved by doing the lab work. | 5 4 3 2 1 |
| 34. I needed more instructions on how to write up my lab reports. | 5 4 3 2 1 |
| 35. The lab work encouraged me to think for myself. | 5 4 3 2 1 |
| 36. For every lab session, the necessary materials were always readily available. | 5 4 3 2 1 |
| 37. Not enough time was given to complete each lab session. | 5 4 3 2 1 |
| 38. I had immediate feedback on how well I have done in my lab work. | 5 4 3 2 1 |
| 39. The total work load for the lab sessions was very heavy. | 5 4 3 2 1 |
| 40. The preparation I did before coming to each lab session helped me to understand what I was doing. | 5 4 3 2 1 |
| 41. The demonstrators offered effective supervision | 5 4 3 2 1 |
| 42. The lab work helped me to develop my problem solving skills. | 5 4 3 2 1 |
| 43.The apparatus used during the lab sessions was not difficult to handle. | 5 4 3 2 1 |
| 44. I felt challenged to find out things for myself during the lab sessions. | 5 4 3 2 1 |
| 45. My ability to observe things carefully was improved by the lab work. | 5 4 3 2 1 |
| 46. I could now do similar lab work without much instruction. | 5 4 3 2 1 |

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

47. The lab work stimulated my interest in Biological science. 5 4 3 2 1

48. The lab work improved my ability to draw conclusions on the things I observed. 5 4 3 2 1

49. The lab sessions were mainly investigative. 5 4 3 2 1

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**PART F THIS SECTION ASKS YOU TO COMPARE TWO OF THE LABORATORIES.**

| STATEMENTS | MAMMALIAN STRUCTURE AND FUNCTION | HUMAN ENERGY AND METABOLISM |
|---|---|---|
| 50.The time alloted for this lab session was adequate. | 5 4 3 2 1 | 5 4 3 2 1 |
| 51. This lab session challenged me to find out things for myself. | 5 4 3 2 1 | 5 4 3 2 1 |
| 52.This lab work enabled me to used my own initiative. | 5 4 3 2 1 | 5 4 3 2 1 |
| 53.This lab work helped me to develop my problem solving skills. | 5 4 3 2 1 | 5 4 3 2 1 |
| 54.There was too much of a cook-book approach in this lab. | 5 4 3 2 1 | 5 4 3 2 1 |
| 55. This lab session was mainly investigative. | 5 4 3 2 1 | 5 4 3 2 1 |
| 56.The manual for this lab was straightforward. | 5 4 3 2 1 | 5 4 3 2 1 |
| 57.The tasks given in this lab were overwhelming. | 5 4 3 2 1 | 5 4 3 2 1 |

**PART G THE TUTORIALS**

**Please indicate the extent to which you agree or disagree with each of the following statements by encircling the appropriate number.**

**5 = Strongly Agree,4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.**

*SECTION I THE TUTORIALS*

**5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree**

| | |
|---|---|
| 58. The topic discussed at the tutorials was always very clear to me. | 5 4 3 2 1 |
| 59. Each tutorial was well organised. | 5 4 3 2 1 |
| 60. The size of the tutorial class was appropriate for effective student participation. | 5 4 3 2 1 |
| 61. The tutorials helped me to understand some of the topics covered in the lectures. | 5 4 3 2 1 |
| 62. I felt free to express my opinion in the tutorial class | 5 4 3 2 1 |
| 63. The lecturer acted as a member of the group rather than as a leader. | 5 4 3 2 1 |
| 64. The lecturer had a thorough knowledge of the subject matter. | 5 4 3 2 1 |
| 65. I knew the names of every one in my tutorial group. | 5 4 3 2 1 |
| 66. Tutorials stimulated my interest in the Biology course. | 5 4 3 2 1 |
| 67. New materials were always covered during the tutorial session. | 5 4 3 2 1 |
| 68. I was always encouraged to contribute during the tutorial session. | 5 4 3 2 1 |
| 69. The lecturer had a friendly attitude towards the students | 5 4 3 2 1 |
| 70. During the tutorials some of the difficulties encountered during the lectures were cleared up. | 5 4 3 2 1 |

71. The lecturer encouraged the students to use their own initiatives. 5 4 3 2 1

72. A relaxed atmosphere existed during the tutorial session. 5 4 3 2 1

73. The tutor clearly explained how the topic discussed related to the rest of the course. 5 4 3 2 1

74. I looked forward to tutorial sessions. 5 4 3 2 1

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***SECTION II THE ASSIGNMENTS***

75. Adequate time was allowed for completing the assignments. 5 4 3 2 1

76. The written assignments increased my understanding of the biology course. 5 4 3 2 1

77. The assignments were related to the biology course. 5 4 3 2 1

78. The instructions for the assignment were very clear. 5 4 3 2 1

79. Marked assignments were returned promptly. 5 4 3 2 1

80. Marked assignments were returned with valuable comments 5 4 3 2 1

***PART H THIS SECTION ASKS FOR YOUR COMMENTS***

81. What in your opinion are the best features of the Biology 1 course?

83. What are the worst features of the Biology 1 course?

84. What changes to theBiology 1 course do you suggest?

85. What in your opinion are the best features of the present laboratory?

86. What are the worst features of the present lab sessions?

87. What changes to the present lab sessions do you suggest?

88. What in your opinion are the best features of the tutorials and the assignments.?

89. What do you think are the worst features of both assignments and tutorials?

90. What changes would you like to suggest to the tutorials or assignments?

*Thank you very much for your co-operation*

## APPENDIX C : DETAILED RESULTS OF THE INDIVIDUAL GROUPS

### DIFFERENCES IN ATTITUDES BETWEEN THE HIGHER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | HIGHER 1994/95 | | | HIGHER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 69.8 | 26.3 | 3.9 | 66.3 | 25.7 | 7.9 | *6.09 |
| 2. The course content was well organised | 64.5 | 29.2 | 6.3 | 69.0 | 24.8 | 6.2 | 2.11 |
| 3. Recommended readings from the text contributed to my understanding of the course | 56.8 | 26.9 | 16.3 | 71.5 | 21.8 | 6.7 | ***25.66 |
| 4. My interest in the course increased as the course progressed | 48.1 | 35.9 | 16.0 | 47.0 | 36.3 | 16.7 | 0.12 |
| 5. Compared to other courses, the work load for this course is very heavy | 35.9 | 37.1 | 26.9 | 46.4 | 33.5 | 20.1 | **10.45 |
| 6. The course objectives were clear to me at the beginning of the course | 36.4 | 34.2 | 29.4 | 54.1 | 29.7 | 16.3 | ***31.27 |
| 7.The pace of the course was too fast | 26.0 | 41.7 | 32.3 | 13.4 | 50.5 | 36.1 | ***21.02 |
| **ASSESSMENT** | | | | | | | |
| 1. The exam questions were reasonable in difficulty | 48.0 | 37.6 | 14.4 | 70.9 | 22.2 | 6.9 | ***45.44 |
| 2. The methods of assessment used in the course measured my competence | 33.7 | 42.1 | 24.2 | 41.8 | 37.9 | 20.3 | 5.83 |
| 3. The exam questions covered most aspects of the course content | 34.9 | 20.7 | 44.4 | 68.3 | 21.0 | 10.7 | ***130.32 |

## DIFFERENCES IN ATTITUDES BETWEEN THE HIGHER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| **STATEMENTS** | **HIGHER 1994/95** | | | **HIGHER 1995/96** | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| **1**. For every lab session, the necessary materials were always readily available | 77.6 | 12.7 | 9.7 | 85.2 | 10.0 | 4.8 | *8.87 |
| **2**. The lab sessions helped me to understand some of the topics covered during the lectures | 68.8 | 22.1 | 9.1 | 70.3 | 17.6 | 12.1 | 3.58 |
| **3**. The lab sessions were well organised | 53.2 | 35.6 | 11.2 | 61.3 | 25.9 | 12.8 | *8.37 |
| **4**. The total work load for the lab sessions is very heavy | 52.9 | 33.8 | 13.3 | 34.5 | 41.4 | 24.0 | ***28.51 |
| **5**. The lab work stimulated my interest in biological science | 48.6 | 35.3 | 16.0 | 58.5 | 29.0 | 12.5 | *7.30 |
| **6**. The lab procedures were clearly explained in the lab manuals | 46.5 | 32.9 | 20.5 | 59.4 | 24.7 | 15.9 | **12.34 |
| 7. I needed more instructions on how to write up my lab reports | 45.1 | 34.0 | 20.9 | 36.2 | 35.2 | 28.6 | *8.04 |
| **8**. The purpose of each lab session was clear to me from the beginning | 40.5 | 36.0 | 23.6 | 43.0 | 25.7 | 31.4 | **10.82 |
| **9**. My skills in interpreting the data were enhanced by the labs | 33.7 | 48.6 | 17.6 | 43.3 | 44.5 | 12.1 | *8.83 |

**DIFFERENCES IN ATTITUDES BETWEEN THE HIGHER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | HIGHER 1994/95 | | | HIGHER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LESS INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 50.5 | 29.2 | 20.3 | 66.9 | 21./4 | 11.7 | ***21.05 |
| 2. The manual for this lab session was clear and straightforward | 50.8 | 35.2 | 14.0 | 57.8 | 28.4 | 13.8 | 4.25 |
| 3. This lab session was mainly investigative | 39.4 | 49.8 | 10.8 | 43.6 | 37.7 | 18.7 | ***14.21 |
| 4. This lab session challenged me to find out things for myself | 55.4 | 34.2 | 10.4 | 40.7 | 36.6 | 22.8 | ***24.10 |
| 5. This labwork helped me to develop my skills in problem solving | 41.5 | 42.1 | 16.5 | 27.7 | 45.6 | 26.7 | ***19.04 |
| 6. There was too much of a cook-book approach in this lab | 23.2 | 43.5 | 33.3 | 24.8 | 44.2 | 31.1 | 0 .49 |
| **MORE INVESTIGATIVE LAB** | | | | | | | |
| 1. The time allotted this lab session was adequate | 43.5 | 23.3 | 33.1 | 63.1 | 18.5 | 18.5 | ***30.27 |
| 2. The manual for this lab session was clear and straightforward | 49.4 | 35.1 | 15.5 | 64.4 | 23.6 | 11.9 | ***17.11 |
| 3. This lab session was mainly investigative | 66.7 | 24.4 | 9.0 | 60.7 | 30.9 | 8.4 | 3.83 |
| 4. This lab session challenged me to find out things for myself | 51.7 | 31.5 | 16.7 | 62.1 | 27.2 | 10.7 | **9.35 |
| 5. This labwork helped me to develop my skills in problem solving | 31.1 | 41.2 | 27.7 | 47.0 | 40.3 | 12.7 | ***32.42 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**HIGHER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | HIGHER 1994/95 | | | HIGHER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **MORE INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 6. There was too much of a cook-book approach in this lab | 19.3 | 45.6 | 35.1 | 22.2 | 46.9 | 30.9 | 1.81 |
| **TUTORIALS** | | | | | | | |
| 1. The size of the class was appropriate for the students participation | 63.2 | 23.9 | 12.9 | 78.2 | 11.7 | 10.0 | ***25.42 |
| 2. The topics for discussion were always clear to me | 56.3 | 27.8 | 15.9 | 66.2 | 23.3 | 10.5 | **9.47 |
| 3. Each tutorial was well organised | 39.9 | 35.3 | 24.8 | 53.2 | 31.0 | 15.8 | ***17.45 |
| 4. I felt free to express myself in the tutorial class | 35.2 | 37.1 | 27.7 | 61.2 | 25.5 | 13.3 | ***59.06 |
| **LOWER /LOWER** | | | | | | | |
| **TUTORIALS** | | | | | | | |
| 1.The size of the class was appropriate for the students participation | 61.7 | 25.0 | 13.3 | 79.3 | 12.1 | 8.6 | 4.55 |
| 2.The topics for discussion were always clear to me | 44.3 | 29.5 | 26.2 | 67.2 | 19.0 | 13.8 | *6.47 |
| 3. Each tutorial was well organised | 26.7 | 35.0 | 38.3 | 58.6 | 29.3 | 12.1 | ***15.41 |
| 4. I felt free to express myself in the tutorial class | 31.7 | 31.7 | 36.7 | 70.7 | 17.2 | 12.1 | ***18.59 |

THE LOWER STUDENTS

## DIFFERENCES IN ATTITUDES BETWEEN THE LOWER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | LOWER 1994/95 | | | LOWER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 60.0 | 25.0 | 15.0 | 61.0 | 30.5 | 8.5 | 1.41 |
| 2. The course content was well organised | 60.0 | 36.7 | 3.3 | 55.9 | 25.4 | 18.6 | *7.68 |
| 3. Recommended readings from the text contributed to my understanding of the course | 68.3 | 20.0 | 11.7 | 61.0 | 32.2 | 61.0 | 2.72 |
| 4. My interest in the course increased as the course progressed | 48.3 | 33.3 | 18.3 | 54.2 | 30.5 | 15.3 | 0.44 |
| 5. Compared to other courses, the work load for this course is very heavy | 44.1 | 37.3 | 18.6 | 55.9 | 37.3 | 6.8 | 4.10 |
| 6. The course objectives were clear to me at the beginning of the course | 31.7 | 38.3 | 30.0 | 55.9 | 37.3 | 6.8 | **12.69 |
| 7.The pace of the course was too fast | 46.7 | 30.0 | 23.3 | 27.1 | 59.3 | 13.6 | **10.35 |
| **ASSESSMENT** | | | | | | | |
| 1. The exam questions were reasonable in difficulty | 51.7 | 33.3 | 15.0 | 66.1 | 27.1 | 6.8 | 3.27 |
| 2. The methods of assessment used in the course measured my competence | 23.3 | 36.7 | 40.0 | 33.9 | 40.7 | 25.4 | 3.22 |
| 3. The exam questions covered most aspects of the course content | 31.7 | 21.7 | 46.7 | 67.8 | 20.3 | 11.9 | ***20.11 |

## DIFFERENCES IN ATTITUDES BETWEEN THE

## LOWER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | LOWER 1994/95 | | | LOWER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. For every lab session, the necessary materials were always readily available | 73.1 | 15.4 | 11.5 | 84.5 | 10.3 | 5.2 | 2.36 |
| 2. The lab sessions helped me to understand some of the topics covered during the lectures | 68.6 | 19.6 | 11.8 | 66.1 | 20.3 | 13.6 | 0.10 |
| 3. The lab sessions were well organised | 57.7 | 26.9 | 15.4 | 52.5 | 33.9 | 13.6 | 0. 63 |
| 4. The total work load for the lab sessions is very heavy | 46.2 | 30.8 | 23.1 | 41.4 | 43.1 | 15.5 | 2.08 |
| 5. The lab work stimulated my interest in biological science | 44.2 | 30.8 | 25.0 | 41.8 | 40.0 | 18.2 | 1.26 |
| 6. The lab procedures were clearly explained in the lab manuals | 48.1 | 28.8 | 23.1 | 47.5 | 28.8 | 23.1 | 0.01 |
| 7. I needed more instructions on how to write up my lab reports | 42.3 | 34.6 | 23.1 | 51.7 | 27.6 | 20.7 | 1.02 |
| 8. The purpose of each lab session was clear to me from the beginning | 48.1 | 28.8 | 23.1 | 40.7 | 18.6 | 40.7 | 4.21 |
| 9. My skills in interpreting the data were enhanced by the labs | 32.7 | 44.2 | 23.1 | 47.5 | 37.3 | 15.3 | 2.71 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**LOWER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | LOWER 1994/95 | | | LOWER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LESS INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 50.0 | 31.3 | 18.8 | 75.0 | 16.1 | 8.9 | *6.97 |
| 2. The manual for this lab session was clear and straightforward | 40.8 | 36.7 | 22.4 | 55.4 | 35.7 | 8.9 | 4.28 |
| 3. This lab session was mainly investigative | 42.9 | 38.8 | 18.4 | 55.4 | 33.9 | 10.7 | 2.07 |
| 4. This lab session challenged me to find out things for myself | 50.0 | 41.7 | 8.3 | 40.0 | 36.4 | 23.6 | 4.40 |
| 5. This labwork helped me to develop my skills in problem solving | 35.4 | 43.8 | 20.8 | 26.8 | 57.1 | 16.1 | 1.86 |
| 6. There was too much of a cook-book approach in this lab | 16.7 | 52.1 | 31.3 | 34.5 | 41.8 | 23.6 | 4.25 |
| **MORE INVESTIGATIVE LAB** | | | | | | | |
| 1. The time allotted this lab session was adequate | 50.0 | 24.0 | 26.0 | 58.6 | 25.9 | 15.5 | 1.85 |
| 2. The manual for this lab session was clear and straightforward | 62.0 | 24.0 | 14.0 | 62.1 | 27.6 | 10.3 | 0.43 |
| 3. This lab session was mainly investigative | 70.0 | 16.0 | 14.0 | 62.1 | 27.6 | 10.3 | 2.18 |
| 4. This lab session challenged me to find out things for myself | 70.0 | 22.0 | 8.0 | 63.2 | 28.1 | 8.8 | 0.60 |
| 5. This labwork helped me to develop my skills in problem solving | 36.0 | 40.0 | 24.0 | 41.4 | 51.7 | 6.9 | *6.30 |
| 6. There was too much of a cook-book approach in this lab | 10.0 | 54.0 | 36.0 | 36.8 | 31.6 | 31.6 | **11.24 |

## DIFFERENCES IN ATTITUDES BETWEEN THE MALE STUDENTS FOR 1994/95 AND 1995/96 SESSION

| STATEMENTS | MALE 1994/95 | | | MALE 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 57.7 | 34.0 | 8.3 | 64.6 | 25.0 | 10.4 | 3.17 |
| 2. The course content was well organised | 70.3 | 24.5 | 5.2 | 65.5 | 23.6 | 10.9 | 3.55 |
| 3. Recommended readings from the text contributed to my understanding of the course | 56.4 | 21.8 | 21.8 | 64.0 | 25.6 | 10.4 | **7.81 |
| 4. My interest in the course increased as the course progressed | 39.7 | 41.7 | 18.6 | 41.2 | 41.2 | 17.6 | 0.09 |
| 5. Compared to other courses, the work load for this course is very heavy | 40.4 | 34.0 | 25.6 | 45.5 | 32.7 | 21.8 | 1.01 |
| 6. The course objectives were clear to me at the beginning of the course | 34.0 | 35.3 | 30.8 | 50.3 | 30.3 | 19.4 | **9.81 |
| 7.The pace of the course was too fast | 26.3 | 42.3 | 31.4 | 15.2 | 53.9 | 30.9 | *7.09 |
| **ASSESSMENT** | | | | | | | |
| 1. The exam questions were reasonable in difficulty | 51.0 | 34.8 | 14.2 | 64.8 | 24.2 | 10.9 | *6.39 |
| 2. The methods of assessment used in the course measured my competence | 30.8 | 38.5 | 30.8 | 41.2 | 35.2 | 23.6 | 4.16 |
| 3. The exam questions covered most aspects of the course content | 43.9 | 21.3 | 34.8 | 66.7 | 24.2 | 9.1 | ***32.34 |

## DIFFERENCES IN ATTITUDES BETWEEN THE MALE STUDENTS FOR 1994/95 AND 1995/96 SESSION

| | MALE 1994/95 | | | MALE 1995/96 | | | |
|---|---|---|---|---|---|---|---|
| **LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. For every lab session, the necessary materials were always readily available | 67.1 | 20.1 | 12.8 | 82.3 | 11.0 | 6.7 | 9.65 |
| 2. The lab sessions helped me to understand some of the topics covered during the lectures | 64.9 | 24.3 | 10.8 | 66.3 | 19.3 | 14.5 | 1.76 |
| 3. The lab sessions were well organised | 59.7 | 28.9 | 11.4 | 57.8 | 28.9 | 13.3 | 0.26 |
| 4. The total work load for the lab sessions is very heavy | 45.6 | 34.9 | 19.5 | 38.8 | 40.6 | 20.6 | 1.60 |
| 5. The lab work stimulated my interest in biological science | 45.0 | 32.9 | 22.1 | 51.6 | 35.4 | 13.0 | 4.52 |
| 6. The lab procedures were clearly explained in the lab manuals | 42.3 | 40.9 | 16.8 | 54.8 | 19.9 | 25.3 | ***16.88 |
| 7. I needed more instructions on how to write up my lab reports | 37.7 | 34.9 | 27.4 | 34.5 | 40.6 | 24.8 | 1.06 |
| 8. The purpose of each lab session was clear to me from the beginning | 38.9 | 36.2 | 24.8 | 39.2 | 27.7 | 33.1 | 3.65 |
| 9. My skills in interpreting the data were enhanced by the labs | 30.4 | 50.7 | 18.9 | 41.8 | 44.2 | 13.9 | 4.66 |

## DIFFERENCES IN ATTITUDES BETWEEN THE

## MALE STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | MALE 1994/95 | | | FEMALE 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LESS INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 47.5 | 35.3 | 17.3 | 64.0 | 23.0 | 13.0 | *8.41 |
| 2. The manual for this lab session was clear and straightforward | 43.6 | 38.6 | 17.9 | 52.2 | 32.3 | 15.5 | 2.23 |
| 3. This lab session was mainly investigative | 32.1 | 52,9 | 15.0 | 44.1 | 37.9 | 18.0 | 6.93 |
| 4. This lab session challenged me to find out things for myself | 46.4 | 40.0 | 13.6 | 39.4 | 35.0 | 25.6 | 6.79 |
| 5. This labwork helped me to develop my skills in problem solving | 39.3 | 41.4 | 19.3 | 21.7 | 47.8 | 21.7 | 2.60 |
| 6. There was too much of a cook-book approach in this lab | 26.6 | 45.3 | 28.1 | 30.6 | 43.1 | 26.3 | 0.59 |
| **TUTORIALS** | | | | | | | |
| The size of the class was appropriate for the students participation | 60.6 | 26.5 | 12.9 | 73.9 | 12.7 | 13.3 | **9.87 |
| The topics for discussion were always clear to me | 55.2 | 29.9 | 14.9 | 69.7 | 20.6 | 9.7 | *7.19 |
| Each tutorial was well organised | 40.0 | 35.5 | 24.5 | 57.6 | 29.1 | 13.3 | **11.37 |
| I felt free to express myself in the tutorial class | 37.4 | 37.4 | 25.2 | 69.7 | 20.0 | 10.3 | **34.01 |

## DIFFERENCES IN ATTITUDES BETWEEN THE

## MALE STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | MALE 1994/95 | | | MALE 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **MORE INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 38.5 | 28.0 | 33.6 | 59.1 | 20.7 | 20.1 | ***13.50 |
| 2. The manual for this lab session was clear and straightforward | 47.2 | 36.8 | 16.0 | 63.0 | 25.5 | 11.5 | *7.80 |
| 3. This lab session was mainly investigative | 65.5 | 23.9 | 10.6 | 55.2 | 35.8 | 9.1 | 5.05 |
| 4. This lab session challenged me to find out things for myself | 54.9 | 29.2 | 16.0 | 56.7 | 28.0 | 15.2 | 0.11 |
| 5. This labwork helped me to develop my skills in problem solving | 36.1 | 37.5 | 26.4 | 42.7 | 43.9 | 13.4 | *8.23 |
| 6. There was too much of a cook-book approach in this lab | 19.4 | 39.6 | 41.0 | 33.1 | 42.9 | 23.9 | ***12.53 |

**FEMALE STUDENTS**

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**FEMALE STUDENTS FOR 1994/95 AND 1995/96 SESSION**

| STATEMENTS | FEMALE 1994/95 | | | FEMALE 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | A | N | D | A | N | D | |
| 1. Overall, I will rate the biology course as very good | 73.9 | 22.1 | 4.0 | 66.2 | 26.8 | 7.1 | 5.48 |
| 2. The course content was well organised | 62.5 | 30.9 | 6.6 | 68.2 | 26.3 | 5.5 | 2.26 |
| 3. Recommended readings from the text contributed to my understanding of the course | 59.5 | 27.6 | 12.8 | 72.7 | 22.4 | 4.9 | ***17.13 |
| 4. My interest in the course increased as the course progressed | 52.6 | 31.3 | 16.1 | 51.1 | 32.1 | 16.8 | 0.16 |
| 5. Compared to other courses, the work load for this course is very heavy | 36.5 | 37.8 | 25.7 | 48.5 | 35.6 | 16.0 | **12.66 |
| 6. The course objectives were clear to me at the beginning of the course | 38.5 | 32.2 | 29.3 | 53.7 | 30.1 | 16.3 | ***19.90 |
| 7.The pace of the course was too fast | 30.9 | 38.8 | 30.3 | 15.6 | 49.7 | 34.7 | ***21.08 |
| **ASSESSMENT** | | | | | | | |
| 1. The exam questions were reasonable in difficulty | 48.2 | 37.0 | 14.9 | 73.1 | 22.3 | 4.6 | ***44.84 |
| 2. The methods of assessment used in the course measured my competence | 34.9 | 41.2 | 23.9 | 39.9 | 40.7 | 19.6 | 2.37 |
| 3. The exam questions covered most aspects of the course content | 30.0 | 20.8 | 49.2 | 69.1 | 19.3 | 11.6 | ***122.64 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**FEMALE STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | FEMALE 1994/95 | | | FEMALE 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. For every lab session, the necessary materials were always readily available | 82.6 | 9.1 | 8.3 | 85.6 | 10.7 | 3.7 | 5.74 |
| 2. The lab sessions helped me to understand some of the topics covered during the lectures | 71.0 | 20.3 | 8.7 | 70.7 | 17.7 | 11.6 | 1.62 |
| 3. The lab sessions were well organised | 50.4 | 38.0 | 11.6 | 61.0 | 26.5 | 12.5 | *8.71 |
| 4. The total work load for the lab sessions is very heavy | 55.4 | 33.1 | 11.6 | 33.9 | 42.5 | 23.5 | ***28.87 |
| 5. The lab work stimulated my interest in biological science | 50.4 | 35.5 | 14.0 | 57.5 | 28.9 | 13.5 | 3.23 |
| 6. The lab procedures were clearly explained in the lab manuals | 47.9 | 28.9 | 23.1 | 59.5 | 28.0 | 12.5 | **12.69 |
| 7. I needed more instructions on how to write up my lab reports | 49.6 | 33.3 | 17.1 | 41.0 | 31.2 | 27.8 | **9.36 |
| 8. The purpose of each lab session was clear to me from the beginning | 40.5 | 36.4 | 23.1 | 43.3 | 23.5 | 33.2 | **13.15 |
| 9. My skills in interpreting the data were enhanced by the labs | 36.1 | 46.5 | 17.4 | 45.1 | 43.0 | 11.9 | *6.11 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**FEMALE STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | FEMALE 1994/95 | | | FEMALE 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LESS INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 52.4 | 25.3 | 22.3 | 69.9 | 19.4 | 10.7 | ***20.51 |
| 2. The manual for this lab session was clear and straightforward | 52.4 | 33.9 | 13.7 | 59.7 | 27.5 | 12.8 | 3.20 |
| 3. This lab session was mainly investigative | 44.6 | 45.9 | 9.4 | 45.1 | 37.0 | 17.9 | **9.32 |
| 4. This lab session challenged me to find out things for myself | 58.8 | 33.0 | 8.2 | 40.2 | 38.3 | 21.5 | ***25.91 |
| 5. This labwork helped me to develop my skills in problem solving | 40.8 | 43.3 | 15.9 | 26.3 | 45.9 | 27.8 | ***17.41 |
| 6. There was too much of a cook-book approach in this lab | 21.0 | 43.8 | 35.2 | 23.4 | 44.4 | 32.0 | 0.72 |
| **TUTORIALS** | | | | | | | |
| The size of the class was appropriate for the students participation | 64.4 | 22.4 | 13.2 | 80.9 | 11.1 | 8.0 | ***22.17 |
| The topics for discussion were always clear to me | 54.9 | 27.0 | 18.1 | 64.5 | 24.2 | 11.3 | *7.87 |
| Each tutorial was well organised | 38.8 | 33.6 | 27.6 | 51.5 | 31.6 | 16.9 | ***14.05 |
| I felt free to express myself in the tutorial class | 34.2 | 35.5 | 30.3 | 58.4 | 27.2 | 14.4 | ***41.28 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**FEMALE STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | FEMALE 1994/95 | | | FEMALE 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **MORE INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 47.4 | 21.1 | 31.5 | 63.6 | 19.4 | 17.0 | ***18.74 |
| 2. The manual for this lab session was clear and straightforward | 53.0 | 31.7 | 15. 2 | 64.9 | 22.8 | 12.3 | *8.10 |
| 3. This lab session was mainly investigative | 67.2 | 24.0 | 8.7 | 63.8 | 17.9 | 8.4 | 1.02 |
| 4. This lab session challenged me to find out things for myself | 52.8 | 32.0 | 15.2 | 65.8 | 26.5 | 7.7 | **12.21 |
| 5. This labwork helped me to develop my skills in problem solving | 28.9 | 43.5 | 27.6 | 47.9 | 40.1 | 12.0 | ***30.20 |
| 6. There was too much of a cook-book approach in this lab | 16.5 | 50.9 | 32.6 | 19.1 | 46.2 | 34.8 | 1.30 |

| | OLDER 1994/95 | | | OLDER 19956/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The size of the class was appropriate for the students participation | 52.1 | 29.8 | 18.2 | 83.3 | 9.1 | 7.6 | 18.06 |
| The topics for discussion were always clear to me | 51.2 | 26.4 | 22.3 | 68.7 | 20.9 | 10.4 | 6.18 |
| Each tutorial was well organised | 35.5 | 33.1 | 31.4 | 56.7 | 28.4 | 14.9 | 9.38 |
| I felt free to express myself in the tutorial class | 39.2 | 35.0 | 25.8 | 74.6 | 16.4 | 9.0 | 21.85 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**OLDER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| **STATEMENTS** | **OLDER 1994/95** | | | **OLDER 1995/96** | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 65.3 | 26.4 | 8.3 | 59.7 | 25.4 | 14.9 | 2.03 |
| 2. The course content was well organised | 63.3 | 30.0 | 6.7 | 70.1 | 17.9 | 11.9 | 4.15 |
| 3. Recommended readings from the text contributed to my understanding of the course | 62.0 | 24.8 | 13.2 | 70.1 | 22.4 | 7.5 | 1.83 |
| 4. My interest in the course increased as the course progressed | 40.5 | 35.5 | 24.0 | 47.8 | 31.3 | 20.9 | 0.93 |
| 5. Compared to other courses, the work load for this course is very heavy | 47.5 | 31.7 | 20.8 | 61.2 | 26.9 | 11.9 | 3.80 |
| 6. The course objectives were clear to me at the beginning of the course | 39.7 | 29.8 | 30.6 | 62.7 | 16.4 | 20.9 | **9.33 |
| 7.The pace of the course was too fast | 32.2 | 34.7 | 33.1 | 26.9 | 47.8 | 25.4 | 3.12 |

| **STATEMENTS** | **OLDER 1994/95** | | | **OLDER 1995/96** | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **ASSESSMENT** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The exam questions were reasonable in difficulty | 47.9 | 37.2 | 14.9 | 77.6 | 17.9 | 4.5 | ***15.95 |
| 2. The methods of assessment used in the course measured my competence | 27.5 | 42.5 | 30.0 | 37.3 | 37.3 | 25.4 | 1.94 |
| 3. The exam questions covered most aspects of the course content | 30.8 | 26.7 | 42.5 | 61.2 | 26.9 | 11.9 | ***22.23 |

## DIFFERENCES IN ATTITUDES BETWEEN THE OLDER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | OLDER 1994/95 | | | OLDER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. For every lab session, the necessary materials were always readily available | 77.3 | 11.3 | 11.3 | 83.6 | 11.9 | 4.5 | 2.39 |
| 2. The lab sessions helped me to understand some of the topics covered during the lectures | 63.5 | 25.0 | 11.5 | 58.2 | 23.9 | 17.9 | 1.37 |
| 3. The lab sessions were well organised | 58.8 | 26.8 | 14.4 | 50.7 | 25.4 | 23.9 | 2.42 |
| 4. The total work load for the lab sessions is very heavy | 50.5 | 36.1 | 13.4 | 38.8 | 43.3 | 17.9 | 2.24 |
| 5. The lab work stimulated my interest in biological science | 45.4 | 36.1 | 18.6 | 42.2 | 39.1 | 18.8 | 0.18 |
| 6. The lab procedures were clearly explained in the lab manuals | 49.5 | 28.9 | 21.6 | 44.8 | 31.3 | 23.9 | 0.35 |
| 7. I needed more instructions on how to write up my lab reports | 42.7 | 32.3 | 25.0 | 44.8 | 29.9 | 25.4 | 0.12 |
| 8. The purpose of each lab session was clear to me from the beginning | 46.4 | 33.0 | 20.6 | 34.3 | 22.4 | 43.3 | 9.76 |
| 9. My skills in interpreting the data were enhanced by the labs | 37.5 | 42.7 | 19.8 | 41.8 | 43.3 | 14.9 | 0.71 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**OLDER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | OLDER 1994/95 | | | OLDER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LESS INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 58.9 | 28.9 | 12.2 | 70.8 | 18.5 | 10.8 | 2.58 |
| 2. The manual for this lab session was clear and straightforward | 54.4 | 31.1 | 14.4 | 60.0 | 24.6 | 15.4 | 0.79 |
| 3. This lab session was mainly investigative | 48.4 | 42.9 | 8.8 | 55.4 | 30.8 | 13.8 | 2.72 |
| 4. This lab session challenged me to find out things for myself | 54.9 | 37.4 | 7.7 | 40.6 | 37.5 | 21.9 | 7.15 |
| 5. This labwork helped me to develop my skills in problem solving | 37.4 | 46.2 | 16.5 | 38.5 | 46.2 | 15.4 | 0.04 |
| 6. There was too much of a cook-book approach in this lab | 24.2 | 40.7 | 35.2 | 33.8 | 43.1 | 23.1 | 3.15 |

| STATEMENTS | OLDER 1994/95 | | | OLDER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **MORE INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 38.9 | 24.4 | 36.7 | 57.6 | 24.2 | 18.2 | 7.35 |
| 2. The manual for this lab session was clear and straightforward | 61.8 | 25.8 | 12.4 | 57.6 | 27.3 | 15.2 | 0.36 |
| 3. This lab session was mainly investigative | 69.3 | 19.3 | 11.4 | 56.9 | 32.3 | 10.8 | 3.45 |
| 4. This lab session challenged me to find out things for myself | 52.2 | 31.1 | 16.7 | 57.6 | 24.2 | 18.2 | 0.89 |
| 5. This labwork helped me to develop my skills in problem solving | 33.0 | 39.6 | 27.5 | 45.5 | 45.5 | 9.1 | 8.42 |
| 6. There was too much of a cook-book approach in this lab | 20.9 | 47.3 | 31.9 | 35.4 | 40.0 | 24.6 | 4.11 |

YOUNGER STUDENTS

DIFFERENCES IN ATTITUDES BETWEEN THE

YOUNGER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS

| STATEMENTS | YOUNGER 1994/95 | | | YOUNGER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 69.6 | 26.2 | 4.1 | 66.4 | 26.5 | 7.1 | 3.30 |
| 2. The course content was well organised | 64.7 | 29.8 | 5.5 | 66.8 | 26.4 | 6.8 | 1.48 |
| 3. Recommended readings from the text contributed to my understanding of the course | 57.3 | 25.9 | 16.8 | 69.7 | 23.6 | 6.6 | ***23.02 |
| 4. My interest in the course increased as the course progressed | 51.2 | 34.7 | 14.0 | 47.5 | 36.0 | 16.5 | 1.39 |
| 5. Compared to other courses, the work load for this course is very heavy | 34.4 | 38.8 | 26.7 | 45.5 | 35.8 | 18.6 | **12.14 |
| 6. The course objectives were clear to me at the beginning of the course | 35.5 | 35.0 | 29.5 | 50.9 | 32.1 | 17.0 | **24.51 |
| 7.The pace of the course was too fast | 28.1 | 41.9 | 30.0 | 13.7 | 51.7 | 34.7 | ***25.26 |

| STATEMENTS | YOUNGER 1994/95 | | | YOUNGER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **ASSESSMENT** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The exam questions were reasonable in difficulty | 49.0 | 36.3 | 14.7 | 69.2 | 23.7 | 7.0 | ***34.62 |
| 2. The methods of assessment used in the course measured my competence | 34.6 | 40.7 | 24.7 | 40.6 | 39.0 | 20.4 | 3.56 |
| 3. The exam questions covered most aspects of the course content | 36.2 | 18.5 | 45.3 | 69.2 | 20.2 | 10.6 | ***128. 90 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**YOUNGER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | YOUNGER 1994/95 | | | YOUNGER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LAB WORK IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. For every lab session, the necessary materials were always readily available | 76.7 | 13.5 | 9.8 | 84.7 | 10.6 | 4.7 | **9.22 |
| 2. The lab sessions helped me to understand some of the topics covered during the lectures | 70.9 | 20.3 | 8.8 | 71.0 | 17.3 | 11.7 | 2.24 |
| 3. The lab sessions were well organised | 52.9 | 36.7 | 10.4 | 61.2 | 27.8 | 11.0 | *6.58 |
| 4. The total work load for the lab sessions is very heavy | 52.2 | 32.7 | 15.2 | 35.0 | 41.5 | 23.5 | ***22.02 |
| 5. The lab work stimulated my interest in biological science | 49.5 | 34.0 | 16.5 | 57.7 | 29.8 | 12.5 | 5.08 |
| 6. The lab procedures were clearly explained in the lab manuals | 45.1 | 35.0 | 19.9 | 59.8 | 24.5 | 15.7 | **15.51 |
| 7. I needed more instructions on how to write up my lab reports | 46.1 | 34.5 | 19.5 | 38.0 | 35.0 | 27.0 | *6.86 |
| 8. The purpose of each lab session was clear to me from the beginning | 38.0 | 37.7 | 24.2 | 43.2 | 25.2 | 31.5 | ***13.41 |
| 9. My skills in interpreting the data were enhanced by the labs | 33.4 | 49.3 | 17.2 | 44.3 | 43.6 | 12.2 | **9.53 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**YOUNGER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | YOUNGER 1994/95 | | | YOUNGER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **LESS INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The time allotted this lab session was adequate | 48.2 | 28.5 | 23.2 | 67.5 | 20.9 | 11.5 | ***28.80 |
| 2. The manual for this lab session was clear and straightforward | 47.4 | 37.2 | 15.4 | 56.6 | 29.7 | 13.7 | 5.97 |
| 3. This lab session was mainly investigative | 37.3 | 50.4 | 12.3 | 43.0 | 38.5 | 18.5 | **10.90 |
| 4. This lab session challenged me to find out things for myself | 54.2 | 34.9 | 10.9 | 40.0 | 37.1 | 23.0 | **21.34 |
| 5. This labwork helped me to develop my skills in problem solving | 41.2 | 41.2 | 17.6 | 25.9 | 46.8 | 27.3 | **20.33 |
| 6. There was too much of a cook-book approach in this lab | 22.6 | 45.2 | 32.2 | 24.5 | 44.0 | 31.5 | 0.34 |

| | YOUNGER 1994/95 | | | YOUNGER 19956/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1.The size of the class was appropriate for the students participation | 67.3 | 21.3 | 11.4 | 77.9 | 12.0 | 10 .1 | **13.70 |
| 2.The topics for discussion were always clear to me | 56.8 | 28.0 | 15.2 | 66.0 | 23.2 | 10.8 | *7.39 |
| 3. Each tutorial was well organised | 40.1 | 35.4 | 24.6 | 53.2 | 31.1 | 15.8 | ***15.91 |
| 4. I felt free to express myself in the tutorial class | 33.7 | 36.2 | 30.1 | 60.3 | 26.1 | 13.6 | ***60.52 |

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**YOUNGER STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | YOUNGER 1994/95 | | | YOUNGER 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **MORE INVESTIGATIVE LAB** | **A** | **N** | **D** | **A** | **N** | **D** | |
| **1**. The time allotted this lab session was adequate | 46.2 | 23.3 | 30.6 | 62.9 | 19.1 | 18.0 | ***21.69 |
| **2**. The manual for this lab session was clear and straightforward | 47.6 | 36.1 | 16.3 | 65.4 | 23.1 | 11.5 | ***22.64 |
| **3**. This lab session was mainly investigative | 66.3 | 24.9 | 8.8 | 61.6 | 30.2 | 8.3 | 2.35 |
| **4**. This lab session challenged me to find out things for myself | 54.2 | 30.6 | 15.3 | 62.8 | 26.4 | 10.8 | 5.95 |
| **5**. This labwork helped me to develop my skills in problem solving | 31.3 | 41.7 | 27.1 | 46.3 | 40.7 | 13.0 | ***27.90 |
| **6**. There was too much of a cook-book approach in this lab | 17.1 | 45.8 | 37.1 | 21.9 | 46.0 | 32.1 | 3.22 |

### 6.4.4 INTENDING BIOLOGY STUDENTS

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**INTENDING STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | INTENDING 1994/95 | | | INTENDING 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 70.7 | 24.4 | 4.8 | 69.0 | 24.7 | 6.3 | 0.78 |
| 2. The course content was well organised | 65.8 | 28.8 | 5.4 | 66.1 | 25.4 | 8.5 | 3.23 |
| 3. Recommended readings from the text contributed to my understanding of the course | 61.1 | 24.4 | 14.5 | 71.1 | 22.0 | 6.9 | **12.70 |
| 4. My interest in the course increased as the course progressed | 48.9 | 35.2 | 15.9 | 51.6 | 33.9 | 14.5 | 0.56 |
| 5. Compared to other courses, the work load for this course is very heavy | 35.2 | 38.6 | 26.1 | 45.4 | 35.1 | 19.4 | *8.58 |
| 6. The course objectives were clear to me at the beginning of the course | 35.5 | 37.8 | 26.7 | 54.3 | 29.4 | 16.3 | ***26.29 |
| 7.The pace of the course was too fast | 27.3 | 40.6 | 32.1 | 13.1 | 51.3 | 35.6 | ***22.45 |

| STATEMENTS | INTENDING 1994/95 | | | INTENDING 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **ASSESSMENTS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The exam questions were reasonable in difficulty | 49.4 | 34.6 | 16.0 | 72.7 | 20.7 | 6.5 | ***41.71 |
| 2. The methods of assessment used in the course measured my competence | 35.1 | 40.3 | 24.6 | 41.2 | 38.1 | 20.7 | 3.04 |
| 3. The exam questions covered most aspects of the course content | 36.6 | 20.3 | 43.1 | 69.6 | 20.7 | 9.7 | ***110.72 |

### 6.4.4 NON - INTENDING BIOLOGY STUDENTS

**DIFFERENCES IN ATTITUDES BETWEEN THE**

**INTENDING STUDENTS FOR 1994/95 AND 1995/96 SESSIONS**

| STATEMENTS | NON-INTENDING 1994/95 | | | NON-INTENDING 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **THE COURSE IN GENERAL** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. Overall, I will rate the biology course as very good | 57.1 | 35.1 | 7.8 | 50.5 | 33.0 | 16.5 | 3.09 |
| 2. The course content was well organised | 62.8 | 30.8 | 6.4 | 74.3 | 19.3 | 74.3 | 3.36 |
| 3. Recommended readings from the text contributed to my understanding of the course | 43.6 | 34.6 | 21.8 | 65.7 | 28.7 | 5.6 | ***14.10 |
| 4. My interest in the course increased as the course progressed | 44.9 | 34.6 | 20.5 | 33.9 | 36.7 | 29.4 | 2.85 |
| 5. Compared to other courses, the work load for this course is very heavy | 47.4 | 30.8 | 21.8 | 55.0 | 32.1 | 12.8 | 2.73 |
| 6. The course objectives were clear to me at the beginning of the course | 38.5 | 20.5 | 41.0 | 50.5 | 27.5 | 22.0 | *7.83 |
| 7.The pace of the course was too fast | 29.5 | 39.7 | 30.8 | 21.3 | 52.8 | 25.9 | 3.24 |

| STATEMENTS | NON-INTENDING 1994/95 | | | NON-INTENDING 1995/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **ASSESSMENTS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| 1. The exam questions were reasonable in difficulty | 51.3 | 38.5 | 10.3 | 67.0 | 30.0 | 2.8 | *7.11 |
| 2. The methods of assessment used in the course measured my competence | 29.9 | 37.7 | 32.5 | 40.4 | 36.7 | 22.9 | 2.92 |
| 3. The exam questions covered most aspects of the course content | 28.2 | 19.2 | 52.6 | 63.3 | 22.9 | 13.8 | ***34.66 |

| | INTENDING 1994/95 | | | INTENDING 19956/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The size of the class was appropriate for the students participation | 64.0 | 23.1 | 12.9 | 79.4 | 11.2 | 9.5 | ***22.15 |
| The topics for discussion were always clear to me | 58.6 | 25.7 | 15.7 | 66.0 | 22.9 | 11.1 | 4.86 |
| Each tutorial was well organised | 39.9 | 35.3 | 24.8 | 55.0 | 28.7 | 16.3 | ***16.96 |
| I felt free to express myself in the tutorial class | 36.5 | 36.2 | 27.4 | 65.1 | 22.9 | 65.1 | **59.89 |

| | NON-INTENDING 1994/95 | | | NON-INTENDING 19956/96 | | | $X^2$ |
|---|---|---|---|---|---|---|---|
| **TUTORIALS** | **A** | **N** | **D** | **A** | **N** | **D** | |
| The size of the class was appropriate for the students participation | 60.3 | 25.6 | 14.1 | 75.0 | 13.9 | 11.1 | 5.08 |
| The topics for discussion were always clear to me | 44.9 | 34.6 | 20.5 | 65.1 | 23.9 | 11.0 | *7.90 |
| Each tutorial was well organised | 34.6 | 34.6 | 30.8 | 52.3 | 33.9 | 13.8 | **9.48 |
| I felt free to express myself in the tutorial class | 30.8 | 32.1 | 37.2 | 54.1 | 26.6 | 19.3 | **11.51 |

# APPENDIX D

# LABORATORY SCHEDULES FOR THE LESS AND THE MORE INVESTIGATIVE LABS FOR 1994/95 AND 1995/96

## FIRST YEAR BIOLOGY

**Laboratory -Term 2, Week 13**

## MAMMALIAN SKULLS

### Objectives

By the end of this laboratory you should be able to :

1) describe the function and arrangement of the different parts of the skull of mammals;

2) using the mammalian skull as an example, describe how a basic pattern has become modified during evolution, for many different ways of life;

3) describe the way of life of an unfamiliar mammal from its skull structure;

4) construct a phylogeny from a set of data on fossil and living organisms.

### Time

| | |
|---|---|
| Skull profiles | - 2 hrs. 5 mins |
| Phylogeny of apes and humans - exercise and discussion | - 40 mins |
| Questionnaire - Evolution and Belief | - 15 mins |

***N.B. The skulls we use in this laboratory are precious : they take many hours to prepare for use, and new ones of some species are now very difficult to obtain. Please, therefore, handle the skulls with great care.***

Remember to read the Chapters on Problem solving - start with Chapter 8, if you have not already done so, and go on to Chapter 9 in the next two weeks.

## INTRODUCTION

During the many years of work that preceded the writing of "The Origin of Species", one of the features of animal and plant life that greatly impressed Darwin was that living organisms are grouped into natural families - each member being a variant of a basic pattern of organisation. One explanation of this is evolution from a common ancestor (though it is not the only explanation).

The skulls of mammals show well how a basic pattern has changed during evolution to meet the needs of different ways of life. We will study other aspects of the organisation of mammals later this term.

There now exist 3 main sub-groups of mammals - the monotremes which lay eggs (e.g. duck-billed platypus), the marsupials, where the young are born early and complete development in a pouch (e.g. Kangaroo), and the eutherians, where the young develop to a relatively late stage in the womb, nourished via a placenta by the mother's blood, (e.g. sheep, dogs, rats, monkeys).

Skull structure and other features of the 3 groups show some basic similarities (they are all mammals) but some major differences. To avoid confusion, we are concentrating on variation in one pattern, **the eutherian skull**.

The head of a mammal 1) contains the brain; 2) is the main seat of the sense organs; 3) is involved in the taking and early treatment of food, and 4) is involved in the inspiration and expiration of air. The skull is the bony part of the head. The position and shape of the sockets, depressions and flanges on the skull can tell us a great deal about the sense organs, nerves, muscles etc. of the head.

## EXAMINATION OF A FAIRLY GENERALISED SKULL (see figure 1)

To find our way around the skull, we will look first at large , fairly generalised specimens. Seat yourself at any one of the skulls numbered 3-6, 8-11, 14-15. Small skulls, and very modified skulls are initially more difficult to interpret. Try to locate all the features mentioned in the following introduction.

The skull consists of the **brain case** (or cranium) which protects the brain and the paired sense organs of the head, and the **jaws**, bony supports to the mouth which assist in feeding. During embryonic development, the upper jaw becomes fused to the brain case, leaving an adult skull in 2 parts: 1) upper jaw and brain case, 2) lower jaw. (The lower jaw forms as left and right halves, fusing at the front of the mouth. This fibrous fusion point sometimes comes loose during cleaning of the skull.)

R.1 What are the paired sense organs of the head?

**BRAIN AND SENSE ORGANS**

The brain is completely enclosed by bone, but nerve trunks open out from the brain at a number of points on the surface of the skull. The **size** of the brain case (proportional to the size of the brain) **relative** to the skull gives a rough measure of the 'mental capacity' of the animal.

R.2 Why should we measure relative rather than absolute size ?

At the back of the brain case, the spinal cord leaves via a large hole, the **foramen magnum** (Latin for 'large hole'). On either side of this are bony processes, the **occipital condyles**, which articulate with the vertebral column. If the first vertebra is present (some skulls only), you can examine how it articulates with the condyles. The position of the foramen and condyles can tell us whether the animal is bipedal or walks on all fours. In bipedal animals they are situated ventrally on the skull; in animals that walk on all fours, posteriorly.

The hearing organs lie below the brain at the back of the skull, enclosed in bony capsules. Each capsule opens to the outside by a canal, the **auditory meatus**, across which the ear-drum is stretched.

The nostrils open at the front end of the skull. Long nostrils are associated with a well-developed sense of smell. The two **nasal passages** are separated from one another by a thin bony wall (often destroyed during cleaning) and from the mouth by a bony **palate**. The nasal passages, above the hard bony palate, are sub-divided into finer passages by scrolls of very fine bone - the **turbinal bones** - which in life are covered by thin epithelial cell layers. In most of our skull specimens, the delicate turbinal bones have been damaged. Look at them in the demonstration specimens on the side bench.

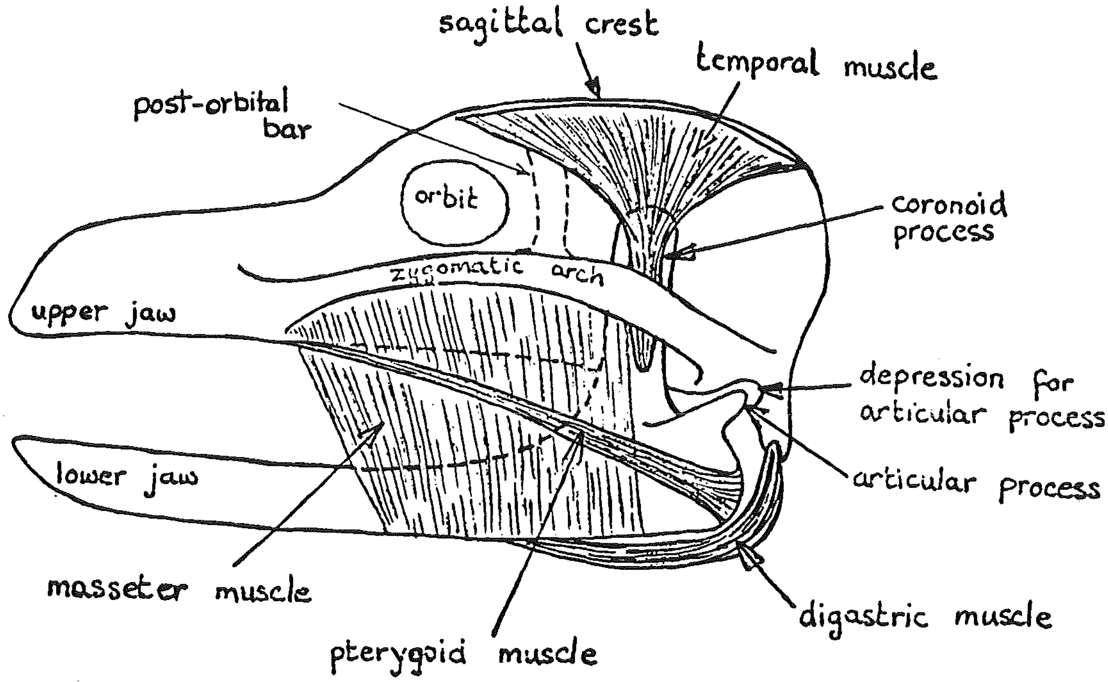
In sheep, the total surface area of the posteroir nasal chamber is increased x5 by the turbinal bones; in dogs by x2.5 and in human beings by only x1.3.
The bony palate and turbinal bones are absent in reptiles and amphibians, whose nostrils open directly into the mouth cavity.

R.3 What are the advantages of the bony palate?

R.4 Suggest two general functions for the sub-division of the nasal passages in mammals, and account for the differences between humans and others.

The eyes are placed in bony sockets - the **orbits**, which connect to the brain by a hole at the back of each socket. The optic nerve passes through this hole. Other holes in the bone of the orbit carry nerves to the eye muscles. The lower edge of the orbit is bounded by a bony bridge, the **zygomatic arch** and, in some species (including humans) the posterior margin of the orbit is protected by a **post orbital bar** (see Figure 1).

**FIGURE 1**




The **position** of the eyes determines whether the animal has more or less **all round vision** (eyes on the side of the head) or a forward-pointing overlapping field of view (binocular vision).

R.5 What is the advantage of binocular vision?

R.6 With what ways of life might you associate:

1) All round vision?

2) Binocular vision?

**JAW MUSCLES AND ARTICULATION** (see figure 1)

The lower jaw is closed by 3 sets of muscles. 1) the **masseter** - joining lower to upper through the **zygomatic arch** (or cheek bone); 2) the **temporal** - linking the **coronoid process** on the lower jaw to the **sagittal crest** along the rear midline of the roof of the skull. The space for this muscle may be confluent with the orbit, or separated from it by a bony post-orbital bar. 3) the pterygoid - linking the back of the lower jaw to a more anterior position on the upper jaw.

R.7 What directions of movement of the lower jaw are associated with each of these 3 muscles?

Well developed temporal and masseter muscles are associated with a high sagittal crest, and wide convex zygomatic arches.

R.8 What sorts of animals might have well-developed masseters and temporals?

R.9 What sorts of animals might have well-developed pterygoids?

The jaws are opened partly by their own weight, and partly by the **digastric** muscle, linking the rear of the brain case to the lower surface of the lower jaw. The rear of the lower jaw has two vertically pointing processes 1) the **coronoid** -attachment point for the temporal muscles, and 2) the articular - which fits into a depression on the lower surface of the brain case. This is the articulation point for the lower jaw, allowing either loose rotational movement as well as up and down movement or only up and down movement, or sliding back and forwards movement.

The **shape** of the depression gives a good idea of the kind of jaw movements possible, though the ligaments binding the bones together in life can be just as important.

R.10 In general, what sorts of animals are likely to have :

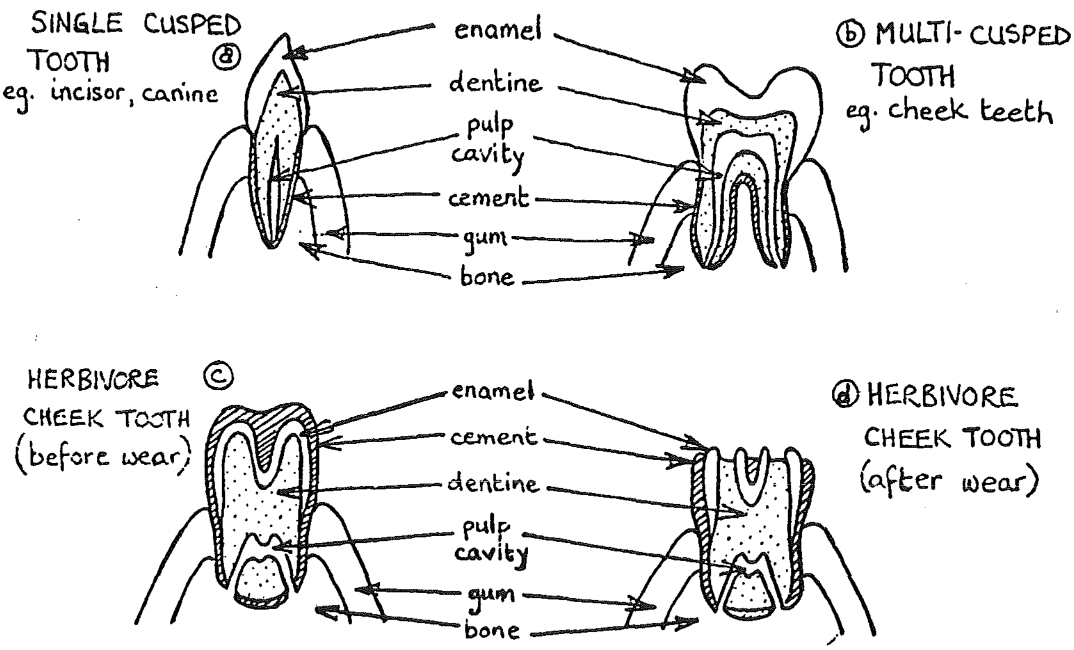
a) loose jaw articulation?

b) strict up and down articulation?

c) sliding back and foward jaws?

**TEETH**

Fig 2.




Mammalian teeth grow in sockets in the jaw bone, the **roots** being inserted in the sockets, the **crown** projecting from the surface. The teeth are anchored in place by a modified kind of bone called **cement**. The body of the tooth is composed of two hard materials - an outer layer of **enamel**, and an inner mass of **dentine**. Within the dentine mass is the **pulp cavity**, containing the cells that form the dentine, some blood vessels and nerve endings. After their period of development, most mammalian teeth stop growing: their pulp cavities become closed off, and the teeth wear away progressively with use. A few kinds of teeth do grow throughout the animal's life, e.g. the front teeth of rodents; the tusks of pigs and elephants.

The crown of a tooth ends in one or more projections, known as **cusps** - these may be sharp points or ridges, or gently rounded.

Adult mammals have up to four distinct kinds of teeth: 1) **incisors** at the front of the mouth, single cusped, for seizing and cutting food; 2) **canines** at the side of the front of the mouth, single cusped, for piercing and tearing food; 3 & 4) **premolars and molars** (known together as cheek teeth) at the back of the mouth, with several cusps; their form is very dependent on function which may be cutting, grinding, chewing or crushing. Molars are distinguished by being present only in the adult dentition, i.e. premolars are the only cheek teeth in the 'milk' dentition.

We can describe the teeth by a **dental formula**, the maximum number of teeth in land mammals being :

| | Incisors (I) | Canines (C) | Cheek Teeth (CT) |
|---|---|---|---|
| Upper jaw (each side) | 3 | 1 | 7 |
| Lower jaw (each side) | 3 | 1 | 7 |

This formula would be written out as $\frac{3.1.7}{3.1.7}$.

The canine in the upper jaw can be recognised by being the most anterior tooth of the second skull bone, (it cannot always be recognised by its shape; it is often very similar in shape to the incisors). In many mammals, the total number of teeth is reduced and some kinds may be completely absent, e.g. rodents have no canines, the gap on the jaw between incisors and cheek teeth being known as the **diastema**. In Cetaceans (whales, dolphins, etc.) tooth patterns are much modified, and there may be many more than the usual maximum 44 teeth. Domesticated mammals, subject to years of artificial selection, may also have unusual dental formulae.

R.11 Write down the dental formula of the skull you are looking at. (N.B. Some of the teeth may have fallen from the skull and become lost. Look for sockets in the jaw as well as teeth.)

Examination of the number and kind of teeth can reveal much about the habits of a mammal. Since they are hard and resistant to decay, teeth have often been important in piecing together the evolutionary history of mammals. The precise form of a tooth determines what it can do. The main patterns of mammalian dentition are:-

1) **insectivores**: little reduction in numbers of teeth. Cheek teeth and others have sharp pointed cusps.

R.12 Why do you think insectivores have sharp-pointed teeth?

2) **omnivores**: cheek teeth with round-topped cusps.

3) carnivores: usually have well-developed canines, and a small number of high crowned sharp cheek teeth, arranged so that on closing the jaws, the teeth shear against one another.

R.13 Explain how this kind of dentition is useful to a carnivore.

4) **herbivores:** incisors for cutting and tearing grass. Cheek teeth for grinding and chewing. Grass is a hard, silicious material, and wears teeth away rather rapidly. The cheek teeth of herbivores are unusual in construction (see diagram 2c). Fusion of the cusps with cement between, leaves a flat-topped surface. This wears unevenly, with ridges of hard enamel, and depressions of the softer dentine and cement. The amount of wear can help determine the age of a herbivore.

5) **gnawing**: continuously growing outward pointing incisors with a constantly renewed cutting edge, formed by the uneven wearing of enamel and dentine.

A few mammals do not conform to any of these main types. Try to work out their dentition when you come to them.

R.14 Teeth can be used for purposes other than food handling. Suggest as many as you can.

## THE HUMAN SKULL

Since the bony skull is covered by soft tissues in life, the shape of the head often bears little relation to the shape of the underlying bones. Use your own head - or your partner's - to investigate a living human skull.

Open and close your mouth to feel where the lower jaw articulates with the upper. Move your jaws from side to side to observe the tightness of the articulation.

R.15 Is the articulation of your jaws tighter or looser than in the mammal skull you have been looking at?

R.16 Use your tongue to count and identify your teeth and write down your dental formula. Is it the same as your partner's?

R.17 From your examination of your own head, what conclusions can you reach about the diet and feeding habits of primitive humans?

## SKULL PROFILES

The laboratory contains skulls from 16 different kinds of mammal (several specimens of a few, single specimens only of others) numbered 1-16. Examine and compile profiles of **NINE** skulls choosing one from each of the groups : 1-2; 3-4; 5-6; 7-8; 9; 10-11; 12-13; 14-15; 16.

Fill in, for each skull, the information listed on the profile sheets **at the end of this schedule.** Sketch any particular features that interest you. Eventually you should be able to deduce a good deal about the way of life of the mammal the skull once belonged to.

In your own time, visit the museum in the Department of Zoology. You will find there a 'skull trail' showing complete specimens and skeletons of the mammals from which the skulls came. There is also information there on the relationships of the different groups and a Mammals Quiz you may wish to enter for. Campbell gives a summary of the different groups of mammals - see pp 656-660.

**N.B. These skulls are precious : new ones take many hours to prepare, and some species are now very hard to get. Please handle the skulls with great care.**

## COMPARATIVE QUESTIONS

On the basis of your observations, answer the following questions.

R.18 Which kinds of mammals have:-

a) a diastema?

b) continuously growing teeth?

c) large canines?

d) no canines?

e) no upper incisors? (only seen in skull 11)

f) a jaw articulation that allows only up and down movement?

g) a jaw articulation that allows considerable side to side movement?

h) all-round vision?

i) highly developed binocular vision?

j) bipedal gait?

R.19 How could you distinguish a rabbit or hare from a rodent by looking at their skulls?.

## THE PHYLOGENY OF APES AND HUMANS

A phylogeny is an evolutionary history. For a group of related species this can be represented as a family tree traced back in time to a common ancestor. An important method of piecing together a phylogeny is from the examination of fossils. The age of fossils can be determined reasonably accurately using radioactive dating techniques. Evidence of relatedness comes chiefly from similarity of appearance and geographical location. In addition, modern molecular techniques can be used in some cases. You are provided with a set of 9 sheets each giving information on a living or fossil species of human or ape.

Work in groups of 4 to produce a phylogenetic tree that you could justify to your neighbours in a discussion at the end of the laboratory.

R.20 Represent your phylogeny in the space below. Give these as code letters first, then discuss your phylogeny with your demonstrator, who will identify the names of the different apes and humans.

R.21 List 4 changes that you can observe to have taken place over the last 30 million years in the evolution of the human skull.

a)

b)

c)

d)

R.22 What do these changes tell us about evolution towards our present way of life?

Two review articles on human evolution, both available in Room 723, are :

Schwartz, - 'The evolutionary relationship of man and orang-utans', Nature **308**, 501 (1984).

Stringer and Andrews, - 'Genetic and fossil evidence for the origin of modern humans', Science **239**, 1263 (1988).

**ALSO** : Campbell's 'Biology' covers human ancestry from pp 657 - 66.

**QUESTIONNAIRE and DISCUSSION - EVOLUTION** : fact, theory or belief?

Please complete the questionnaire on the relationship of scientific evidence to beliefs. If you wish, your demonstrator will discuss the issues raised with you.

# FIRST YEAR BIOLOGY - MAMMALIAN SKULL PROFILES

1. **Skull number** 2. **Size of skull**

3. **Teeth** a) Dental formula :

   b) Special features of :

   Incisors :
   Canines :
   Cheek teeth :
   Diastema :

4. **Jaws** a) Articulation : shape and direction of slot in brain case :

   b) Muscles : ? how well developed are :

   1) zygomatic arches :

   2) sagittal crest :

   3) point of attachment on lower jaw of the pterygoid muscles :

5. **Eyes** :- Binocular or all-round vision;

   Presence of post-orbital bar.

6 **Foramen magnum** : position

7. **Special features** (if any) :

   e.g. : relative capacity of brain case;

   relative weight of skull;

   relative length of nostrils.

8. **Deductions** about the way of life of the animal, and a tentative identification.

# BIOLOGY LEVEL 1

## Laboratory Term 2, Week 18

## Immunology

(A) ACTION OF ANTIBODIES:

(i) agglutination

(ii) lysis

(iii) precipitation

(B) BLOOD CELLS

(C) BLOOD GROUPS : Demonstration of haemagglutination - determination of the ABO groups.

(D) FILM :- "Immune targets: a case of 'Flu".

(E) HOME EXERCISE : How well do you understand blood groups?

### Objectives

Having completed this laboratory you should:

1 Be able to define in your own words antigen and antibody;

2. Understand the principle and describe some of the uses of agglutination;

3. Understand the process of antibody-mediated lysis of red blood cells and be able to describe the role of complement in the reaction;

4. Understand the principle of the precipitation test and be able to describe its use as an experimental technique;

5. Be able to distinguish the main kinds of mammalian blood cells and to describe their main functions;

6. Understand the basis of inheritance of the ABO blood groups.

**Reminder : Have you read Chapters 8-10 of the Problem Solving?**

## (A) Action of antibodies

Antibodies represent one major element of a vertebrate's system of defence against invading disease organisms. They are a class of soluble proteins known as gamma-globulins, secreted by specialised cells (plasma cells) in response to immunological stimulation of the body. The stimulus leading to the production of antibodies involves the recognition by the body of foreign molecules associated with e.g. invading organisms. Such molecules - **antigens** - elicit production of an antibody, or antibodies, which will combine specifically with them. In simple laboratory tests such combinations, forming an **antigen-antibody** complex, can produce visible results such as agglutination, lysis or precipitation of the antigen involved.

In this practical you will carry out tests as a means of demonstrating some of the properties and functions of antibodies. For convenience, laboratory tests utilize simple and often **unnatural** antigens to produce clear results - however the principles illustrated are relevant to the antibodies that are produced in response to disease organisms.

R.1 What is an antigen?

R.2 What is an antibody? Referring to your lecture notes if necessary, remind yourself of the basic structure of an IgG antibody molecule with its two antigen-binding sights.

### (i) Agglutination of Red Blood Cells

Antigen agglutination is the clumping together of particulate antigen sources such as bacteria, trypanosomes or, as here, red blood cells, by means of antibodies.

R.3 Using information given to you in the lectures draw a diagram to show how an antigen-antibody reaction brings about agglutination.

In this experiment, the antibodies that you will use are present in the serum of a rabbit (serum is blood plasma minus clotting constituents). Of the two tubes of rabbit serum provided, one (**normal rabbit serum**) was taken from a rabbit which had not undergone any particular experimental procedure. The other (**immune rabbit serum**) came from a rabbit that had been immunized against **sheep** red blood cells (by injecting it twice with sheep red cells some time before the blood was taken.) In both cases, the serum has been heated to 56°C to destroy complement (see (ii) page 4).

R.4 What does the term 'immune' mean? Give examples of antigens to which you have developed an 'immune' response.

***Procedure*** (Work in pairs).

Using a different 1 ml syringe, without a needle, for each reagent, make up the following mixtures in the four solid watch glasses provided.

| | |
|---|---|
| watch glass 1 | 2 drops sheep red blood cell suspension + 2 drops 1% normal rabbit serum |
| watch glass 2 | 2 drops sheep red blood cell suspension + 2 drops 1% immune rabbit serum |
| watch glass 3 | 2 drops horse red blood cell suspension + 2 drops 1% normal rabbit serum |
| watch glass 4 | 2 drops horse red blood cell suspension + 2 drops 1% immune rabbit serum |

Cover and label each watch glass. Agitate gently to mix and incubate at 37°C.

R.5 In which of the watch glasses are there antigens as far as rabbits are concerned?

R.6 In which of the watch glasses are there antibodies?

R.7 In which of the watch glasses are there antibodies specific for the added antigen? Since antigen-antibody reactions are specific, it is in this watch glass that you would predict agglutination to occur.

After 5-10 minutes incubation, examine under low microscope power. Repeat **at intervals during the rest of the laboratory period**. Look carefully at the red blood cells in suspension, not the bead of cells which collects in the bottom of the dish (re-suspend the bead by very gentle shaking).

R.8 What has happened in each case? Leave for 1-2 hours before answering.

R.9 Has the result fulfilled your expectations?

If not, consult your demonstrator who will tell you whether the discrepancy is due to failure of the experiment or an error in your deductions.

R.10 If, in a particular watch glass, antibodies specific for the added antigens were not initially present, would they be formed if you waited long enough? Give reasons for your answer.

This reaction is called **haemagglutination** and is widely used in modern medicine for blood grouping.

### (ii) Lysis of red blood cells

Normal serum contains a heat-sensitive component called **complement** which combines with antigen-antibody complexes. If the antigen involved is situated on a cell membrane, then the complex + complement may bring about local destruction of the membrane leading to lysis. In this test the model antigen is again the sheep red blood cell and the antibodies you will use are present in the serum of a rabbit which has been immunised by injection of sheep red cells.

As different rabbits contain different amounts of complement in the serum, it is customary to heat the serum at 56°C for 30 minutes to destroy the complement (56°C is chosen as this does not destroy antibodies - except for one type - IgE). Complement is prepared independently and added in specific amounts thus avoiding the confusion which can arise if different amounts of complement are present.

***Procedure*** (Work in pairs).

This experiment involves 4 different mixtures of reagents. Label (number and name) your tubes before you start. Measure out the reagents with the graduated syringes, using a separate one for each different reagent. Be careful not to squirt liquids out of syringes too hard, or you will cause haemolysis by mechanical damage of the red blood cells.

The tubes should contain:

| | |
|---|---|
| tube 1 | 2 ml sheep red blood cells<br>0.1 ml complement |
| tube 2 | 2 ml sheep red blood cells<br>0.5 ml 1% immune rabbit serum |
| tube 3 | 2 ml sheep red blood cells<br>0.5ml 1% immune rabbit serum<br>0.1 ml complement |
| tube 4 | 2 ml sheep red blood cells<br>0.5 ml 1% immune rabbit serum<br>0.1 ml heated (for 30 min at 56$^{o}$C) complement |

When you have set these up, incubate them for 45 min. at 37$^{o}$C in a water bath.
While the tubes are in the water bath, deduce what results you would expect.

R.11 In which of the tubes should antigen - antibody complexes be formed?

R.12 In which of the tubes should **agglutination** occur?

R.13 In which of these tubes should **lysis** occur, and why?

After 45 minutes incubation, remove the tubes from the waterbath and resuspend the contents by shaking. From each tube, using a clean pipette each time, remove a small amount of the suspension and place 2 drops on a clean slide, then cover. Examine these drops for signs of agglutination, using your microscope.

R.14 Do the results fulfil your expectation from R.12? If not, what are the possible explanations?

Centrifuge the tubes at 2500 r.p.m. for 2 minutes, after making certain that the centrifuge is balanced.

Examine the tubes. The reaction you are looking for is called **haemolysis** and involves the breaking down of red cell membranes with release of haemoglobin . Thus where haemolysis has occurred, haemoglobin, which is red, will be present in solution; where no haemolysis has taken place, the haemoglobin will be confined to the red cells, whether or not they have agglutinated.

R.15 In which of the tubes has haemolysis occurred?

R.16 Has the result fulfilled your expectations? If not, consult your demonstrator.

R.17 The antigen in these experiments was:-

(i) sheep haemoglobin

(ii) glycolipid - protein complexes forming the surface of sheep red blood cells

(iii) protein in the rabbit serum

(iv) complement

Which is correct? ---------------------------------------------------------

***(iii) Precipitation*** (Demonstration)

When antibodies and antigens are both in solution, antigen - antibody combination often results in the formation of a precipitate which can be visualized in an agar plate.

To test the identity of an unknown solution X or Y, an agar plate is poured and holes cut in it as shown in the diagram. Wells A, B, and C are filled with **known** sera (plural of serum), in this case, A = horse, B = rabbit, C = calf; (i.e. these sera contain horse, rabbit or calf antigens).

Into the central well, we put a few drops of the unknown solution (X or Y): in this case, the unknowns are antisera (i.e. contain antibodies) against horse, rabbit or calf antigens.

Antisera are made by injecting the appropriate antigen (here horse, rabbit or calf serum) into an animal and then taking blood (from which cells and clotting constituents are subsequently removed) when the animal has had time to produce antibodies. Usually two injections of the antigen are given separated by some weeks, because far more antibody is produced following a second contact with the antigen. The animal's responses to these experimental procedures correspond to their normal responses to infection or indeed to contact with foreign tissue (e.g. skin grafts, organ transplants).

After the dish has been set up, it is incubated for some time to allow the proteins to diffuse into the agar, and to interact there.

Now look at the demonstration plates. The signs of precipitation are most easily seen by illuminating the dish obliquely near a lamp.

R.18 Describe the appearance of the antigen-antibody interaction in an agar plate.

R.19 State the identity of the unknowns X .................., and Y ..................

Because it is so easy to perform and so sensitive (as little as 3 micrograms of antibody can be detected), this precipitation test, or a modification of it, was widely used for detecting the presence of tiny quantities of specific macromolecules e.g. hormones. Today there are other sensitive techniques for detecting specific macromolecules with antibodies, which frequently have a colour change as the indicator of an antigen/antibody interaction rather than precipitates. The colour change comes about through tagging the antibody with an enzyme which is resited with its specific substrate.

## (B) Blood cells

In this section, you will use your compound microscope to examine a stained prepartion of mammalian (mouse) blood.

To examine the cells of most kinds of tissue, it is necessary to go through quite a complex process of preservation, sectioning and staining to give you a thin slice that light passes through and where there is contrast between different components. We looked into these techniques in the laboratory in week 3 - Developmental Biology.

However, it is easier to prepare **blood** cells for microscopy. The cells are in a fluid suspension and a thin smear of blood on a slide can give you a single layer of cells to examine. Smears are air-dried, fixed, then stained with dyes which pick out the nuclei and secretory granules of the various kinds of leucocytes ('white' blood cells). The erythrocytes (red blood cells) have their own pigmentation (haemoglobin) and are usually little altered by staining.

Because blood cells are rather small, to distinguish their details it is necessary to use the oil immersion ( x100) objective. Remember that in doing this, you should focus and select an area for examination first with x10, then x40, then place a small drop of immersion oil on the part of the slide you are examining, and swing the x100 objective into position. Only slight refocussing should then be necessary.

R.20 Identify and draw to scale : (i) erythrocytes; (ii) polymorphonuclear leucocytes; (iii) lymphocytes.

R.21 Given that erythrocytes are 7 - 8 μm in diameter, how big are -

(i) polymorphonuclear leucocytes? .......................................

(ii) lymphocytes? ................................................................

R.22 What are the functions of (i) polymorphs?

(ii) lymphocytes?

## (C) Blood groups

There are about 15 common blood group systems in humans which are distinguishable by immunological tests on red blood cells. The first and most important of these is the ABO system discovered by Landsteiner in 1900. This system is of major clinical importance in the selection of blood for transfusion.

Four main groups of individuals are distinguishable on the basis that their red cells have one or the other, both or neither, of two antigens termed A and B. A person's blood group can therefore be classed as either A, B, AB or O. In addition, his/her serum contains either one or the other, both or neither of two antibodies, anti-A and anti-B. A person does not make the antibodies that would cause agglutination of his own cells, but possesses the antibodies compatible with his/her own antigens. Thus a person of group A has cells carrying the A antigen and serum containing anti-B antibody.

R.23 Which blood group antibodies would be found in the serum of a person of

a) group O b) group AB ?

In blood transfusion, problems arise when incompatibilities occur between the ABO **antigens** of the **donors,** and the **antibodies** of the **recipients**. There is no real problem if there are incompatibilities between the **antibodies** of the **donors**, and the **antigens** of the **recipients,** because these antibodies will be so dilute.

R.24 If someone is of blood group A, to which blood groups could that person act as :

a) donor? .................................. b) recipient ? .............................

R.25 Why is a person of group **O** called a **universal donor** and someone of group **AB** a **universal recipient**?

Blood group antigens are genetically determined. Offspring do not have the A antigen unless one of their parents has it; neither do they have the B antigen unless one parent has it. However, group O children occur not only among the offspring of O parents, but also of A and B parents. Mating of an AB with an O may produce A and B offspring, but no AB offspring. From this it is clear that A, B and O are determined by alleles at the same locus. The following genotypes are thus possible : AA, AO, BB, BO, AB, OO.

R.26 In a court case, the right of an older son to succeed to a title was challenged by a younger son on the grounds that the older was illegitimate. If the father's blood group had been A, the mother's B, and the older son's O, **could** the older son have been legitimate?

Give reasons for your answer.

Another important blood group system in humans is the **Rhesus system**, so-called because it was first discovered by injecting rabbits with red cells obtained from the Rhesus monkey. Approximately 85% of Europeans possess red blood cells containing an antigen called the Rhesus factor. Their blood is described as **Rhesus positive**. The remainder lack the Rhesus antigen and are called **Rhesus negative.**

R.27 What dangers are inherent in pregnancies resulting from matings of Rhesus negative women and Rhesus positive men and why?

***Blood Group Testing.***

*This will be demonstrated to you in your groups by your demonstrator*

The percentages of different blood groups in the population vary appreciably from one part of the world to another. In Europe the highest percentage of Group B (25-30%) is in the northeast and declines gradually to below 5% in parts of southwestern Europe like Spain. Rh-negative is about 15% of the population in Europe but among the Basques it is a surprising 30%, while among the people of eastern Asia and the North American Indians Rh-negative is extremely rare.

The percentages of various blood types in the population of Scotland and England are given below.

| | O | A | B | AB | Rh-negative | Rh+positive |
|---|---|---|---|---|---|---|
| Scotland | 51 | 35 | 11 | 3 | 17 | 83 |
| England | 47 | 42 | 8 | 3 | 17 | 83 |

**(D) Film :- "*Immune targets: a case of 'flu*".**

R.28 What 'flu virus antigens can be used in the production of a vaccine, and what problems are associated with them?

R.29 What are the prospects of a successful 'flu vaccine in the future?

**(E) Home exercise**

How well do you understand blood groups? Try the following problem at home.

A technician has 4 separate samples of whole blood collected at a blood donating session. The technician knows that one sample is from group A, one from group AB, one from group O and one from group B, but the labels have got mixed up. Given only a centrifuge, centrifuge tubes, pasteur pipettes, physiological saline and some glass slides, how could the technician work out which sample was which, and how far could she/he get? Explain fully how you would use the different pieces of equipment available.

**Discuss your answer with your demonstrator next week.**

35/ZSHT2W18

# MAMMALIAN STRUCTURE AND FUNCTION

## Aims

- To investigate the anatomy of a rat.
- To investigate the histology and ultrastructure of the small intestine.

## Objectives

At the end of the laboratory, you should be able to
- recognise and name the female and male reproductive organs, the chief organs within the thoracic and abdominal cavities, and some of the blood vessels.
- describe the function of the organs that you have examined.
- by examination of light microscope slide and electron micrograph, to recognise and name the main visible structures, and describe the functions of villi and microvilli.

## Introduction

The forerunners of modern biological investigation appeared in the 16th and 17th Centuries. The first of them was Andreas Versalius (1514-1564), who made the first serious studies of human anatomy by dissecting corpses. He discovered that the body is composed of numerous complex but beautiful subsystems, each with its own function, and he pioneered the comparative approach, using other animals to work out the purpose and organisation of these anatomical units. Another of these pioneers was Antony van Leeuwenhoek (1632-1723) who had the idea of using the microscope to look at living things. He thus discovered sperm and the eggs they fertilised and the cells of which all living things seemed to him to be composed. In this laboratory, which is in two parts, we will be following in the footsteps of these pioneers, using a rat to investigate the structure of a mammal and a microscope to investigate how the structure of the small intestine is adapted to its function. Fine structure will be examined by means of an electron micrograph.

## Section A

## Demonstration dissection of a male rat

The **male rat** supplied was killed by anaesthesia approx. 15 minutes before the laboratory started. Although the dissection will be carried out by a demonstrator with the aid of closed circuit TV, the following description of the dissection is written in the form of a set of instructions for doing the dissection yourself.

Arrange the rat on the **board** so that its head points away from you and its ventral side is uppermost, i.e. the rat is lying on its back.

### a) Leg vein

Cut through skin a few mm anterior to the urinogenital opening (penis). Extend cut anteriorly in mid-ventral line to the neck, and then cut laterally for 1 cm towards the forelimbs, taking care that only the skin is cut through and NOT the muscular body wall. Cut diagonally back from initial point of incision down the right leg nearly to the ankle, so as to expose the inside surface of the leg. Loosen skin on right side of body with fingers, holding muscular body wall with one hand and skin in the other. You may wish to pin the rat to the board through its hands and feet.

Examine the inside surface of the skinned thigh. You will see clearly a large vein (femoral vein) and beside it a thin, opaque, white strand - this is a nerve (a branch of the femoral nerve).

Grasp the right leg with your left hand so as to compress between thumb and forefinger the femoral vein <u>below</u> the knee. Stroke the blood out of the femoral vein <u>once</u> (fairly firmly) from the knee right up to the body wall.

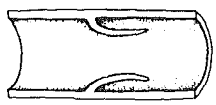
R.1 Does the blood refill the vein? (Describe what happens in a couple of sentences)

Release the leg.

R.2 From which direction does the blood refill the vein? - from the foot or body end?

R.3 What deductions can you make about the control of blood flow in the vein?

R.4 In the following diagram of a section of a valve in a vein viewed from the side, state whether the blood flows from left to right or the reverse, and how the valve prevents backflow of blood.



**b) Reproductive organs**

R.5 What does mean? and mean?

Cut through the posterior (hind) end of the scrotal sac. Note that there is a layer of skin and then a thin transparent layer of muscle - cut through both in order to free the testes. At each end of each testis is a much coiled tubular structure with the delightful name of EPIDIDYMIS. In a fully mature rat a lot of sperm would be found stored in the epididymis but in your young male the epididymis will still be relatively small and may contain only a few sperm.

The testis is connected by very fine tubules, which are too fine to see with the naked eye, to the **anterior** part of the epididymis. The anterior part of the epididymis connects to the posterior part, and from this the sperm travels along the VAS DEFERENS, a white tubular structure. Follow the vas deferens up into the abdominal cavity; note how it goes through a 'hole' in the muscular body wall. (This is the inguinal canal and is a point of weakness in men: loops of the intestine may descend through this aperture, giving an inguinal hernia.). The testis therefore lies outside the main abdominal cavity.

R.6 Why should this be?

R.7 Is the testis in this position throughout development?

Cut up the inguinal canal and extend the cut forward in the mid-ventral line to the sternum (breast bone) being careful to cut only the muscular body wall, and not the organs lying within the abdominal cavity.

At the posterior end of the abdominal cavity, follow the vas deferens to where it 'disappears' just dorsal to the urinary bladder, which usually contains urine and looks like a yellow balloon. If empty it resembles a white pea.

Identify large (approx, 1-3 cm long), finely lobed, almost frilly organs, the seminal vesicles attached to the vas deferens.

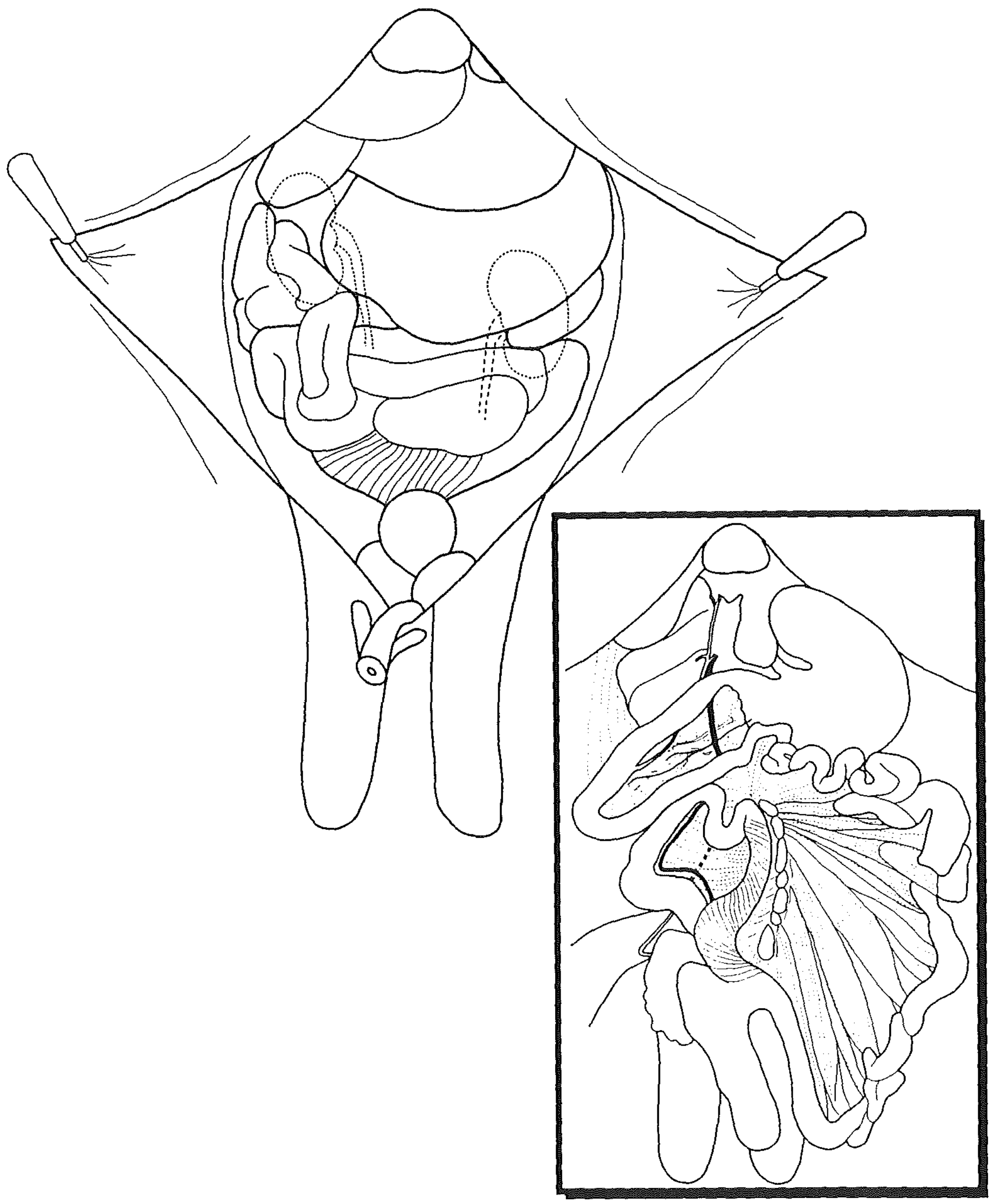
R.8 The semen ejaculated by a male consists mainly of the SEMINAL FLUID in which the spermatozoa are suspended. The seminal vesicle was at one time thought to store spermatozoa - what do you think its function might be?

R.9 Where are the sperms stored?

To avoid killing more rats, the female reproductive organs are shown by fixed demonstration specimens and photographs which you will be examining in the second part of the laboratory.

**c) Abdominal organs**

R.10 Now examine the organs lying within the abdominal cavity. Identify LIVER, SPLEEN, KIDNEYS, SMALL INTESTINE, CAECUM, COLON and RECTUM. Displace the organs slightly to the left so that as many as possible of them are visible. Label these organs in the following diagram.



Displace the intestine to the animal's right (your left); you will now see the rectum, dorsal to the bladder. This is the terminal region of the large intestine.

Find the small intestine leaving the stomach (the first few cm of the small intestine is called the DUODENUM).

Grasp the duodenum where is leaves the stomach with your right hand and the duodenum about 4 cm away from the stomach with your left. Lift up this 4 cm of the duodenum so as to stretch the connective tissue (mesentery) between the duodenum and liver.

Look at the mesentery within the loop. You will see a lot of diffuse (scattered), pink tissue - this is the PANCREAS. In all mammals the pancreas is situated in this region, a loop formed by the duodenum, but in most mammals it is a much more 'solid' structure. You may eat it under the name of "sweetbread".

**d) Stomach - distensibility, pH, regions ; intestine - length and structure**

Ligature (i.e. tie) the OESOPHAGUS, where it enters the STOMACH using the **cotton** provided and cut the oesophagus anterior to the ligature. Ligature the duodenum 2-5 mm from its junction with the stomach; cut the duodenum below the ligature. The stomach should now be completely closed off. Remove the stomach to a Petri dish.

You will see the stomach is divided into two regions, being a pinkish colour near the duodenum (pyloric region) and pale brown at the other, cul-de-sac-end (cardiac region)

R.11 Draw the stomach to indicate the relative size of the 2 regions and label them.

Inject through the pinkish part of the wall 10 ml of **saline** (Hanks solution) which has a **pH indicator** added to it (pink when neutral, yellow when acid).

R.12 Draw the stomach again , indicating the size of the **two** regions.

R.13 Which region of the stomach has swollen more? What is the significance of this observation?

Withdraw a few ml of the liquid from the stomach.

R.14 What conclusion can you draw about the pH inside the stomach?

Now return to the intestine, still in the rat. Notice that the intestine is organised as a series of loops each held in place by a thin, transparent sheet of tissue called a mesentery. Notice the extensive system of blood vessels in each mesentery. The venous part of this system joins up to take blood to the liver - the HEPATIC PORTAL system.

R.15 What is the function of this system? (Recall that most veins take blood directly to the heart rather than to a new organ).

**e) Aorta, vena cava, kidneys, ureter and bladder**

Return to the abdominal cavity.

Identify the very large dark blood vessel running up the mid-dorsal line. Running parallel to it is a narrower vessel of a rather bluish colour. One of these vessels is a vein, the INFERIOR VENA CAVA, through which blood flows from all posterior parts of the body except the intestine, carrying it back to the heart. The other is an artery, the DORSAL AORTA, carrying oxygenated blood from the heart to the abdominal organs and posterior muscles. Very carefully use a needle to clear the connective tissue around the vessels to show both clearly.

R.16 Which of these two vessels is the artery and which the vein?

a) Large dark vessel -

b) Narrower paler vessel -

R.17 Why is b) narrower and paler than a)?

Major branches of both these vessels, the renal arteries and veins, enter and exit from the kidneys (notice the asymmetry of their positions in the abdomen). The interior of each kidney links to the bladder via a narrow tube, the ureter. The ureters are difficult to see, but can be made visible by injecting dye into the kidney. Inject 0.05 - 0.1 ml of 0.2% aqueous indigo carmine into a kidney, using the 1 ml syringe with 3/8" needle, as follows. Insert the needle through the outer side of the kidney till the needle tip is in the centre of the kidney, near where the blood vessels join the kidney - unless the kidneys are very small, this means inserting almost to the base of the needle. To get to the right place, the syringe should enter the kidney parallel to the bench top. Now inject the dye and observe where it goes.

R.18 What can you deduce from this observation?

R.19 If you wished to transplant kidneys from one rat to another, how many connections would you have to make to each kidney?

R.20 Can you suggest why it is that kidney transplants are now routine, whereas transplants of other major organs, e.g. heart, have only been done on a much smaller scale?

**f) Thoracic cavity**

Next week, we will investigate the thoracic organs of a sheep, but it is worth looking at them in your rat.

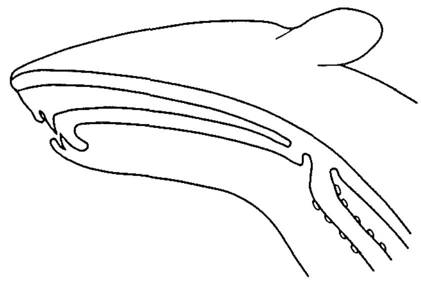
Make a 'window' into the thorax by cutting the ventral section of the thoracic wall away. Identify LUNGS, HEART, THYMUS, DIAPHRAGM.

**g) Mouth, pharynx and trachea**

Remove the skin from over the neck and throat by cutting the skin in the mid-ventral line from the posterior to the lower jaw. Where the lower jaw joins the neck, 2 pairs of SALIVARY GLANDS will be seen (in shrews these glands produce venom as well as saliva; in snakes it is another pair of salivary glands with ducts leading into the the upper jaws that produce the venom). Cut in the mid-line between the salivary glands and expose a muscle layer which covers the TRACHEA (wind-pipe); the latter is easily identified by its rings of cartilage. Remove this layer of muscle so as to expose the length of the trachea.

Place the rat so that its head is on your right (onyour left if you are left-handed). Cut through the jaw on the animal's right from the mouth backwards, and expose the junction of the trachea and OESOPHAGUS. Make a similar cut on the other side and remove the lower jaw. Note the tongue. A seeker will prove useful to distinguish these passages. Find the internal opening of the nose, a tiny hole located dorsally at the back of the mouth, near the junction of the trachea and oesophagus. Note that the nose (the air passage) is dorsal to the mouth, whereas the trachea is ventral to the oesophagus.

R.21 Label the diagram below to show that you have identified the mouth, nasal cavity, oesophagus and trachea. Mark in the EPIGLOTTIS, the valve that prevents food passing into the trachea.



R.22 When would you expect the epiglottis to close off the tracheal opening?

## Section B

### a) Female reproductive system

To avoid killing more rats, the female reproductive organs are shown by fixed demonstration specimens and photographs. Look at the specimen of a **non-pregnant** female.

R.23 Make a labelled sketch of the system, to scale, to show OVARIES, FALLOPIAN TUBES, UTERUS AND VAGINA.

Now examine the specimen of a **pregnant** female rat.

R.24 Write a brief note on the differences you can see between pregnant and non-pregnant specimens. Add a sketch if that will help you.

To demonstrate the posterior part of the reproductive system, it is necessary to cut through the PELVIC GIRDLE, a bony arch which has attachment points for the legs and for the backbone.
The cut ends of the girdle are shown in the demonstration specimens. The ventral part of the girdle is fibrous, not bony - this is important at the time of birth, because, under the action of hormones, the fibres loosen, and allow the pelvic girdle to widen, so that babies can be born without getting too squashed. The girdle can't widen all that far, so its diameter limits the size of babies at birth.

R.25 a) Do you think that male mammals have the same kind of pelvic girdle as females?

b) Can you think of any mammals where baby size is not likely to be limited by the size of the pelvic girdle?

**b) The histology and fine structure of the small intestine**

(i) Transverse section of the ileum (part of small intestine)

Stains: Haemalum, eosin and alcian blue.
nuclei - purple; cytoplasm - pink; mucus - bright blue

Examine the slide first with the x4 objective. As you might expect, you see a cross section of a tubular structure. We term the inside of a tube its LUMEN. Notice the large projections from the intestinal wall into the lumen; these are finger-like processes called VILLI.

R.26 In order to appreciate how sections of villi can have this appearance, draw the outline of one of your fingers cut in: a) longitudinal section; b) oblique section; c) transverse section.

R.27 What is the function of these villi?

Change to the x10 objective, then move the slide so that a part of the intestinal wall is in the middle of the field and turn to the x40 objective. Examine the intestinal wall. You should see the following, starting from the outside:

1) A limited, inconspicuous, thin layer of cells around the outside, called the SEROSA.

2) The main muscle layers consisting of circular muscle and longitudinal smooth muscle fibres.

R.28 Which of these muscle layers is the outer?

3) Further in than the muscle layers is a broad region in which it is difficult to make out exactly what tissues are present. However, you should be able to find blood vessels.

R.29 How have yiu identified blood vessels/

This complex region consists of connective tissue, more smooth muscle cells (less regularly arranged than in the outer layers) blood and lymphatic vessels, nerves and lymphoid cells. (We shall return to the lymphoid cells when talking about defence of the body). The region is concerned with the transport of digested food, once it has crossed the intestinal lining.

4) The innermost layer forms the lining of the intestinal lumen (any lining layer is called an EPITHELIUM). This epithelium covers the villi and lines the tubular glands which plunge deep into the intestinal wall (known as CRYPTS OF LIEBERKUHN). In section, you may not see any distinction between the villi and the crypts, but in life the villi show as waving finger-like processes. The crypts are glands at the bases of the villi which are usually closed, but open intermittently to release their contents.

R.30 You should see two kinds of cell in the epithelium; one is primarily a mucus secreting cell, the other an absorbtive cell. Make an accurate drawing to show the appearance of these cells. Notice particularly the luminal appearance of these cells. In a favourable section, these may appear refractile (shiny). You'll see the reason for this in the electron-micrograph.

(ii) Fine structure of the ileal epithelium

Now look at your electron micrograph. This shows detail of cell structure much better than the light microscope can.

You can now see clearly that the ileal epithelium is composed of tall columnar cells. the luminal ends of the cells are folded into many fingerlike projections - MICROVILLI. The old light microscopists could just make these out as hair-like projections, and called them the 'brush-border'. They are the cause of the refractility you may have seen in your light microscope section. In your micrograph, the microvilli are cut at all sorts of different angles.

R.31 What might be the function of the microvilli?

Amongst the absorptive epithelial cells are mucus-secreting cells.

R.32 How do these appear in your micrograph?

The bases of the epithelial cells join onto an area of connective tissue, blood capillaries and lymph vessels. These are not clearly seen in the micrograph. The columnar cells contain prominent nuclei and many mitochondria. The cell boundaries interdigitate with each other.

R.33 What possible reasons are there for cell margins interdigitating rather than having a flat surface of contact?

All the cells and nuclei are bounded by this membranes. Some of the cells are cut in an almost perfect longitudinal direction. You may see only small fragments of some cells.

R.34 On each of the benches you will find a line drawing of this electron micrograph with different structures labelled. Fill in opposite the list of structures below, the letter corresponding to that structure:

| | | |
|---|---|---|
| MICROVILLI | MITOCHONDRION | COLUMNAR CELL |
| NUCLEUS | CELL MEMBRANE | MUCUS CELL |
| INTERDIGITATIONS | NUCLEAR MEMBRANE | |

Now check with the correct answers on the back of the line drawing.

Mitochondria are involved in the processing of chemical energy for the cell's use. Active cells such as absorbtive cells tend to have a lot of mitochondria.

**Objective questions: multiple choice** (only one correct answer per question)

These questions are to allow you practice in the kind of multiple choice question we will set you in your examinations. They are not part of the continuous assessment component of the module. For answers see last page of this laboratory handbook.

1. In a male rat, motile sperm are stored in:
   (a) the testis.
   (b) the epididymis.
   (c) the seminal vesicles.
   (d) the prostrate glands.

2. Which of the following would you find in the wall of the small intestine of the rat?
   (a) smooth muscle.
   (b) cardiac muscle.
   (c) striated muscle.
   (d) skeletal muscle

3. The gall bladder of the rat is to be found:
   (a) suspended in the mesentery between a loop of the duodenum.
   (b) closely associated with the liver.
   (c) lying next to the bile duct.
   (d) the rat does not have a gall bladder.

4. The pancreas of a rat is to be found:
   (a) around the lower part of the oesophagus.
   (b) closely associated with the kidneys.
   (c) in the mesentery attached close to the large intestine.
   (d) suspended in the mesentery between a loop of the duodenum.

5. The layers in the wall of the small intestine are: serosa, mucosal epithelium, submucosa, circular muscle, longitudinal muscle. In which order do they occur, going from OUTSIDE to INSIDE?
   (a) serosa - longitudinal muscle - circular muscle - submucosa - mucosal epithelium.
   (b) longitudinal muscle - circular muscle - submucosa - serosa - mucosal epithelium.
   (c) circular muscle - submucosa - longitudinal muscle - serosa - mucosal epithelium.
   (d) serosa - circular muscle - longitudinal muscle - submucosa - mucosal epithelium.

6. Which of the following is NOT a function of the pancreas?

    (a) production of digestive enzymes.

    (b) production of an alkaline solution.

    (c) production of hormone insulin.

    (d) production of bile.

7. Which of the following statements is WRONG regarding the stomach?

    (a) It is the major seat of digestion in the body.

    (b) Its contents are acidic.

    (c) It is covered on the inside by a mucous secretion.

    (d) In a rat it is divided into two distinct regions.

8. Which cells produce mucus?

    a) goblet cells.

    b) chief cells.

    c) β-cells.

    d) mast cells.

9. Where is bile produced in the body?

    a) spleen.

    b) colon.

    c) liver.

    d) kidneys.

10. What is the main physiological process in the colon?

    a) absorption of water.

    b) digestion of fat.

    c) control of peristalsis.

    d) secretion of pepsin.

**Assignment:** (worth 5% of the total marks for this module)
To be completed in your own time and handed in while you are in the lab in week 21. Marks will normally only be credited to you if you hand this assignment in on time. Detach it from the lab schedule (via the perforations) and hand it in to your demonstrator, who will assess and return it by the end of week 23. A model answer will then be posted in the Biology Teaching centre.

## A) FUNCTIONS OF THE ORGANS

Denote the function(s) of each organ by writing one or more of the letters indicating function in the spaces provided. (Each letter corresponds to the function of only one organ; i.e. each letter should be used only once).

**Organ**

1. Liver __________
2. Stomach __________
3. Spleen __________
4. Kidneys __________
5 Small intestine __________
6. Large intestine (i.e. caecum, colon and rectum)__________
7. Pancreas __________

**Function** *

a) secretes insulin and glucagon into blood
b) produces urine
c) absorbs products of digestion
d) stores glycogen
e) absorbs water from the gut
f) breaks proteins into peptides
g) stores blood and produces antibodies
h) secretes alkaline fluid and digestive enzymes into the duodenum
i) stores food
j) digests proteins, carbohydrates & fats
k) produces bile
l) regulates body fluids
m) regulates glucose, lipid and amino-acid level in blood

* Note: These organs may have functions in addition to the ones listed.

## B) INTESTINAL SURFACE AREA

Total intestinal surface is greatly increased by the formation of finger- like projections - the villi, and the presence at the apex of each lining cell of a battery of tiny projections, the microvilli. In mammals, microvilli are about 1.5 μm long and 100 nm in diameter. The diameter of an intestinal absorptive cell is about 5 μm.

(i) Assuming microvilli and absorptive cells are essentially flat-topped cylinders, and that the microvilli are close-packed with no wasted space, work out by how much microvilli alone increase intestinal surface area.

(ii) How realistic are these assumptions (answer in 2-3 sentences at most)?

You must show all the calculations that underlie your answer. If you show no working, no marks will be awarded, even if the answer you give is correct. Use the page overleaf for your answers.

STUDENT NAME ________________ MATRICULATION NO. __________
DAY Tu/W/Th/F TIME am/pm LAB 712/717 SEAT NO.______

[Page for calculations/answer to part (i) and answer to part (ii)].

# HUMAN ENERGY METABOLISM

## Aim

- The aim of this project is to investigate the flow of energy through your body. You will measure the energy content of your food, your daily energy expenditure and the amount of energy you keep stored inside you as fat. This is described by the equation:

**Energy Intake = Work Done + Heat Produced + Energy Stored**

## Objectives

- Understand what is meant by Basal Metabolic Rate (BMR), Resting Energy Expenditure (REE), Total Energy Expenditure (TEE), Body Mass Index (BMI) and energy stored.
- Appreciate the relationship between them.
- Have some idea of the ranges of values of BMI.
- Account for why different people might have different values for each of these measurements.
- Read the article 'Don't blame the metabolism' by Dr Andrew Prentice from the Medical Research Council News of Autumn 1995 (No. 68). NB. Copy enclosed with this lab schedule.
- Produce a report of your practical work.

## Plan of project

There are five distinct parts to this project: a briefing tutorial, data that you gather in your own time, a laboratory session, a discussion, and the writing-up of the project for assessment.

## Section A

## The briefing tutorial

### Background: the human body as a machine

A useful approach to studying the physiology of the body is to think of it as a machine or engine. This approach has been developed by Knut Schmidt-Nielsen and is set out in his book on **Animal Physiology**, published by Cambridge University Press (University Library Catalogue No. Physiology A8-1970S). Think of your body as an engine. Its energy comes from its tank of petrol (= food intake) which is used to provide the power to drive the wheels. No engine is one hundred per cent efficient so some energy from the fuel (or food) is lost as heat; working engines get hot. When the engine stops, spare fuel remains in the petrol tank or, as in our case, is stored in the body. This analogy may help you understand the significance of the equation which forms the basis of the project.

Energy in our food is locked in the chemical bonds holding molecules together. The bonds between glucose molecules contain the energy in starch. When these bonds are broken - invariably through enzyme action - energy is released.

Energy is measured by physiologists in terms of either heat produced (calories) or work done (joules).
A kilocalorie (kcal = Calorie) is the amount of heat required to raise the temperature of 1 kg of water by 1$^{o}$C (usually starting at 16$^{o}$C).

A joule (J) is the amount of energy expended when 1 kg is moved a distance of 1 m by a force of 1 Newton.

1 kcal = 4184 J = 4.2 kJ

**Definitions: Energy Metabolism is the overall use of chemical energy.**

- Basal Metabolic Rate (BMR) is the amount of energy needed to support basal metabolic processes (e.g. kidney function, tissue repair, resting heart beat) per unit time (usually 24 h).
- Resting Energy Expenditure (REE) is the amount of energy used at rest.
- Metabolism is the series of processes by which energy is released from nutrients in the body.
- Metabolic Rate (MR) is the energy metabolism per unit time (often measured as oxygen consumption).
- Total Energy Expenditure (TEE) is the amount of energy used (= work done [including underlying BMR] + heat produced).
- Body Mass Index (BMI) provides a useful measure of health. It is calculated by dividing the subject's weight in kg by the subject's height in m squared; i.e.wt/ht$^2$.

The values obtained for the BMI are usually interpreted as follows:

| | |
|---|---|
| < 20 | underweight |
| 20-25 | healthy |
| 26-30 | overweight |
| > 30 | possible obese |

though their full interpretation depends on many factors including age, sex, physiological condition and so on.

**Organisation:**

**Teams**

In this project it is necessary to work in teams (3 per laboratory). The group seated round one laboratory bench is an appropriate size for the team (c.16 students), though some adjustment may be necessary to give even numbers of both males and females.

**Diaries**

Find the Food and Activity diaries. Establish how to complete these. Remember the accuracy of the original data is critically important to the success of the experiment. Decide when you will complete the diaries.

## Section B

## Food and activity diaries

### Food diary

You should accurately record in the tables provided (pink pages) everything you eat and drink in a 48 hour period. Try and choose a period that is typical of your normal eating pattern. List the items you eat in the first column and the approximate amounts in the second column. Great care and personal honesty is needed to ensure that an accurate record is kept of everything that is eaten or drunk.

### Activity diary

You should accurately record in the tables provided (pink pages) **all** the activities you undertake over the same 48 hour period as the food diary. Fill in the first three columns before the lab. Account for the full period.

### Preparation for the laboratory session.

- Remember to bring your food and activity diaries when you come to the laboratory class.
- Wear clothing which will allow easy access to the sites of skinfold thickness on the upper arm and abdomen.
- Bring a calculator.

**FOOD DIARY**

Name:

Date: Sex: Weight: kg

| | Food/drink consumed | Portion small/med/large | Amount (g) | Energy Content (kcal/100g) | Total Energy Content (kcal) |
|---|---|---|---|---|---|
| Breakfast | | | | | |
| Lunch | | | | | |
| Tea | | | | | |
| Supper | | | | | |
| Extra snacks | | | | | |

**FOOD DIARY**

Subject:

Date: Sex: Weight: kg

| | Food/drink consumed | Portion small/med/large | Amount (g) | Energy Content (kcal/100g) | Total Energy Content (kcal) |
|---|---|---|---|---|---|
| Breakfast | | | | | |
| Lunch | | | | | |
| Tea | | | | | |
| Supper | | | | | |
| Extra snacks | | | | | |

**ACTIVITY DIARY**

Date:

| Time of day | Activity | Duration (hours) | Activity factor | Duration x activity factor |
|---|---|---|---|---|

**ACTIVITY DIARY**

Date:

| Time of day | Activity | Duration (hours) | Activity factor | Duration x activity factor |
|---|---|---|---|---|

## Section C

## Laboratory

### Todays activities

- Calculation of daily energy intake from food diary.
- Calculation of Resting Energy Expenditure (REE) by measuring oxygen consumption using a spirometer.
- Calculation of daily Total Energy Expenditure (TEE) from activity diary.
- Measurement of skin folds with calipers in order to estimate body fat content.
- Measurement of height and weight and calculation of Body Mass Index (BMI).
- Collection of team data by entry into the spreadsheets on the computers in 716.

### 1. Calculation of energy intake from your food diary

Select a 24 hour period from your food diary and use the tables of the energy equivalence of the various foods provided in the laboratory to fill in columns 4 and 5 of the selected 24 hr period of your Food diary. Calculate your total energy intake for the 24 hr period.

Total energy intake per 24 hours: _______kcal.

Weigh yourself on the laboratory scales. Remove your shoes before weighing and then subtract 1kg to allow for your clothing.

Body weight: _______kg

Divide your energy intake by your weight to give your energy intake/kg.

Total energy intake per 24 hr/body weight: _______kcal per kg per day.

This value represents the first term (Energy Intake) in our initial equation. When you have completed the calculation, add your values to the class record. This will provide information about the range of daily energy intake.

SPACE FOR CALCULATIONS

**2. Calculation of energy expenditure from your activity diary**

Select the same 24 period used for the food diary. Use the charts provided in the laboratory to complete columns 4 and 5 of the selected 24 hr period of your activity diary by including the activity factor and calculating the amount of energy expended as the product of duration and activity factor. The values in this right hand column (duration x activity factor) over the 24 hour period can now be added up and divided by 24 to give an average daily activity factor.

Average daily activity factor ________

SPACE FOR CALCULATIONS

**3. Resting energy expenditure**

A true basal metabolic rate (BMR) can only be measured during absolute relaxation since it is the absolute minimum energy expenditure compatible with life i.e. minimum cardiac, renal, nervous system function etc. This is impossible to achieve in a student laboratory. Consequently, you will measure resting energy expenditure (REE), which is slightly greater. This is not the true minimum value of a BMR but is the equivalent measurement during resting conditions.

REE can be calculated from the volume of oxygen taken up by the body per unit time. All metabolic activity ultimately involves the utilisation of oxygen so oxygen consumption can be converted to energy expenditure. Each litre of oxygen consumed produces 4.8 kcal of energy.

Oxygen consumption can be measured directly when a subject breathes from a spirometer containing a known volume. The carbon dioxide produced is removed so the volume of gas declines progressively as it is consumed by the subject. Your subject should sit quietly wearing a noseclip and breathe through the mouthpiece from the spirometer. Note the initial volume of oxygen in the spirometer. Breathe from it for 10 minutes. Remember to start and stop at the same point in your subjects respiratory cycle; eg. begin by inspiring from the spirometer and end by expiring into the spirometer. Note the final volume. Divide the total consumption by the duration to obtain an average consumption per minute.

Weight of Subject = ______kg

Starting Volume = ______
Final Volume = ______
Oxygen Consumed = ______

Time taken: = ______

Resting oxygen consumption (Oxygen consumed in litres divided by time in minutes)
= ______l/min

Resting energy expenditure (Oxygen consumption per min multiplied by 4.8)
=.____________ kcal per minute
=.____________ kcal per hour
=.____________ kcal per day

Enter the value you obtain for daily REE onto the table on the board.

**4. Total energy expenditure**

Now calculate your daily Total Energy Expenditure (TEE) in kcals by multiplying your Resting Energy Expenditure (REE) by the average daily activity factor from your activity diary. This represents the work done component of the formula on the first page.

Daily TEE = REE (per day) x Activity Factor (average daily)

__________ kcal/day

Divide this by your weight to obtain a value of TEE per kg per day.

TEE = __________ kcal/kg/day

This value represents the second and third terms (Work Done + Heat Produced) in our initial equation.

**5. Energy stored calculated from your fat content**

Body fat content represents the final term (Energy Stored) in the initial equation. However, whereas the first three terms of the equation have been calculated on a daily basis (kcal per kg per day), the energy stored can only be measured on a much longer term basis (as the amount of energy you have stored in your lifetime). If energy intake exceeds the expenditure then the excess is stored as fat. Any deficit reduces the quantity of fat stored. Body fat content is difficult to measure directly but an estimate can be made by measuring skin fold thickness with calipers at four standard sites. The thickness of skin is known and so the thickness of the fold minus skin thickness gives an estimate of the layer of fat.

**Skinfold Thickness**

Use the leaflet in the laboratory to help you identify the sites where measurements will be made. Take 3 measurements from each of the 4 sites mentioned (biceps, triceps, suprailliac, subscapular) and note them in the table below. Take your measurements quickly to avoid discomforting the subject. Calculate the mean of each of these 3 measurements and note it in the table.

Sex of Subject ________ Age of Subject __________.

Skinfold thickness (mm)

| | 1. | 2. | 3. | MEAN |
|---|---|---|---|---|
| Biceps | ______ | ______ | ______ | ______ |
| Triceps | ______ | ______ | ______ | ______ |
| Suprailliac | ______ | ______ | ______ | ______ |
| Subscapular | ______ | ______ | ______ | ______ |
| TOTAL | | | | ______ |

Use the total to estimate the percent of body fat from the table provided in the leaflet.

% Fat _______ Body weight _______kg Fat _______kg

Enter these values into the group data chart on team computer in Room 716.

### 6. Body mass index

The Body Mass Index (BMI) is a useful indicator of body composition and of energy stored. This is calculated by dividing the body mass in kilos by the height in metres squared. The BMI is often used clinically to estimate levels of obesity. For example, for someone who weighs 70 kg and is 1.7m tall, the BMI is 70/(1.7x1.7)=24.2 kg/m$^2$

Now calculate your own BMI

weight _______kg height _______m height$^2$ _______m$^2$

Therefore my BMI is _______kg/m$^2$

Use the Table on page 2.2 to interpret what this value means. Record your values on the computer in Room 716.

### 7. Analysis

**Group data to be collected**

MALES

| Energy intake per day per kg | Energy Expenditure per day | % Body Fat | BMI | |
|---|---|---|---|---|
| | | | | 1 |
| | | | | 2 |
| | | | | 3 |
| | | | | 4 |
| | | | | 5 |
| | | | | 6 |
| | | | | 7 |
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| | | | | 11 |
| | | | | 12 |
| | | | | 13 |
| | | | | 14 |
| | | | | 15 |
| | | | | 16 |

MEAN VALUES

| | | | |
|---|---|---|---|
| | | | |

FEMALES

| Energy intake per day per kg | Energy Expenditure per day | % Body Fat | BMI |
|---|---|---|---|
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MEAN VALUES

| | | | |
|---|---|---|---|
| | | | |

## Section D

## Discussion

At the end of the laboratory work there will be a discussion of the results that have been obtained by the whole class. Here are some points you may wish to consider.

1. Can you relate the measurements you have made to the equation:
   Energy Intake = Work Done + Heat Produced + Energy Stored

2. How reliable are the measurements made and the calculations performed?

3. In the light of the information you have obtained from lectures, from reading and from this laboratory:-
   a. Do you consider your diet is balanced in terms of energy intake?
   b. What is the healthiest way to consume your required energy?
   c. If your BMI lies outside the healthy range of body mass index, what steps should you consider taking to get back into the healthy range?

USE THE REST OF THIS PAGE TO MAKE NOTES ABOUT THIS DISCUSSION.

## Section E

## Laboratory report

You are required to submit a written report on this laboratory. It is worth 15% of the total marks for this module. It should be handed in during your normal laboratory time in week 19. It will be handed back to you after the Easter Vacation. The report should have a title and each page should have your name, matriculation number, laboratory number and laboratory time at the top. The report should include the following sections:

**Introduction** This should include the aims of the experiment and a general introduction. (100 words maximum)

**Methods** This can refer back to the schedule, but you should describe in detail any additional methods or where your methods differed from those described in the schedule. (250 words maximum)

**Results** You should describe your results in words and refer back to your actual data. The results should be illustrated by tables and graphs and include the group data. You should include your calculated results, but not all your raw data.

**Discussion & Conclusions** You should state what you can conclude from your results and relate your findings to the general concepts of energy metabolism. (250 words maximum)

Your report should be written in good English and in your own words; it should not just reproduce sections of the schedule. It does not need to word processed, but must of course be legible.

**Objective questions:**

These questions are to allow you practice in the kind of multiple choice question we will set you in your examinations. They are not part of the continuous assessment component of the module. For answers, see the last page of this laboratory handbook.

**True/False** (circle the correct answer)

1. Energy intake must balance energy expenditure in any 24 hour period. True/False
2. Adult males and females have a similar average fat content. True/False
3. Average daily energy expenditure is similar in males and females. True/False
4. Underweight adults tend to have higher resting metabolic rates. True/False
5. There is a tendency for body weight to increase progressively with age. True/False
6. Regular exercise must lead to reduction in body weight. True/False
7. Walking at a moderate pace more than doubles the resting energy expenditure. True/False

**Multiple choice** (only one correct answer per question)

8. Which of the following activities increases energy expenditure to at least 4 times the resting rate?
   (a) walking at a moderate speed.
   (b) swimming at a moderate speed.
   (c) both of the above.
   (d) writing a lab report.

9. Jogging at a moderate rate uses 550 kcal/hour. How many hours jogging uses up the energy equivalent of 1 kg of fat?
   (a) about 15 minutes.
   (b) about 1.5 hours.
   (c) about 15 hours
   (d) about 1.5 days.

10. If you consume an excess energy intake of 100 kcals/day, then after 1 year your body weight will have increased by
   (a) about 100g.
   (b) about 1kg.
   (c) about 10kg.
   (d) about 10g.

11. If you adjust your diet to be in energy deficit by 500 kcalories/day, how many kilos of fat will you consume after 1 month?
    (a) about 1kg.
    (b) about 5kg.
    (c) about 10kg.
    (d) none.

12. Clinically obese individuals have body mass indices which
    (a) are less than 25.
    (b) lie between 20 and 35.
    (c) lie between 25 and 30.
    (d) exceed 30.

13. Energy expenditure can be calculated indirectly from oxygen consumption. Consumption of 1 litre of oxygen is equivalent to an energy expenditure of
    (a) 4.8 kcal.
    (b) 4.8 kjoules.
    (c) 4.8 cal.
    (d) 4.8 joules.

14. The principal site of energy storage is
    (a) glycogen in skeletal muscle.
    (b) blood sugar.
    (c) adipose tissue.
    (d) glycogen in the liver.

15. When estimating the fat content of the body using skinfold measurements
    (a) the skin thickness is unimportant.
    (b) the average fold thickness at 4 standard sites bears a constant relationship to total fat content.
    (c) the only important sites of fat deposition lie at the sites measured.
    (d) one should squeeze the calipers as hard as possible.