AN EVALUATION STUDY OF THE TEACHING AND LEARNING IN A UNIVERSITY HUMAN PHYSIOLOGY LABORATORY

by

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In partial fulfilment of the requirements for the degree of Doctor of Philosophy, University of Surrey, 1980
TO MY MOTHER
ABSTRACT

This evaluation study is concerned with the 'unexpected outcomes of the teaching and learning processes of a university human physiology laboratory course. From a comprehensive 'general' evaluation of the students' perceptions of the course as determined by field studies, interviews and a questionnaire there emerged several important issues concerning the teaching and learning in the laboratory. Each of these issues was studied in detail.

Issue One is the role of the video-tapes which are used for teaching the laboratory work. The students' attitudes to being taught by video are described and analysed; this information is employed in the production of a 'research' video-tape which was used for teaching in the laboratory. An evaluation of this tape gave rise to an evaluation tool for analysing future video-tapes.

Issue two is the relation between the lab course and the other components of the students' degree course. The lab course is construed in a positive way and is thought to be a major influence on the students' overall degree course.

The third issue is a consideration of the role of the lab course in the students' university education. The students' attitudes to university aims before and after the lab course is established, and an analysis of the role which they retrospectively thought the course played in the change in attitudes is given.

The final concern - issue four - is the development of a taxonomy for defining objectives in the perceptual motor domain. Existing taxonomies are discussed and an analysis of the principles underlying taxonomies is given. A composite taxonomy is then offered for consideration along
ACKNOWLEDGEMENTS

My grateful thanks are due to the following:

Professor Lewis Elton and Dr Roger Howland for supervising the research.

The academic and technical staff of the University of Surrey human physiology laboratory.

The many students who took the laboratory course and who were so willing to take part in the research and who gave so generously of their thoughts and time.

Dr Malcolm Parlett for invaluable advice, and Ms Nita Spektorov who was a source of inspiration during the video-tape productions.

Garry Dearden, Vivien Hodgson and Diana Laurillard.

Dr Trevor Bryant for advice on the cluster analysis, and the staff of the University of Surrey computing unit.

Dr Gaye Manwaring for commenting on chapter six.

Ed Garrison for support while I was working in Perth, Western Australia.

Sid O'Connell for reasoned discussions.

Gladys Stevens, Sue Lethbridge, Mickie Fortuna and Jan for typing the manuscript and the Leverhulme Trust for generous financial support.
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INTRODUCTION
0 Introduction

0.1 Thesis Problem

An evaluation study of the teaching and learning in the human physiology laboratory at the University of Surrey.

Background

Initially, the study was centred around two aims: (1) improving the teaching of practical skills in the laboratory, and (2) devising means of assessing students learning of these skills.

It was originally intended to develop a taxonomy for defining objectives in the psychomotor domain as a method of achieving these two aims. The taxonomy was to be derived through a study of existing video-tapes used for teaching in the laboratory, and would then be used in the preparation of further tapes. Existing taxonomies would form the basis for the development of the new taxonomy.

However, early experiences in the laboratory indicated that this original research strategy was not necessarily the only way, nor indeed the best way, of achieving the two project aims. It became clear that concentrating only on the development of the taxonomy might in fact not be the most appropriate strategy to pursue.

This became evident in the early stages of the field work (Chapters 2 & 3) when it emerged that there was considerable discontent with the functioning of the laboratory. The format and teaching
effectiveness of the video-tapes used for teaching the laboratory work (from which the taxonomy was to be developed) was being questioned, particularly by the students - the role of the laboratory reports was unclear - the general teaching philosophy employed in the laboratory was under criticism.

This discontent and general questioning suggested that it would not be sensible to derive a taxonomy from what appeared to be a badly functioning system. Instead, it was agreed that a study which would look at the general teaching and learning in the laboratory, as well as going some way toward proposing a taxonomy based on existing ones, would serve to meet the two aims outlined above: the teaching in the laboratory would hopefully be improved, and there would still be a taxonomy for use in improving the assessment techniques, albeit one which would need to be tried out and improved with use.

It was therefore decided that the outcome of the thesis would mainly be in terms of the thesis problem outlined above along with a proposed taxonomy developed from existing ones which would be offered for consideration.

0.2 Outline of the Thesis

The study is in two stages:

Stage I

Stage I of the study comprising Chapters 1, 2 & 3 commences with a discussion of the general methodology employed and a review of
literature on laboratory work. A description of the early days in the field follows, and is followed in turn by a general appraisal of the teaching and learning in the laboratory.

Chapter 1: The general methodology of the study - based on Illuminative evaluation strategies - is discussed. A short description of the physiology laboratory course is followed by a review of the literature on laboratory work. The chapter concludes by pointing out the innovatory research approach adopted in this study.

Chapter 2: This chapter provides some necessary background to the main parts of the study: it describes the early days of field work when most of the time was spent observing, taking notes, involving participants in informal discussions, taking part in experiments, and so on. This is interlinked with a discussion of the related literature on carrying out field work.

Chapter 3: Considers the general aspects of the teaching and learning in the laboratory. The results of interviews and a questionnaire about the laboratory provide the background data for the formulation of hypotheses about certain emerging issues concerning the teaching and learning in the laboratory. These issues are considered in detail in Stage II of the study.

Stage II

Stage II of the study, comprising Chapters 4, 5, 6, 7 & 8, focusses on the analysis of the issues arising from Stage I of the study.
Chapter 4 : Issue 1, is concerned with the role of the videotapes in the laboratory course. A detailed analysis of a sample of videotapes is followed by a description of the systematic production and evaluation of a "research" videotape; the impact of this videotape on the student is discussed and a tool for the evaluation of other tapes is offered for consideration. The effectiveness of the laboratory instructions schedule accompanying videotapes is discussed, and the visual impact of the videotapes is explored.

Chapter 5 : Issue 2. The ways in which the students view the laboratory course compared with the other parts of their degree course is explored.

Chapter 6 : Issue 3. This chapter looks at the broader educational role of the laboratory course: the effects of the laboratory course on the students' views of their general university education is focussed upon.

Chapter 7 : Issue 4. The Taxonomy. Existing taxonomies for categorising objectives in the psychomotor domain are looked at and some misgivings about their appropriateness for use in the physiology laboratory are pointed out. A composite taxonomy is proposed with an example of its use.

Chapter 8 : This chapter attempts to pull the various outcomes of the investigations of the earlier chapters together. An interpretation of the meaning of the outcomes of the study in relation to the teaching and learning of the laboratory course is offered.
CHAPTER 1

THE METHODOLOGY AND LITERATURE REVIEW ON LABORATORY WORK
1.1 Illuminative Evaluation Studies

The underlying considerations which have determined the methodological style of the study are those of illuminative evaluation (Parlett & Hamilton 1972). Illuminative studies incorporate methodologies which take account of the complexity of teaching and learning; as a study develops the issues of importance and relevance to the learning milieu emerge and can be considered at length. Often as not, the teachers and students being studied are unaware of these issues and of their significance in the teaching and learning process of which they are part; the strength of these studies lies in the fact that they try to illuminate these issues.

The illuminative approach has five characteristics:

"(a) It is **problem-centred** - beginning (as all applied research does) with issues and concerns as defined in real life settings;

(b) It is **practitioner-oriented** - designating its chief function to provide information and insight for professional educators;

(c) It is **cross-disciplinary** - drawing especially on psychology, sociology, psychiatry and social anthropology for concepts and ways of thinking;

(d) It is **methodologically-selective** - interviews, questionnaires, observation and analysis of documents are used in various combinations, according to the circumstances, defined problems, and stages of the investigation;
(e) It is heuristically organised - the researchers progressively focusing and redefining the areas of inquiry as the study unfolds, in the light of accumulating experience and as the crucial issues-to-be-studied become uncovered."

(taken from Miller & Parlett 1974).

These characteristics make illuminative studies flexible and responsive - they respond to the phenomena of the situations being explored. Illuminative studies generally graduate through five steps* (Parlett 1974). The relationship of these steps to the structure of the present study is indicated below:

Step 1: Setting up the Evaluation, when questions such as "Who is it for?", and "What will I do?" are asked.
Step 2: Open-ended Explorations, the researcher becomes familiar with the situation being studied by staying in it.
Step 3: Focussed Enquiries, general trends are focussed on; there may of course be several iterations of this stage, depending on the individual inquiry.
Step 4: Interpretations, the data is organised and interpreted; details are filled in.
Step 5: Reporting the Study, the report is geared towards the audience and readers.

At some point in an illuminative study the research will pass through each of these stages; there is often considerable flow from one stage to another, back and forth as hypotheses are generated, tried out and produce new hypotheses which in their turn are explored. The concern

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* Parlett calls these "stages"; I call them "steps" so as not to confuse them with the use of the word stage to describe the progress of my research.
is to explore what are termed "emerging issues" and indicate their relevance to the teaching and learning milieu being studied. As it is pointed out in the original paper (Parlett & Hamilton 1972), illuminative studies are not ideologically or methodologically bound by the restrictions and constraints often imposed by the agricultural-botany research paradigm.

I do not intend to provide an analysis of the pros and cons of illuminative evaluation strategies compared with other research strategies: this has been done elsewhere (e.g. see Parlett and Hamilton 1972; Parlett 1972; Hamilton et al 1974; Dearden 1979). The need for studies of this nature, which provide "interpretations in context", has been voiced by others (e.g. see Cronbach 1975; Stake 1967; Dearden 1979).

However, it will be useful to single out several articles which, in their way, present the very essence of illuminative studies. Possibly, the most comprehensive example is that of Miller and Parlett (1979) which is a major study of the examination process at one university. Pocklington and Jamison (1974) describe a study of educational provision for blind and partially sighted children in which the research design continually evolved as the study progressed. They comment that: "... the heuristic nature of illuminative study means that the problems under investigation define the methods to be used, and an expanding knowledge base defines the appropriate research design".

This is very much the case with the present study, as I shall indicate later.
Dearden and Laurillard (1977) provide an illustration of the concept of progressive focusing in the evaluation of a medical school program, and Parlett and King (1971) describe an innovation termed "concentrated study" which was evaluated in the illuminative style.

1.12 Other considerations

This study is heavily influenced by at least two other conceptual research strategies, both of which are compatible with the general philosophy of Illuminative studies. They are the case study and the idiographic research approach.

Case Study

The case study method shares much in common with the methodological consideration implied in illuminative evaluation. It is concerned very much with the teachers' and students' viewpoints of curriculum problems: "Case study research attempts to reach understanding through the detailed study and portrayal of individual instances, persons, ideas, institutions and events" (Adelman & Walker 1975, p.224).

Of the case itself, Stake (1976) points out: "The case need not be a person or enterprise. It can be whatever "bounded system" (to use Louis Smith's term) is of interest. An institution, a program, a responsibility, a collection, or a population can be the case. This is not to trivialize the notion of "case" but to note the generality of the case study method ..." (p.7).
Such attitudes often blind the researcher to the need for flexibility in educational research methodologies. Talking of case study methodology, Adelman & Walker (1975) point out:

"The advantage of such an approach for our purposes is that it contains considerable flexibility, allowing the researcher to move from one hypothesis to another throughout the period of research. This freedom of movement is essential to an enquiry which aspires to be genuinely exploratory, and which makes few claims for highly generalizable findings". (p.229).

This moving-from-one-hypothesis-to-another is similar to the initial, exploratory stages of an illuminative study where the researcher is assessing the knowledge she is accumulating, a process leading to progressive focussing onto emerging issues. This is particularly so in the present study: I spend most of the first chapter portraying the teaching and learning process of the physiology laboratory and in continually forming hypotheses on the basis of initial explorations in the laboratory. This leads onto the definition of significant issues which, having emerged from my experiences of participating in the laboratory and from the knowledge thus gained, are in turn given consideration as research problems worthy of analysis, in keeping with the considerations of both illuminative studies and case-studies.

Some examples of case studies are Parlett and Simons 1976; Simons and Parlett 1976; the case studies described in Studies in Laboratory Innovation published by the Nuffield Foundation and the Portrayal of a Science Curriculum (Kelly et al 1977).
Another aspect of this study is the way in which I often focus on the intensive study of individual students, especially in the investigations described in chapters 3, 4 and 5. This approach, termed idiographic, is advocated as a viable and useful research strategy by Stephen Kemmis (1978) (although it was the earlier 1976 version of this paper which initially influenced me). Such approaches have, of course, been used extensively in psychiatry; George Kelly's theory of personal constructs (Kelly 1955) is derived in part from his studies of individual patients. (I shall return to Kelly's work and methodology in chapter 5).

Idiographic approaches are part and parcel of the illuminative study approach: an examination of illuminative studies will show that the intensive study of individuals is extensively employed (e.g. see Miller & Parlett 1974; Parlett & King 1971; Parlett & Simons 1976; Simons & Parlett 1976). The intensive study of individuals in learning situations provides the researcher with a mass of qualitatively rich data (e.g. see Snyder 1971); data which is grounded in the learning phenomena of the situation being studied and which, as the above mentioned studies indicate, provide the architects of the various learning contexts with specific information about their ongoing effects on the students involved.

1.2 The Physiology Laboratory Course

Before describing the early stages of the research, some background
information about the laboratory course in necessary.

The physiology laboratory course is part of the degree course of students studying human biology, nutrition and biochemistry. Along with a theory course of lectures, the laboratory course runs for three terms from the middle of the students' first year to the middle of their second year. There is one laboratory class each week lasting 3 hours, and the students are required to write a laboratory report on this which is handed in for assessment, the grade counting towards their overall Part I grading (9%).

More than one hundred students split into two classes attend the physiology laboratory each week; because of this and because of the high cost of physiological equipment, a 'circus' system of teaching is used in which five experiments are run at the same time in each half of a term, so that ten experiments are available during each of the three terms; by rotating round the laboratory, each student will complete ten experiments in each term.

When it was introduced this circus system placed a heavy burden of teaching on the laboratory demonstrators who had to introduce the students to each experiment twice a week for five weeks at a time. The repetition often led to inconsistencies in what was taught from week to week; to overcome this, a method of presenting the introductory material in a recorded form was devised.

Videotaped introductions were thought to be the most suitable medium for conveying both the conceptual and manipulative material to be taught to the students. This standardised introduction would give
uniformly consistent teaching to the students by the academic staff. As one of the architects of the scheme professed in its early stages:

"... academic staff will determine in toto the material taught in the laboratory, the students will benefit from having experimental work explained by academic specialists, from the enriched content of the teaching, and from clear, unambiguous and consistent explanations of their laboratory work". (Howland 1975).

In the early stages of using the videotapes for teaching, only two of the five experiments were introduced in this way; the students viewed the tape in a room adjoining the laboratory, moving into the laboratory to carry out the practical work. A demonstrator was available to answer questions if the students required.

This system proved acceptable to the majority of students, with the proviso that the videotapes should not take over completely from live explanations and that a demonstrator should always be available to answer questions after watching the tape (Howland 1975). The students considered the clear demonstrations and special media techniques beneficial to learning.

1.21 The Present Laboratory System

Teaching in the physiology laboratory is now done completely by videotaped introductions to the practical work. The laboratory is equipped with a distribution system capable of showing five videotapes
simultaneously to groups of up to sixteen students. Two students view a nine inch monitor and each student has a headset with variable volume control. A demonstrator is available throughout each class.

The videotapes are all prepared in advance of the laboratory classes in the University's TV studios; they are presented by academic specialists and are produced by a professional TV producer who is a member of the University's Audio Visual Aids Department. They are in monochrome and generally last for between twenty-five to thirty-five minutes (some are a little longer).

Each tape has four connected sections:

1. A statement of the aims of the experiment.
2. A theory introduction to the practical work.
3. A demonstration of the practical work.
4. Questions.

The bulk of the tape is taken up by the theory introduction and the demonstrations (copies of each tape are lodged in the University library for students' viewing, if required, before or after each laboratory class).

The students view each tape in the laboratory immediately prior to carrying out the laboratory practical work. They are guided in carrying out the work by a structured laboratory manual (called a laboratory schedule) which accompanies each tape; these schedules contain a condensed version of the taped program and also pose
questions which the students have to answer in the spaces provided. The students are required to follow the instructions in the schedule in order to perform the set practical work; each practical class is designed to illustrate and amplify the theory taught in the lectures. This "integrated" approach ensures that every student completes every practical in more or less the same way. There are no "open-ended" classes.

Laboratory technicians set out all the necessary equipment, apparatus, solutions and so on required for the practical work before the students arrive in the laboratory. The students usually work in pairs, but sometimes in groups if necessary. Each student is required to complete the laboratory work and to answer the questions posed in the laboratory schedule, which is handed in each week for assessment.

1.3 Literature Review of Laboratory Work

This review of the literature on laboratory courses and teaching is concerned mainly with pointing out what the present areas of concern in this field of educational research are; one reason for doing this is to highlight the innovatory research approach adopted in the present study.

Research into science laboratory work can be considered from two perspectives, viz (i) the aims of laboratory courses and (ii) innovations and trends in laboratory teaching.

1.3.1 The aims of laboratory work

The Hale Report (HMSO 1964) in a sense set the trend for investigating
and discussing the aims of experimental work in science undergraduate laboratories. Five main aims were considered necessary in laboratory teaching, centering around training the student in manipulative skills, techniques of report writing and the design of experiments; laboratory work was also deemed necessary for emphasising points from lectures.

Lee (1969; 1970) surveyed the opinions of students who had completed their degree course on the aims of laboratory work in mechanical engineering. Rather than emphasising the training aspects of such work (as the Hale Report did), the students included in the survey were concerned more with laboratory work having been a stimulant to their thinking and independence in learning and with it helping them understand the need for communication of results, say to management for action.

Chambers (1964; 1966; 1972) surveyed the opinions of physics teachers in 35 institutions of higher education about their attitudes to the aims of laboratory work; the most important outcome of this was that the fostering of critical awareness was considered to be the most important aim of the laboratory work. Chambers argues that because of this, laboratory work is just as important as theory teaching not just from a vocational viewpoint but from a purely educational standpoint also.

Adamson and Mercer (1970) suggest that the development of an understanding of the experimental approach is the main aim of introductory biology laboratory work. When lectures and laboratory classes are related, then the laboratory work often acts as
reinforcement to the lectures.

Smithers and Hambler (1969) asked final year sandwich course biologists to rate their level of satisfaction with the achievement of some aims of industrial experiences. Forty-six students were questioned and the results are given in Table 1.1.

**TABLE 1.1** Levels of satisfaction with aspects of sandwich experience (as reported by Smithers and Hambler 1969).

<table>
<thead>
<tr>
<th>EXPERIENCE</th>
<th>% rating Good or Very Good</th>
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<tr>
<td>1. Design of experiments</td>
<td>56.5</td>
</tr>
<tr>
<td>2. Specialised techniques relevant to the final year</td>
<td>41.3</td>
</tr>
<tr>
<td>3. Execution of experimental work</td>
<td>80.4</td>
</tr>
<tr>
<td>4. Writing reports</td>
<td>50.0</td>
</tr>
<tr>
<td>5. Independent evaluation of results</td>
<td>52.2</td>
</tr>
<tr>
<td>6. Use of instruments not used in University</td>
<td>21.7</td>
</tr>
<tr>
<td>7. Consultation of papers</td>
<td>63.0</td>
</tr>
<tr>
<td>8. Interpretation of results with supervisor</td>
<td>67.4</td>
</tr>
</tbody>
</table>

Most of these experiences are ones which a student could, theoretically, gain through university laboratory work, but the quality of them seems to be higher when they are experienced in industry, and hence their effect on the student is probably consequently higher also.
In relation to the vocational aspects of biology courses, Broadbent (1974) lists eight aims of sandwich training. Two of these appear in Table 1.1, viz report writing and supplementing university work. The other six are:

1. To integrate theory and practice and thus reinforce learning.
2. To assist students to relate their academic work to its wider social context.
3. To increase knowledge of subjects not directly forming part of the degree course.
4. To gain insight into personal relationships in industrial and professional situations.
5. To promote the maturity and social adjustment of students.
6. To clarify and enhance career prospects.

Aims 4 and 5 are exceptional in being affective aims, ones which would probably not be considered a part of university laboratory work.

The most comprehensive analysis of the aims of science laboratory work is probably that of Tremlett (1972).

Tremlett surveyed the literature and conducted his own survey of staff and students' criticisms of chemistry laboratory courses and on the aims of laboratory courses. The findings of his survey clearly corroborated those of the literature up to that time. His findings are that:

1. There is considerable concern over the effectiveness of undergraduate laboratory courses.
2. Staff are not clear on the aims of laboratory courses. Tremlett comments:
"... faculty views not only did not agree on the same laboratory aims for comparable courses in different institutions, but that disagreement existed within the same institution and even between faculty teaching the same laboratory classes. There was also evidence to suggest marked differences of opinion about the relative importance of aims which are held in common". (p.30.)

3. Students and faculty aims for laboratory courses are not the same. This is indicated in Tables 1.2 and 1.3, which are taken from Tremlett.

Only three aims are held in common:

<table>
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<tr>
<th>Faculty rating</th>
<th>Student rating</th>
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<tr>
<td>1. Skill training</td>
<td>3</td>
</tr>
<tr>
<td>2. Illustrate and amplify lectures</td>
<td>2</td>
</tr>
<tr>
<td>3. Experimental understanding</td>
<td>5</td>
</tr>
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</table>

but the importance of these differs between the two groups. The students wish to use their initiative and originality while in the laboratory (Table 1.3), but as an aim, this is not even mentioned by faculty.

Tremlett points out that students are rarely told the aims of laboratory classes, a situation which obviously affects their attitudes to laboratory work.
TABLE 1.2  Faculty Aims of Laboratory Courses  
(from Tremlett 1972, p.38) (in order of frequency)

1. Develop manipulative, preparative and instrumental skills.

2. Illustrate and amplify the lecture material.

3. Stimulate thought through experimental interpretation.

4. Recognise the precision and limitations of laboratory work.

5. Record accurately and communicate results clearly.

6. Plan effective use of available laboratory resources.

7. Acquire experimental understanding.

8. Learn the use of chemical literature.

9. Show that experiment is the basis of theory.

10. Illustrate the use of experimentation as a process of discovery.

11. Develop observational skills.

12. Develop personal responsibility and reliability for experimentation.

13. Learn from making mistakes without penalty.

14. Give stimulation and a sense of achievement.

15. Give experience of working in a laboratory.

16. Measure typical physio-chemical constants.
<table>
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<th>Students' Aims of Laboratory Courses</th>
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<td>(from Tremlett 1972, p. 57) (in order of frequency)</td>
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1. Offer opportunities for initiative and originality in tackling chemical problems experimentally.

2. Illustrate and amplify the lecture material.

3. Develop manipulative, preparative and instrumental skills.

4. Opportunity for contact with faculty.

5. Acquire experimental understanding.

6. Study topics not covered in theoretical courses.

7. Plan effective use of laboratory time.
4. Because of (3) above, students fail to recognise the kind and quality of laboratory skills required.

5. Most laboratory courses are formal; the student has to follow instructions to get the "correct" results. There is minimal opportunity for thinking about the experiments.

6. The students clearly expressed a wish to have laboratory classes which allow them to show initiative and originality.

The amount of time spent in the laboratory was also criticised; most students in term three of their first year and throughout the second year spend between six and ten hours per week in the laboratory. The usefulness of this is not always clear; certainly the benefits to the students are questionable.

Tremlett also points out that procedures were never made clear to the students; there was never any explicit statement about what criteria are used to assess the students laboratory work and reports. As a consequence, students never knew what qualities they were expected to show during particular classes and which would form the basis of assessment.

Tremlett employed his findings in the systematic development of a chemistry laboratory course in which the definition of aims and objectives was a major aspect. Boud (1973) also used a set of aims to diagnose areas for course improvement in university science and engineering laboratory courses. His use of the Aims Questionnaire stemmed from the need to assess both staff and students' aims as a
way of pointing to disparity of the two groups' aims, leading to improving the course after discussing the reasons for the disparity. This is obviously a viable way of overcoming this problem, which was shown to exist by Tremlett (1972).

Summary

The research into the aims of laboratory work suggests that members of staff running the same laboratory course often do not share the same aims for the course, and that students' aims of laboratory work are usually at variance with their teacher's aims - often because the students were never told in the first place what aims their teachers were hoping to be achieved.

Sufficient research has now been conducted in this area to allow me in the present study to diverge slightly and examine the unexpected outcomes of the physiology laboratory course. This aspect of the study emerged as an important issue in the initial, exploratory stages of the work, as I shall explain in Chapter 2.

1.3.2 Some general trends in laboratory teaching

Boud et al (1979) distinguish eight possible innovatory approaches to laboratory teaching:

1. **Keller Plan of Personalized System of Instruction (PSI)**
   A course which students pursue at their own pace within broad limits. There are tests at frequent intervals which students have to master in order to proceed with the course, e.g.
see Keller 1968.

2. **Audio-Tutorial Method (A-T)**

A course run in segments usually of about one week's duration. Students study through a variety of educational media and hands on experience in a study carrell. The audio-tutorial method includes a range of learning methods; lecture, tutorial, individual study and theoretical and practical elements of a course are integrated within each part of the program, e.g. see Postlethwaite 1972; Carre 1969.

3. **Computer Assisted Learning (CAL)**

The use in the laboratory of computers as learning aids rather than as computational devices. Often computers are used to model or simulate situations of processes which are not available to be studied through direct experience for reason of cost, time or sophistication, e.g. see Laurillard 1977.

4. **Learning Aids Laboratory**

The use of a variety of audio-visual supplements to learning. It may be structured in many ways and is used for both laboratory and non-laboratory experiences. Through the use of media it is possible for phenomena to be studied that are not normally available or for study to take place at times scheduled by students, e.g. see Poller 1977; Ramsay 1973.
5. **Modular Laboratory**

A course composed of a program of coherent packages which may be assembled in various sequences, e.g. see Dowdeswell 1973.

6. **Integrated Laboratory**

Different disciplines of sub-disciplines are integrated in a common laboratory learning experience, e.g. see Howland 1975.

7. **Project Work**

A broad term covering a variety of more or less open-ended problem solving experiences, e.g. see Boud (197?).

8. **Participation in Research**

Students are involved in the research work of the faculty as part of the undergraduate program, e.g. see Boud 1979.

Within these categories, the physiology laboratory being investigated in the present study could be termed an Integrated Laboratory cum Learning Aids Laboratory since several subdisciplines of biology are integrated into the laboratory and because the students are taught by video-tape.

As well as these innovations there are some other trends which do not easily fit into the eight categories. Boud & O'Connell (1970) describe a self-service laboratory in which the students have to teach themselves.
Two types of experiments are mentioned, one termed the 'single purpose experiment' in which the student is directed in the performance of a single experiment designed to promote some cognitive aspect of learning; and the second, called an 'open-ended experiment' in which the student has a greater degree of control over what is done and has to show some initiative in carrying the work out: the aims behind this are both cognitive and affective.

Black et al (1968) describe an innovatory teaching and learning method in physics which requires groups of five students and one teacher to look at a problem or particular aspect in physics. The topic is discussed and any practical work involved is planned and prepared by the group as a whole, although individual students may have to write reports on the successful completion of the work. Unlike much of the practical work described by Tremlett (1972), the aims of this are to emphasise creativity, student initiative, self expression and so on.

O'Connell (1975) describes a laboratory course designed to promote independence in learning within the laboratory situation. This is a carefully planned experience stretching over the students' undergraduate career which aims at producing physicists who are sufficiently able to be independent in their practical work.

Johnstone (1979) describes a model for undergraduate practical work which, like O'Connell's, stretches over the students undergraduate career. The laboratory system is designed to introduce students to manipulative skills, by a variety of means, then require them to use these skills in the investigation of practical problems.
All of these approaches and trends are attempts at treating students as thinking, participating individuals, and in utilising external teaching media, such as videotapes, tape-slide packages, structured texts and so on, in an area of education which, traditionally, has suffered from a lack of inspiration and an over-emphasis on "cookery-book" teaching.

Summary

Some innovative trends in laboratory teaching indicate that university teachers are becoming interested in devising laboratory courses which treat students as thinking, participating individuals rather than merely requiring them to carry out laboratory work in a "cookery-book" fashion.

1.3.3 Teaching laboratory work by videotape

Videotapes are being used in a variety of ways for teaching undergraduates; their use in laboratory course teaching seems to be developing dramatically (Watson 1977), and they are often employed in an effort to overcome particular teaching difficulties and problems rather than as effective teaching media in themselves, although once employed they are often seen to have this attribute.

The reasons for using videotapes in a science laboratory course are not always given in the literature, but the aims that are given include the following:

2. To reduce the demonstrator's need to repeat experiments and therefore also save time. (Simpson 1973).

3. To provide exactly the same demonstration to each student (Howland 1975).

4. To overcome the many problems of teaching large numbers of students. (Fisher 1974a, 1974b, Howland 1975)

These initial reasons for using videotapes can be distinguished from the advantages of using them since the advantages are not always clear until the tapes have been employed for some time. The perceived advantages of using videotapes, instead of employing the more "traditional" forms of teaching, are:

1. **Time**
   They save time and eliminate much expense in preparing laboratory classes (Simpson 1973, Howland 1975, Watson 1977, Lightfoot 1978, Fisher 1974b, Emkey 1978). More time can be spent on each lesson since it is given only once every 2/3 years, as a consequence more thought can be given to the planning and presentation.

2. **Teaching advantages**
   (i) More time is often available during term to devote to the students themselves (Fisher 1974b).

   (ii) The teaching of laboratory techniques can be staggered during the laboratory course (Simpson 1973, Howland 1975).

(iv) Students can learn techniques at the time they are needed (Watson 1977).

(v) Reviewing of demonstrations is possible (Emkey 1978, Pontello 1975).

3. Learning advantages

As well as those in (2) above:

(i) Students viewing videotapes can perform laboratory skills better than those not (Pantello 1975, Kempa 1974).

(ii) Previewing of demonstrations prepares students for laboratory classes (Emkey 1978).

These are characteristics of using videotapes which seem to be advantageous irrespective of the situation in which they are used. Videotapes are incorporated into laboratory courses in a variety of ways, viz:

(i) As the sole method of instruction (e.g. Emkey 1978, Howland 1975).

(ii) To supplement other forms of instruction (Watson 1977).
so that the advantages gained are often determined by the aims for using the tapes. In the physiology laboratory investigated in this study, the videotapes are used as the main method of instruction, although laboratory demonstrators are available to help and advise students if required.

Students attitudes to videotapes

Very little work has been conducted into students attitudes to being taught by videotape in laboratory courses. Generally speaking, most students accept such teaching as part of the overall teaching techniques used in universities (e.g. qv Evans 1956), although other teaching techniques are often preferred, e.g. small discussion classes (Chu & Schramm 1968). Within the area of laboratory teaching there seems to be general acceptance for the inclusion of videotapes as a teaching medium, in one way or another (Earl 1977, Fisher 1974b, Howland 1975, Norton 1974, Watson 1977).

Few studies have explored, in depth, the students attitudes to being taught by videotape. Watson's study does present some detailed attitudes to the use of short (about ten minutes in length) videotaped demonstrations in chemistry laboratory teaching, but that seems to be the only one.

The only system which approximates to the physiology laboratory being investigated in this study is that of Emkey (1978), but even that system differs in many ways from the present one. Videotapes are used to teach both theory and practical skills in the system described by Emkey, to this extent they are similarly employed to those
in the physiology laboratory. However, the students in Emkey's study have to view the tapes outside of the laboratory. In the physiology laboratory, the students view the tapes in the laboratory immediately prior to doing the experimental work. Other differences in the system reported by Emkey are (a) discussions on the use of the tapes take place during the lecture periods, (b) students have the facility of repeating any experiments if they wish, and (c) students can choose when to do the experiment and with whom they wish to do it. These characteristics are significantly different from the present system.

Summary

This survey of the use of videotapes in teaching laboratory work indicates that:

1. Videotapes are used in a variety of laboratory courses.

2. The way the tapes are incorporated into each course differs, but generally they are used for:
   
   (a) conveying all the teaching necessary,
   
   or
   
   (b) as an adjunct of supplement to the teaching.

3. Both students and staff appear to accept their usage in the situations described.

However, little research, if any, has been concerned with the specific details of students attitudes to videotape teaching, the effectiveness
of the tapes, as seen by the students, has not been assessed and the relationship between what is taught in the tapes and what actually occurs in the laboratory has not been established. The importance of the visual impact of video teaching has been taken for granted but has not been investigated.

These are the issues of importance in relation to video tape teaching in the physiology laboratory which emerged in the development of the present study and which are considered in detail in Chapters 3 & 4.

1.3.4 Implications for this study: Unexpected outcomes

New approaches are bound to produce unforeseen outcomes which could not have been anticipated in the initial stages of setting up the innovation. The physiology laboratory course is an innovation which relies on teaching practical laboratory skills by video tape (with the use of structured laboratory manuals); it is to the unexpected outcomes of this system that I shall be addressing myself in Chapters 3 and 6 of this study.

None of the research described in this review has concerned itself with what actually happens in laboratories. To assess the aims of laboratory work most researchers have adopted one of two approaches:

1) They have supplied students and staff with possible aims and have asked them to rate their importance according to certain criteria.

2) They have asked those involved to say what their aims are.
These studies have concentrated on the explicit, finalised aim of laboratory work, the assumption is that the activities of the laboratory courses do in fact reflect these formal aims - but as we have seen, this is not always the case. In any respect, the studies have not analysed the ongoing teaching and learning processes of the laboratory courses: this is what the present study attempts to do.

It departs from the above-mentioned studies in several ways:

1. It is concerned with exploring the unexpected outcomes of laboratory teaching and learning (as opposed to the intended outcomes).

2. It is concerned with exploring in detail (a) the effectiveness of video-tape teaching in the physiology laboratory, and (b) students' attitudes to being taught by video-tape.

These are research concerns which have not been explored in detail in any of the studies mentioned above.
2.1 Introduction

This chapter documents the early stages of the study: the time when I was trying to establish the study, familiarise myself with the laboratory as a learning milieu and determine the way in which my work should progress.

2.2 Apprentice Researcher

Common sense is a fine attribute for researchers who are novices in the field of study, the assumption being that researchers are constructivists of the social environment as much as anyone else (Magoon 1977) and will, of course, tap their own areas of experience in an attempt to provide guidelines for developing and maintaining their present research strategies. Problems and possibilities can be foreseen to some extent and action can be initiated to deal with the foreseen contingencies in a way which will maintain credibility in the eyes of other researchers and those participants in the field who are being 'researched'.

However, the unforeseen is the unprepared for and in the area of social science research, especially participant observation where the researcher is immersed in the ongoing social situation, to be unprepared in the area of methodological considerations and philosophical ethical questions can be an unnecessary extra burden to the effective completion of a project.

To this extent I found myself, at the beginning of my research, flung in at the deep end. My resources of common sense were being taxed to the limit, strategies developed to cope with the world at large had
their uses, but also their limitations in that area of the world concerned with educational research. My apprenticeship as a researcher (Macdonald 1975) had begun without me being fully aware or fully prepared for it! One of my research aims at this time was to try and decipher the "best" and most "acceptable" ways of carrying out my research into the teaching and learning of the physiology laboratory course.

2.3 The initial concern of "being" in the physiology laboratory

My initial concern was not so much "how to go about my research" but more "how to survive in and make sense of" the learning situation of the laboratory. Because these initial "survival strategies" determined to a large extent what I did later in my work, the way I thought about the work and the particular ways in which I carried the work out, I feel they should be documented and considered as an integral part of my research. I shall concern myself with doing that here, as well as citing the literature which influenced my thinking and actions at this time.

At the beginning of the study time was an important factor, for at least two reasons:

1. The students in the laboratory would be completing their laboratory course in just over one term, since they had been in the laboratory for about one and a half terms already and I was anxious to tap their knowledge and perceptions of the laboratory milieu as "matured participants" before they left. So I was forced to be expedient and decide quickly just what information I wanted from these students at this stage, so that any outcomes could be used to structure further work,
which would have to be carried out on the new class of students.

2. Much work had already been done in producing the teaching video tapes. Several were being produced at this point and there was little possibility of more being produced in the very near future. If I wanted to gain information concerning the production of the tapes (and this was obviously of prime importance for any consideration of the role of the tapes in the general laboratory teaching and learning) - and if I wished to be influential in their development, then I had to become involved in this aspect of the laboratory learning scene immediately.

Because of these two points I had to immerse myself in the laboratory situation as well as become familiar with the production of video tapes in the university's TV production studios.

Aligning myself, somewhat cautiously at first, with the social-anthropological educational research paradigm as encountered in Parlett and Hamilton's (1972) paper, I decided that my best initial role in the laboratory would be that of participant observer, i.e. in "observation conducted while participating to some degree in the lives of those being observed" (Delamont 1975). Such a 'formalised' role was not possible in the TV studios, so I had to be satisfied there with being an observer and with taking every opportunity to take part in productions and discussions with those involved in producing the video tapes.
2.4 The laboratory milieu

Early in the project it became clear that there could be at least three possible perspectives of the teaching and learning in the laboratory. The first which I encountered was that of the three academic staff working in the laboratory. The academic staff took pains to justify to me the role of the video-tapes in the laboratory teaching context.

The technical staff appeared to have developed their own particular perspective of the laboratory, which was mainly in relation to questions of power and control in the effective running of the laboratory.

Finally, the students' perspective: theirs was a varied, checkered perspective which I soon realised would be the most interesting and important one to portray.

My initial concerns revolved round my own social role as a participant observer (Vidich 1966). The chances of aligning myself with one of the three groups had to be avoided; I had not to develop any special group allegiances. My role was to be the impartial observer of teaching and learning in the laboratory, in all its varied areas, and not a judge of the situation. The relevance of participant observation in such a situation is that it allows you to obtain information in the participants (students, lecturers, technicians) environment and social milieu and from their particular perspectives without becoming too involved in it yourself; this should prevent
imposing alien meanings upon the actions of the participants, meanings which are not grounded in the on-going situation (Glaser & Strauss 1968). Delamont (1975) describes the participant observer role as one of watching, listening and asking - discovering what all the actors think is important.

This involved considerable skill and tact. Three possible images (Vidich 1969) could have been held of me, and each one had to be carefully considered and dealt with:

1. The "academic staff" may have seen me as an inexperienced, somewhat presumptious postgraduate student, researching an area in which I had no previous experience, i.e. researching teaching in which I had never been involved as a teacher. As well as this, my interactions with both the technical staff and the students no doubt conjured images of me colluding with the "enemy". I therefore had to justify my presence academically, as well as to constantly ensure that my role of impartial observer was known to them.

2. The image of me held by the technical staff also had to be "controlled". My role as a researcher (a future "academic" perhaps) who had entree to discussion on matters of policy and control probably formed the basis for their mode of communication with me. Their vociferous concern for the effective running of the laboratory betrayed their malcontent with the way things were done and the manner in which they were treated; they possibly saw me as a 'link' between themselves and the "academic staff" - someone who could voice their opinion for them in an accepted way. This, I think, worked to my advantage.
Their eagerness to talk about the laboratory and the quality of comments offered was of inestimable value in the initial stages of the research.

3. I went to great lengths to ensure an acceptable image by the students. This, I think, was not too difficult to set up and continue. My own undergraduate career had only recently finished - so I could identify fairly easily with the students, and, I think, they with me. I introduced myself to each one and said who I was (that I was not a member of the biological sciences staff) and what I was doing, ensuring that I emphasised my role as a postgraduate student carrying out research for a higher degree (a strategy proposed by Richardson (1960), who emphasises the structuring of the researcher's role in the field). The role into which I hoped they would put me was that of another student interested in their ideas on the running of the laboratory course.

As an "objective marginal" (Vidich 1960) I was in a position to develop my own perspective of the laboratory milieu, which as we shall see, changed as I became more knowledgeable about the functioning of the laboratory. Both Richardson's (1960) paper on establishing field relations and Bains (1960) description of his own initiatory participant observation work helped and encouraged me in these early stages. The more theoretical aspects of the methodologies of participant observation were accessible in Schatzman & Strauss (1973), the reading of which formed a theatrical backcloth to much of the work.
2.5 The Students' Perspective

Whilst continuing to use these three groups of informants as sources of information, I began to concentrate on the students' perspective more and more. There were two reasons for this:

1. Academic Staff versus Technical Staff:
   The academic staff versus technical staff issue had the makings of a potential political confrontation; I was worried about becoming involved in this and being dragged into the political intrigues of the laboratory. Interesting as it may have been, it would undoubtedly have jeopardised my role as a researcher working in the laboratory. I had to decide on my research priorities and common sense told me that these lay with exploring the student prospective.

2. More importantly, the students are the recipients of the teaching and as such warranted my full interests.

I began to address myself to this, to the "collectively held ideas and collectively enacted patterns of activity" (Becker et al. 1968) which were held by the students. I started by observing the students at work in the laboratory; after the initial introductions when I explained my presence and purpose to each student, I spent some time merely sitting unobtrusively watching them carry out their work. I observed them watching the video-tapes, beginning their practical work, discussing it amongst themselves and carrying it out.
This strategy soon developed into listening to their interactions and asking them questions. I soon became fully immersed in the ongoing activities. I began to sit and view the video-tapes with a different group each week, trying to get some feeling of the nature of this form of learning. I became the recipient of the students questions, allowing them to question me about the way the laboratory was run - not often being able to provide an answer, but at least acting as a therapeutic buffer to their particular concerns, and at the same time becoming aware of their needs. Occasionally this involved me in helping the students with the experimental techniques being used (most of which were new to me) and in acting as a "guinea pig" in some of the work requiring human subjects. This was particularly effective in experiencing, at first hand, the students' translation of the techniques taught in the tapes to the laboratory situation, as I shall show later.

It was during these early field experiences that it became clear that there was much more of concern and interest in the effective running of the laboratory than the original concern of developing a taxonomy could do justice to. I had no concrete evidence to support this notion at this point (although, as we shall see in Chapter 3, it was justifiable); but the informal discussions with all the participants, and my observations of the students, academic staff and technicians at work led me to believe that it would not be sensible to derive a taxonomy from what appeared to be a badly functioning system: better to investigate the system first.

The purpose of the early, explanatory field studies was to familiarise
myself with the ongoing teaching and learning of the laboratory and gain some insight into the students' perspective of this. After nearly one term of field observations I felt equipped to begin a more formalised exploration, one which would develop from the knowledge gained during the field observations. It is to this that I shall now turn in Chapter 3.
CHAPTER 3

A GENERAL APPRAISAL OF THE TEACHING AND LEARNING IN THE

LABORATORY COURSE
3.1 Introduction

The present chapter is concerned with the more formalised explorations into the teaching and learning of the laboratory course, with special reference to the students' general attitudes to being taught by videotapes. Essentially this chapter is hypothesis forming, using the information gained to help derive several tentative hypotheses concerning the teaching and learning process of the laboratory. These hypotheses can be construed as emerging issues (Parlett & Hamilton 1972) which warrant further investigation. The emerging issues are described at the end of the chapter.

These formalised explorations and the emerging issues which developed from them continually pointed to aspects of the teaching and learning in the laboratory which needed further investigation.

3.2 From observation to analysis

The initial exploratory work described in Chapter 2 soon gave rise to impromptu, informal discussions with individual students and groups of students as they carried out their work*. I became aware of students who were particularly adept at voicing opinion about the laboratory environment and who often managed to see beyond the confines of the laboratory itself. Similarly, there were students who shied away from being questioned, at least publicly, but who were willing to offer comment when they were outside the laboratory. All of this

* This chapter draws on information obtained from all the students taking part in all the laboratory classes, i.e. students studying Biochemistry or Nutrition as their main degree subject as well as those studying Human Biology.
helped structure my thoughts, and indicated areas for further exploration.

This ongoing process logically led to a series of in-depth interviews being conducted in which I used the ideas and information gained so far to examine some of the points raised. By conducting formal, in depth interviews focussing on the teaching and learning of the laboratory, I hoped to obtain a range of "in depth" responses (qv Merton et al 1956). My relationship with the students had helped me determine which ones might be good informers for the interviews; as well as the obviously vociferous students, I wanted to interview some "quieter" types. Unknowingly, these interviews were to provide a wealth of information of exceptional quality, I think partly because I conducted them in a very free and easy manner, allowing the students to use me as a therapeutic springboard for their grievances.

3.2.1 The interviews.

The early participant observation work had provided me with much information about the running of the laboratory, the use of videotapes for teaching in the laboratory, and students' attitudes and opinions about their work. I had sufficient exploratory information to allow me to focus-in on some related aspects of the effective functioning of the laboratory so that more detailed information about these issues could be gained. This strategy seemed quite appropriate to the implementation of the concept of progressive focussing (Parlett & Hamilton 1972; Dearden & Laurillard 1977). There were four main aims of the interviews:
1. To further investigate, in depth, points raised during the field observations.

2. To establish the veracity of my own personal ideas.

3. To prepare the way for the development of a questionnaire on the teaching and learning of the laboratory.

4. To help determine the nature of future work.

Obtaining willing informants was no problem, but choosing students who could be beneficial to my work required some consideration. Dean's paper 'Fruitful Informants for Intensive Interviews' (Dean 1969), suggested the best strategy to adopt. He describes two categories of informants:

1. Those sensitive to the area of concern,
   and
2. Those "more-willing-to-reveal" (p.143).

My contacts with the students gave me some insight into their character. Having got to know most of them over the period of a term, I felt satisfied that I could make judgements on their usefulness as "fruitful informants". Most students chosen were of the "more-willing-to-reveal" type - mainly "frustrated" or "needy" persons, but also one particularly naive informant.

In the interviews I wanted to gain further insight into the quality of information already gathered; they were in no way structured for
quantitative analysis. Because I chose to interview ten students, each one was given one and a half to two hours; in some cases it ran into three hours. I obviously went into the interviews with certain questions to ask (qv Table 3.1) but I allowed each student to be as flexible as she liked so as to use her experiences and particular construction of the laboratory in answering the questions. My approach to the interviews was partly structured on common sense, partly on Merton's manual of problems and procedures for conducting focussed interviews (Merton et al 1956). As with the rest of my research, I was concerned not with the objective content of the laboratory teaching and learning, but with the students' feelings, attitudes, perceptions and constructs of the laboratory milieu. Each interview took place in the students' own campus room or my own campus room (not my office); each was audio-tape recorded with the students' permission.

3.2.2 Analysing the interview protocols

The recorded interviews were later transcribed. Since the interviews were not structured, the system of analysis adopted for dealing with the protocols allowed me to be responsive to each student's opinions and attitudes, as well as relating them all together. The following stages were involved in the analysis:

1. Listening to the recording to get some indication of the "feeling" of it: was the student relaxed? How did I pose the questions and what effect did this seem to have on the student's answers, on rapport; what inflections emphasised which points being made by the student?
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<th>Table 3.1</th>
<th>The Main Questions Asked During the Interviews</th>
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1. Introductory Questions

(i) Do you always know what particular experiments you will be doing in the laboratory before you enter the laboratory?

(ii) What do you think of the laboratory classes?

(iii) How confident do you feel while doing the laboratory work?

2. Laboratory Schedules and Laboratory Report

(i) General - What do you think of the laboratory schedules?

(ii) Do you ever read the schedule before going into the laboratory?

(iii) Is the theory usually new to you?

(iv) Are you given sufficient detail to enable you to carry out each separate experiment?

(v) How do you go about writing your reports? How much time do you spend on it roughly?

(vi) What do you think the importance of the report is:

(a) to you
(b) to your tutor/lecturer
(c) as part of your overall assessment
3. Tapes

(i) What do you think of the video-tapes?

(ii) Do you ever feel you would like to stop the tapes momentarily and just think about what has been said?

(iii) Have you ever wanted to stop the tape and replay a section? Why? (for what reasons).

(iv) Do you ever switch off from watching the tapes?

(v) If you were given the chance, would you like to play back parts of the tape while in the laboratory? Why?

(vi) What do you think about the format of the tapes? introduction, specific parts, etc.

Probe - Are any parts more important to you than others?

Probe - Are any parts too long/too short?

Introduction: Is this useful, easy/difficult to follow, too long/too short, relevant to laboratory work?

(vii) Do you ever view the tapes before going into the laboratory, e.g. in library: if YES - why?
2. Transcribing the recording - each recording was transcribed fully, ensuring that points in (1) above were explicit in the transcription.

3. Reading through the protocols over and over to determine the main points of each interview.

4. Listing the main points of each interview separately.

5. Listing all the points raised by all the students and their frequency of occurrence.

(I should point out that this was the first analysis of the protocols. Further re-analysis occurred when I needed information on 'new' issues).

The analysis allowed me to establish the relevance and possible importance of issues which had arisen during the field observations. I felt sure that I could now proceed to design a questionnaire to further investigate these attitudes (a form of triangulation), and also to suggest which of the issues would best be followed up.

3.2.3 The Questionnaire

The participant observation (PO) work and the focussed in depth interviews aimed at assessing general attitudes to the teaching and learning situation in the laboratory: some of the issues raised were further examined in the questionnaire. As well as this, an assessment of the students' general attitudes, especially with respect to video-tape teaching, was necessary also in the questionnaire -
this would form the background to the interpretation of other attitudes.

The interviews and PO work suggested three possible areas of questioning. Throughout the early work in the laboratory there was always much discussion about the usefulness of the tapes. These discussions seemed to me to be clouded somewhat by individual student's feelings about their own willingness to accept this mode of instruction in lieu of live demonstrations in the laboratory. Attitudes were equivocal, the pros and cons of video-tape learning were discussed and individual preferences articulated: willingness to accept video teaching was a contentious item which seemed worthy of further analysis.

Along with this was the issue of choice of instruction. Some authors propose a choice of instructional system as an acknowledgement of individual differences in student learning (e.g. Wargo 1977). Often in the informal discussions and interviews with the students, the question of being offered a choice was raised; the suggestion being that video teaching may be particularly unsuitable for some individuals. This was linked to the third general issue, that it is unreasonable to ask everyone to learn from this form of instruction.

The format of these questions in the questionnaire and the results of the students' attitudes to them are given in Appendix 1.

The sections which follow describe and explore the students' attitudes to the laboratory course and are based on the observation work, the interviews and the questionnaire results (full results of which are provided in Appendix 1).
3.3 The Students' Attitudes to being taught by Video-Tape

3.3.1 Students' willingness to take further instruction by video-tape.

The degree of willingness to take further instruction by video-tape (VT) is probably a reflection of the students' attitudes to the present system of VT teaching in the physiology laboratory. It is therefore encouraging that 66% of the students questioned are willing to take such further instruction. This information is in itself useful to know, especially as there appears to be considerable discussion about the merits of VT teaching in the laboratory in its present form: the perceived benefits to the students apparently outweigh the plethora of problems involved in the system.

However, no matter how useful such information is, it lacks real meaning if there are no substantial reasons given for holding the attitudes: it cannot be assumed that all those students willing to take further instruction have the same reasons for saying so. Foreseeing this possibility, I also asked the students to give their reason for answering this question in the way they did. Many reasons were offered for the students' willingness or unwillingness to take further instruction by VT. The variety of reasons not only substantiates the students' attitudes to VT teaching, but also when considered from different perspectives provides an assessment of the benefits and disadvantages of learning from VT as perceived by students, and an indication of the needs of these students in the laboratory learning milieu.
Willingness to accept further video-tape instruction

An analysis of the students' reasons suggests eighteen possible ones for accepting further instruction and eleven for rejecting such a possibility, as is shown in Table 3.2. Those reasons supporting willingness to take further instruction can be divided into two areas of benefits to the student: viz Learning benefits and practical benefits.

Learning benefits
The students' perceptions of the learning benefits are grouped into eight categories. The most widely perceived learning benefit is the increased clarity of the individual student's view of the laboratory demonstration: laboratory demonstrations are traditionally given "live", before the student attempts the experiment herself. Very few laboratories have proper facilities for teaching in this way; the demonstrator goes through the experimental techniques with the class crowded round, straining over each other's shoulder or perched on top of stools or benches trying to see what is being demonstrated. Much detail is consequently missed by the students, either because they cannot see properly in the first place or because the strain of perching on a stool becomes too great forcing them to adopt a more comfortable posture, but one from which they cannot fully see the demonstration. Having undoubtedly experienced such a situation in other laboratories, the benefits of VT teaching in the physiology laboratory, where every detail taught can be seen clearly by the students, are obvious to these students (see Table 3.2). One student commented:

"Instruction by video-tape tends to give a better idea of the experiment and techniques involved in a fast and convenient way. It is convenient to me and is obviously convenient to the demonstrator. Video-tapes can show
TABLE 3.2

Q.1 Willingness to take further laboratory instruction by video-tape (VT)

15 - Very Willing 25 - Willing 4 - Don't know

STUDENTS' PERCEPTIONS OF THE BENEFITS OF VT TEACHING

1. Learning Benefits

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Students stating this</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>With video, every student gets a clear view, e.g. close-up of details</td>
<td>19</td>
</tr>
<tr>
<td>(ii)</td>
<td>Videos offered easy and clear listening</td>
<td>5</td>
</tr>
<tr>
<td>(iii)</td>
<td>Useful diagrams and graphs are used in videos</td>
<td>5</td>
</tr>
<tr>
<td>(iv)</td>
<td>Outside influences are minimised with video</td>
<td>3</td>
</tr>
<tr>
<td>(v)</td>
<td>Can follow better with video</td>
<td>1</td>
</tr>
<tr>
<td>(vi)</td>
<td>Videos hold students' attention more than live demonstrations</td>
<td>1</td>
</tr>
<tr>
<td>(vii)</td>
<td>Videos are more comprehensive than a live demonstration</td>
<td>1</td>
</tr>
<tr>
<td>(viii)</td>
<td>Videos are only good for theory teaching</td>
<td>1</td>
</tr>
</tbody>
</table>
### TABLE 3.2 (cont'd)

#### 2. Practical Benefits

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Students stating this</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Videos can be repeated if not understood (in laboratory/library)</td>
<td>7</td>
</tr>
<tr>
<td>(ii)</td>
<td>Videos allow the tutor to re-do an experiment until the desired result is obtained, i.e. overcome the problems of live demonstrations in the laboratory</td>
<td>7</td>
</tr>
<tr>
<td>(iii)</td>
<td>Videos are efficient - allow five different experiments at the same time</td>
<td>5</td>
</tr>
<tr>
<td>(iv)</td>
<td>Videos save the lecturers' and technicians' time</td>
<td>3</td>
</tr>
<tr>
<td>(v)</td>
<td>If animal preparation, only one animal need be killed</td>
<td>3</td>
</tr>
<tr>
<td>(vi)</td>
<td>Videos give faster instruction</td>
<td>2</td>
</tr>
<tr>
<td>(vii)</td>
<td>Videos are necessary for demonstrating difficult experiments</td>
<td>1</td>
</tr>
<tr>
<td>(viii)</td>
<td>Videos allow &quot;ideal&quot; demonstrations in a short time</td>
<td>1</td>
</tr>
<tr>
<td>(ix)</td>
<td>With videos, demonstrators don't get bored or hurry the job</td>
<td>1</td>
</tr>
<tr>
<td>(x)</td>
<td>Videos are just as good as live demonstrations</td>
<td>1</td>
</tr>
</tbody>
</table>
small fiddly techniques in far greater detail - and to everyone; this is not generally the case with live demonstrations" (Student 27).

Personal viewing of the tapes confirms this perceived learning benefit; consideration is obviously given to ensuring that the techniques and procedures demonstrated in the tapes are clearly portrayed, and the students' acknowledge this as a strategy which facilitates easier learning. Similarly with hearing the instructions, listening is personalised since each student has personal headphones, a situation which probably helps minimise "outside influences" (benefit 4).

The usefulness of the variety of visual impact which is possible on video-tapes is also perceived as a learning benefit by the students. Diagrams, graphs and other visual teaching strategies are often used in the tapes, to emphasise something previously mentioned, to provide accessible assimilation of difficult ideas of concepts and so on. As Baggaley (1973b) points out, students differ in their capacity to handle aural and visual information; perhaps this benefit to learning is only perceived as such by those students who can easily cope with visual information, but it is obviously one of the most important aspects of video-tape teaching and as such will be discussed more fully in a later section.

The other perceived benefits to learning are mere idiosyncratic, but as such emphasise the variety of individually construed benefits of such a system of teaching.
Practical benefits
Similarly with the students' perceptions of the practical benefits of the system. The facility of reviewing tapes after the initial laboratory viewing is perceived as beneficial: the tapes are available both in the laboratory and the university library for students to re-run them if desired. This could be useful to a student who has missed some point in the tape and wishes to review it before carrying out the day's work in the laboratory, or for the student who wishes to view the tape as an aid to writing a laboratory report or for revision purposes. However, beneficial as this is, very few students appear to take advantage of this facility mainly because they are pressed for time both in the laboratory and in the larger context of their overall university education. During my observations in the laboratory, I never once saw a student reviewing a tape, and every indication was given that there just is no time for going over sections of the tape which are not clear in their minds. Perhaps the use of this facility is not fully encouraged by those running the laboratory; maybe it is not so easy to re-run a tape to the points where review is desired. No matter what the explanation, it is clear that this practical benefit is not being fully exploited.

An obvious advantage of teaching by video-tape is that much time can be given to preparing the tape, so that the lecturer can ensure that all procedures are clearly and expertly performed in an effort to present a "near perfect" demonstration. As a practical benefit to the lecturer, the students perceive this as being useful, the lecturer can 're-do' an experiment until the desired result is obtained and captured on the video-tape, thus overcoming the problems of live
demonstrations in the laboratory where environmental fluxes may determine the effectiveness or otherwise of the demonstration:

"... it is possible for the tutor to carry out the experiment several times if necessary to obtain the required results. This may be frustrating for the tutor ... but it ensures that the students see the correct procedure". (Student 16).

It is interesting to ponder over the consequences of this particular perceived benefit: just how does the student know that the experimental procedures taught on the tape may be the final product of many "tries" at the experiment? This point is raised by the producer of the video-tapes (Ms. Nita Spektorov) who believes that such a perception is to some extent an indictment of the "truthfulness" of the experiment being video-taped. If the student realises that an experiment could not be taped on the first attempt, but needed several attempts to get it right, then how will she approach the experiment herself when she comes to do it? Will her attitude to the work be affected; could her determination and perseverance to perform the experiment correctly be diminished in the light of realising that even the lecturer needed several attempts before performing it correctly?

The final, professional demonstration, in a well produced tape where nothing appears to go wrong, may give rise to a certain amount of frustration when the student comes to tackle the experiment herself. She tries to emulate the demonstration in the tape and often as not discovers that what appears so simple and routine in the demonstration acquires a technical dexterity and elusiveness of quite unexpected magnitude. Such a situation was graphically described by a student
during an interview:

"the demonstrator has done it so many times ... he sort of whips it off (student acting this out) here, puts that on there and it comes up "Pthunk !" "Pthunk!" (on the screen); beautiful results, you know. And you think "Good God !" ... It's very off-putting when you see him do all this ...
"bung this in here with a syringe and you get "PDOING !!!!" ...
and you do it, and you get "pdoing" " (Student 6).

The discrepancy between what is taught on the tape and what can be achieved in the laboratory situation can obviously lead to attitudes to learning being adversely affected, as we shall see later in this chapter. The very existence of a statement like the following one gives cause for concern:

"Too often experiments demonstrated in the video-tape are not reproducible in the laboratory, even by the demonstrators !". (Student 30).

The truth of such a statement is obviously worth assessing, and will be considered in the following chapter.

In the production of video-tapes for teaching the highest technical and professional considerations possible are obviously required (qv Neads 1977 for other considerations also); but some thought has to be given to indicating to the audience the sort of problems and difficulties they are likely to face when carrying out the experiments themselves. To omit such information is surely tantamount to
neglecting the real needs of students struggling to accomplish the unobtainable: such a situation is a travesty of teaching!

The other practical benefits are less contentious. Benefits 3 and 4 i.e. that video teaching is efficient, allowing five different experiments at the same time and saving both lecturers and technicians time, are benefits which were indeed aimed at by the architects of the scheme, and it is no surprise that the students should be aware of this. Similarly with the perceived benefit of receiving demonstrations given by people who are not 'bored' and who do not try to hurry the job in hand. (Benefit 9). This refers to live demonstrations, in which the demonstrator may be teaching the same experiment over and over again to different groups of students: sooner or later the demonstrator becomes bored with the repetition and may try to alleviate this by rushing through the work, obviously to the disadvantage of the students present. Again, such a situation has obviously been experienced by these students, and they are quick to indicate it's absence in the physiology laboratory, where the video-tape teaching has mainly overcome such problems by each student being presented with the same taped demonstration.

Unwillingness to accept further video-tape instruction

What of the eleven possible reasons for not accepting further instruction by video-tape? (see Table 3.3). Again, the range of reasons offered indicates the variety of individual student differences: some of the reasons suggested are held by many students, some by only one student but all are surely worthy of the interest of those running the laboratory course.
### TABLE 3.3

Q.1 Non-willingness to take further laboratory instruction by video-tape

<table>
<thead>
<tr>
<th>13 - Unwilling</th>
<th>4 - Very Unwilling</th>
</tr>
</thead>
</table>

**REASONS**

1. **(i)** Cannot ask questions at point of not understanding 12
2. **(ii)** Attention/concentration is diminished with video 6
3. **(iii)** Can't stand video / don't learn this way 3
4. **(iv)** Live demonstrations present the demonstrator with difficulties experienced by students 2
5. **(v)** Live demonstrations give more time for explanations and demonstration of techniques 2
6. **(vi)** Uncomfortable / irritating ear-phones 1
7. **(vii)** Live demonstrations can be spontaneous 1
8. **(viii)** Videos are impersonal and artificial 1
9. **(ix)** Videos produce a feeling of claustrophobia 1
10. **(x)** Live is cheaper 1
11. **(xi)** Videos are too long winded 1

Students stating this
It was suggested earlier that the reasons offered for not wishing further instruction might usefully be perceived as an indication of the students needs in this learning context; obviously the students are criticising the video-tape teaching system and by doing so are saying that such a system is not meeting their learning needs.

The need which is most widely held as being absent is the lack of opportunity to ask questions while viewing the tapes. If, and when, there is a point in the tape which is not clear, then a student may wish to ask a question at this point to clarify her understanding. With a group of students viewing the same tape as they do in this system, then such a possibility does not occur, either the student would have to stop the tape completely and have her question answered and simultaneously interrupt the other students' watching the tape, or draw herself away from the tape to ask the question, but at the same time missing the rest of the tape. Neither of these is really acceptable, and it appears that to "hold" the question over until after viewing the tape does not always help, because the student either forgets the question or really needs to have an answer at the point of not understanding:

"If you don't catch one point, it is not repeated, and from then on the rest of the tape is hard to understand. With live demonstrations you can ask as soon as you miss a point and thus understand the rest of the demonstration".

(Student 28).

This is an important drawback: if a student "misses a point" or does not understand something in the tape and is unable to have it clarified, then the relevance and understanding of the rest of the tape may be lost; and for that student the tape may become ineffective in helping her carry out the practical work.
The problem of attending to a video program and concentrating on it is another reason for students' unwillingness to accept further video instruction. This is probably related to the more forthright reason that some of them cannot "stand" video teaching (Reason 3), partly because of irritating headphones (Reason 6). Because of the nature of video-tape teaching as employed in the physiology laboratory, where the tapes are saturated with information - much effort is required to maintain a satisfactory level of concentration while viewing the tapes. The VT's run for anything between twenty to thirty-five minutes, a not inconsiderable time when perched on top of a high, backless laboratory stool with only the voice of the presenter coming through the headphones. Concentration wavers and if a student's attention is lost then her level of comprehension will be diminished (the laboratory schedule does carry sufficient information to carry out the experiments; but the student may nevertheless feel "cheated" or at least inadequate when carrying out the work if she could not follow the tape because of her inability to concentrate while viewing it). One typical comment was:

"I personally find immense difficulty in concentrating on the tapes shown. I spent most of the time in complete oblivion to what was being shown". (Student 52).

This problem of concentration is one to which I shall return in the next chapter.

The other reasons for being unwilling to take further video-teaching are less widely held: reasons 4, 5 and 7 relate to the benefits to
students of live demonstrations, which give "more time for explanations" and can be "spontaneous" and, relating back to the "professionalism" of the teaching in the tapes issue, present the demonstrator with the difficulties experienced by the students—perhaps a point often neglected.

The impersonal and artificial set-up associated with such a system of teaching, and a feeling of claustrophobia produced by the system are also offered as good reasons for not wishing further video instruction.

However, two main points emerge from this analysis: the students are unable to ask questions, and they have difficulty in concentrating. Those students who need immediate feedback on their questions and those who find it difficult to concentrate on the programs will not be particularly keen to take further instruction by video-tape—and this seems to account for about 33% of the students.

Summary
Most students are willing to take further instruction by video-tape since this form of teaching offers both learning benefits and practical benefits to the student. However, being unable to ask questions while viewing the tapes and problems in concentration are considered drawbacks to the system.

3.3.2 Should there be a Choice of Instruction?
Although the students are willing to take further instruction by video-tape, their reservations suggest that there are problems with the system; should a choice of instruction therefore be given to the students? This section considers this question.

As I have indicated, two thirds of the students are willing to take further VT instruction, but a similar proportion feel that there should, however, be a choice of instruction by video or by live demonstration (cf Evans 1956; Russock 1974). I think this indicates how aware the students
Q.1 Should a choice of video/live demonstration be offered?

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>21</td>
</tr>
</tbody>
</table>

**REASONS FOR SAYING 'YES'

(i) Students' individual differences, e.g. in learning, remembering from video, in listening and watching videos 13

(ii) Freedom to choose what suits you best 6

(iii) Live demonstrators are needed to help clarify points / answer questions at the time of instruction 9

(iv) Must be in the mood for video 1

(v) Students fall asleep in long videos 1

(vi) Videos should be used only for special purposes, e.g. dissections 1

(vii) Live demonstrations are less detached 1

(viii) Live demonstrations may provoke more interest 1

**REASONS FOR SAYING 'NO'

(i) A choice would be difficult to arrange / would cause chaos 13

(ii) Videos have higher standards 2

(iii) Live demonstrations are better 2
are of the problems and difficulties faced by some of them in learning by video, and although each student may or may not be willing to take further video-tape teaching, they realise that other students should be given the choice. This is borne out by the reasons offered for saying that there should be a choice (qv Table 3.4). The main reason is that each student is an individual, and as such may have individual needs or problems associated with video teaching; some students cannot learn well from videos, while others are particularly adept at learning this way and can remember much better after viewing a tape. There are also individual difficulties in listening and watching the tapes:

"People vary in how much they gain from the two types, and for some the video-tapes are better, for others live demonstrations, where you can ask questions on the spot; so it would be better for all concerned if we had a choice". (Student 7).

The need to ask questions is echoed once more (reason 3); reason 2 - having the freedom to choose what suits you best - is probably grounded in the need to acknowledge individual differences. Some students emphasise that "one has to be in the mood to sit and stare at the square box" : some weeks they are, some weeks they are not! Still others mention "falling asleep" during tapes, while others suggest that live demonstrations are less detached and may provoke more interest than video-tapes.

The rest of the students feel that there should either be video-teaching
(reason 2, for saying 'No') or live demonstrations (reason 3); most students in this group realise that a choice would be difficult to arrange and might cause chaos: so it has to be either one or the other, but not both.

Summary

A choice of instruction is probably impossible, given the circumstances existing in the laboratory at the moment. But the point at issue is the feelings of the students and nearly two thirds feel a choice should be offered. If the students feel a choice should be offered, does this mean that they think some students cannot learn sufficiently well from this system? I shall consider the students attitudes to this question in the following section.

3.3.3 Can all students learn equally well from video-tapes?

All but three students feel that it is unreasonable to expect every student to learn equally well from the video-tapes (see Table 3.5). This may appear to be a rather naive question - of course no-one would expect every student to learn equally well in any one situation; but of course, most teachers (implicitly or not) DO expect this to occur - the wide employment of the lecture bears this out. The question could be re-phrased: "Can we expect students to learn equally well in every different situation?" and the answer is obviously, NO!

However, I would suggest that in this particularly novel learning situation, there are good reasons for NOT expecting equal learning, reasons which may not apply say to the lecturing situation. One student hit on a
Q.3 Is it reasonable to expect every student to learn equally well from video-tapes?

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>58</td>
</tr>
</tbody>
</table>

Students stating this

**REASONS FOR SAYING 'NO'**

(i) Student individual differences with video 30

(ii) Student concentration difficulties with video 8

(iii) Forget questions after watching video 5

(iv) Grasping points from video is difficult 3

(v) Uncomfortable 2

(vi) Too long 1

**REASONS FOR SAYING 'YES'**

(i) No reason why everyone should not learn this way 3
possible reason:

"Not everyone is ADAPTED to that form of learning".

Nearly all pre-university teaching is conducted either by lectures or by some written form. The strategies necessary for learning by these methods are acquired at an early stage in the educational process, and are quickly 'practised' and refined, more or less. It could be said that the student ADAPTS herself to learning these ways - she "learns how to learn" from them - and so to her they become the teaching and learning norm.

It may be that the laboratory students have not yet "learned how to learn" from video-tapes; they don't know how to organise their learning skills in this teaching milieu, as one student suggested:

"Not everyone enjoys being glued to a box or for that matter learns from such a situation. If you have the capability of attending to the video-tape for the whole length, then it is a good method of learning, but if not you tend to miss vital points or worse become confused and switch off completely". (Student 27).

Using the medium effectively

Baggaley (1973) and Neads (1977) address the issue of using the medium effectively, but in a different way. The problem of lack of experience in learning from video and the low level of adaptation to such a teaching system is not just a problem to be solved by the student. The teacher and producer involved in developing the material need to be
aware of the novel nature of the coded message in visual information processing. They can help the students become aware of its meaning by informing them of the nature of the code involved:

"the producers of media materials have overlooked the fact that in educational usage information must also be decoded before it can be assimilated. And when techniques are developed for specific instructional purposes ... the audience should be informed of their coded value". (Baggaley 1973).

An example of "techniques for specific instructional purposes" is the use of split-screens for portraying two different kinds of information at the same time; there can be confusion over the meaning of such a technique if it is not explained beforehand. This point will be discussed more fully in the following chapter.

The producer of the physiology video-tapes questioned the need to "arouse" the students' learning in the context of the laboratory: the video-tapes are used in the context of "necessity", their relevance to the teaching and learning in the laboratory is obvious. I agree that their relevance is obvious, but this does not justify neglecting the motivational needs of the students: the relevance of their university classes for obtaining a degree is also obvious to them - but their motivation, for better or worse, still has to be aroused. Talking of the ideology of broadcast television and educational television, Neads (1977) points out that: "the ideology of the organization results in the ETV producer concentrating on the educational information dimension and forgetting attributes in the arousal".
I might add that the same could be said of the lecturer who has commissioned the program—his or her ideology is educationally oriented. So the point in the student's statement should be acknowledged, and steps should be taken to arouse student interest in this form of teaching and to inform the students, in advance, of the meaning of codes used in the tapes.

The students' views

The students' reasons for saying it is unreasonable to expect every student to learn equally well from video-tapes address the problem of decoding the visual material before being able to assimilate it, and the need for "arousal" strategies to be used in the tapes. Problems of individual differences in learning from the tapes (qv Table 3.5) could be alleviated by a more careful consideration being given to students' problems in decoding the information, while their difficulties in concentrating may be reduced if the students were more highly roused while watching the tapes. Possible strategies for achieving these points will be considered in the next chapter.

Reasons 3, 4, 5 and 6 are less widely held, but nevertheless worth attention. Once again, the need to be able to ask questions is given; for some students, grasping points from video-tapes is difficult and is probably related to the two main points discussed above, as is the length of the tapes: if they are too long (as some appear to be) then arousal will fall flat and ability to concentrate will obviously diminish. An individual may have been brought up on television, but should she automatically be expected to learn from it?
Summary

Most students feel it is unreasonable to expect every student to learn equally well from video-tapes, mainly because different students learn in different ways and some have the "ability" to learn from this system while others do not.

3.3.4 The effectiveness of the video-tapes

So far I have considered the students' attitudes to being taught by video-tape. I will now move onto considering the effectiveness of the tapes, as perceived by the students. Here I shall explore the students' attitudes to the content of the tapes and their teaching effectiveness, as well as establishing their views on the general structure of the tapes.

The content and teaching effectiveness of the video-tapes

One of the aims of the interviews and the questionnaire was to assess certain aspects of the teaching and learning of the laboratory (as perceived by the students) so as to prepare the way for future systematic research on the production and development of the video-tapes. Before any such systematic research could be carried out there had to be feedback from the students about the video-tapes, which would indicate the areas of concern which required investigation (conceptually, this was considered to be progressive focussing (Parlett and Hamilton 1972)). I have already discussed some of the feedback obtained and will here discuss the students' perceptions of the content and teaching effectiveness of the video-tapes.
Before any systematic work on the production and development of the video-tapes can be conducted, it is necessary to have some indication of the students' attitudes to such factors as the clarity of explanation of the tapes, the interest level of the tapes and information on their attitudes to the video-tape structure.

The clarity of the video-tapes

The clarity of explanations given in the tapes is considered to be generally "good" to "fair" (see Appendix 1). It must be remembered that this is a reflection of the students' general attitude to all the video-tapes, no doubt some are better than others (a point to which I will return in Stage 2 (Chapter 4) of the study). Certain sections of some tapes are particularly clearly explained by using good production techniques, as one student clearly feels:

"I can think of various practicals when an animated diagram of the apparatus has been quite useful. I take in more the actual diagrams". (Student 5).

So difficult explanations can be made clearer for the student by the effective use of the medium.

However, I have shown previously that there is a certain amount of vagueness and lack of real understanding amongst the students when they come to carry out the practical work, so the fact that they think the tapes good in terms of clear explanations may, on the face of it, be somewhat surprising. What this amounts to is, I think, that the students feel that in explaining the laboratory work the tapes are indeed clear, but they themselves are not so clear about what they are doing when they come to carry out the experimental work.
They can follow what they have to do while they watch the tape, but in the ensuing two and a quarter hours things become less clear as they rush to get the work done.

The tapes do appear to offer clear explanation of the procedures involved, but there are indications that even this could be improved. The problem seems to lie in the students' difficulty in grasping and recalling all the information given in the tapes. As they are watching a tape each part of it seems clear to them, but taken as a whole remembering back to each section proves more of a problem:

"Sometimes the tape finishes and you think" "where on earth do I start" .... by the time you get to the end of the tape you often can't remember what on earth was the first part they did". (Student 2).

This phenomenon is related to two other aspects of the video-tapes, their length and the level of information presented in them. The length and information level of the video-tapes. Most of the tapes last from between twenty to thirty minutes (some a little longer) - quite a considerable time for a student to sit on a high laboratory stool and try to concentrate on a video-program:

"I find that most of them go on just that bit too long; by about three quarters of the way through it makes me absolutely just fall asleep ... I find it very difficult to keep awake. My attention just wanders ... If I'm not looking at something else ... I'm not really taking any of it in at all ... I think having shorter tapes would help ... if the tape was only about 10-15 minutes long I could take in more". (Student 5).
In the same time period, much more information can be delivered when teaching by video-tape than can be when teaching "live"; the time spent preparing and editing the video-tape lesson makes this possible. The same time that is usually given to a live presentation of the laboratory work in the laboratory is devoted to the presentation in the video-tape and as a consequence more information than the student can really deal with is presented:

"The video-tapes are crammed full of information which is just too much to take in ... too much theory". (Student 4).

is a common complaint by the students, who soon realise that much of the information in the tapes is also duplicated in their notes.

"Sometimes when it seems to be going on a bit - and its stuff you've covered in lectures anyway - and you think, "Oh, I've got all of this in me notes. I needn't bother particularly paying attention". (Student 2).

So the video-tapes never generate much more than a medium interest level (see Appendix 1) because they are often too long and contain far too much detailed information. The interest of the students is, however, captured at certain points of the tape, notably when the techniques necessary for carrying out the day's practical work are being demonstrated (Appendix 1, Question 11). The student realises that as far as achieving her main aim of getting through the day's practical work is concerned, the demonstration sections of the tape need only concern her, so she "switches off" at the other less
vital and less interesting parts:

"The tape to me is good in realising what you've got to do in the experimental technique, but for anything else I just tend to switch off and look around the laboratory and do anything but listen to it - unless it's the actual technique we're going to use".
(Student 15).

This is a common sentiment held by many students. The practical procedure section is the section which is given attention:

"I think you look at the practical procedure; but don't take much of the theory in ... learn it up later".
(Student 7).

and is also part of the tape which they would prefer most consideration given to:

"The video-tape would be much more useful if it was devoted to demonstrating the experimental techniques".
(Student 30).

Summary

In terms of the content and teaching effectiveness of the video-tapes, the students feel that they are good for teaching the experimental techniques and for providing clear explanations. However, there is little agreement as to their interest level and they are thought to be "crammed full of information", a situation which diminishes student
attention, causing the students to "switch off" from viewing the tapes unless the actual techniques are being demonstrated.

3.3.5 The structure of the video-tapes

I indicated in the preceding section that the students found the demonstrations in the video-tapes both stimulating and useful for carrying out the laboratory work, and that generally speaking the tapes presented too much information to be assimilated just before a laboratory class.

A somewhat more systematic analysis of the various sections of the tapes would help distinguish the important and necessary sections from those considered unimportant, and this is what I shall consider here. Most of the tapes produced for use in the laboratory follow a set structure of four sections viz an introduction and aims section; general theory section; a demonstration of the laboratory techniques to be used, and a section on questions. In terms of time taken, the bulk of the tape is in the middle two sections, i.e. theory and demonstration. Is this general structure the best way of presenting the material, and what do the students feel about the relevance to their laboratory work of each section, the interest level of each and the time devoted to them?

In terms of relevance, all sections of the tapes are considered relevant for enabling the students to perform their laboratory work (see Appendix 1); but the only one of any real interest to the students is the demonstration section (the others are considered either "acceptable" or the students are equivocal about them). This confirms
and corroborates the analysis in the previous section, i.e. that the demonstrations are the most important aspects of the video-tapes.

Similarly also with the students' attitudes to the time devoted to each section: the theory introduction (and to a lesser extent, the questions section) is too long (see Appendix 1). The students are unhappy about the amount of theory in each tape and think these sections are too long and boring to pay attention to at a time when their minds are really on preparing themselves for carrying out the experimental work in the laboratory. Speaking of the general theory introduction, one student commented:

"If it were more detailed in the schedule there would be no need for it in the video-tape. It is hard to go straight into the theory of an experiment, before it is done, at 10 a.m. in the morning, usually having only just got up, and to understand it. Concentration is hard to keep, especially with distractions in the laboratory ... it would be easier to concentrate on it after the laboratory, when writing up". (Student 12).

Another typical view was:

"I would prefer if they were much more geared towards the experiment, the experiment of techniques we had to do - spent longer showing us those". (Student 9).

the underlying reasoning being that anything else is superfluous half
an hour before the student is about to carry out the experiments.

Summary

All sections of the tapes are considered useful, but the theory sections appear to be too long and contain too much theory; the demonstration sections are the most important and interesting to the students.

3.3.6 Completing the laboratory work

Up until now I have been exploring the students' attitudes to being taught by the tapes and their feelings about the effectiveness of the tapes. I would now like to consider what happens after the students have viewed the tapes and are using the information presented in them to help them carry out the practical work; do the tapes have any lasting visual impact on the students which can be beneficial to them; and once they have done the practical work, how do they go about analysing their results and writing the laboratory report?

Each of these points will be taken up and explored in turn.

Carrying out the laboratory work after viewing a video-tape.

Throughout the informal discussions in the physiology laboratory, I was constantly confronted by the students with comments about "not being sure" of what they were doing in the laboratory. My field notes have documented this at several times, indicating a certain amount of confusion over the work being done, a vagueness in carrying out the procedures necessary to perform the experiment. One field observation
indicates a student's confusion and my own thoughts on the reasons for such a situation; the practical work concerned was the completion of a frog-heart perfusion, which involved dissecting a frog to locate the heart, cannulating the aorta and performing some tests on the heart.

Observational Note

Asked the student how things were going:
"Oh, not too well", student looks back at her frog's heart. She is trying to find the aorta but isn't too sure which vessel it is. Some confusion as to where it is and how to identify it. Students fumbling around, not very sure of what they are doing. Eventually called Dr. "Black" over to help out.

Theoretical Note

Why is there so much apparent vagueness and lack of comprehension so soon after the demonstration (on the video-tape)? Have students not had enough theory beforehand? Or if they have, have they forgotten it - or was the demonstration not very effective at pointing out the aortic vessel?

The students seemed to have started the practical work without initially ensuring that they were fully aware of what they were to do and how to do it. I had noted earlier that after watching the video-tape they had
immediately started the practical work without stopping to think about what was involved and what they should be "looking" for.

This was borne out on another occasion also. I was observing a group of students who were involved in measuring the effect of exercise on certain human body functions. Being short of a willing guinea-pig to do the exercises I offered to do them so that they could measure the effects on me; they gladly accepted. It was soon obvious that they were somewhat uncertain about some of the procedures involved. Initially, no-one could find my pulse to take a base-line reading, and some time was spent trying to locate it on my wrist. Later they experienced similar difficulties in using the *physmograph* for measuring blood pressure; no-one knew how to set it up - which parts went where - and after this had been sorted out with some help from myself, there was considerable confusion as to how to use the apparatus properly; they seemed uncertain about the manipulative procedures involved and also about how to read and interpret the scale. And all of this had been demonstrated an hour beforehand on the video-tape. One might expect a certain amount of uncertainty in carrying out the manipulative procedures, especially if this was a new piece of equipment being used; but the level of uncertainty over reading the scale and interpreting the meaning of the readings suggested that there was some discrepancy between the video-tape demonstration, and the students' comprehension of it. For some reason the students were not fully aware of what they were doing and why.

This issue of comprehension and understanding seemed sufficiently important to warrant further attention. I questioned the students in
the interviews about it; again they showed considerable concern about
their lack of understanding when carrying out some parts of their
work in the laboratory. And when questioned on this point in the
questionnaire, only 16% of the students could say that they feel very
aware of what they do in the laboratory; the majority feel only
vaguely aware of what they are doing (see Appendix 1)

Vague awareness.

What causes a situation like this? There seem to be several
contributing factors which may separately or in combination dimish the
students' awareness of what they are doing.

1. One is the amount of work to be understood and carried out
in the three hours of each laboratory class. Having spent
at least half an hour or more watching the video-tape, the
students then have only two and a half or two hours in which
to complete the work. The work in itself may not be
particularly intellectually demanding, but it often involves
carrying out procedures which are new to the students and
which require some considerable time devoted to them in order
to ensure they work properly. But the amount of work to be
invested is often the main source of complaint:

"Very often there is so much to do in the time
you've got that you're spending every minute you've
got thinking "What's the next stage of the experiment?"
- you don't really have time to think further than that".
(Student 9).
So the time needed to get the work done seems to preclude any thought being given to what the student is actually doing as she does it. This is similarly lamented by another student who thinks that there is too much detail to be dealt with in the practical work to allow her to be fully aware of what she is doing:

"If you asked us on some practicals what we'd done and what the answer to a question was - we couldn't tell ... even if we'd done it a week before, because they're just too detailed".

(Student 4)

and their understanding may in fact be reduced after having taken part in a practical class:

"... sometimes you come out and you're still totally confused - or you may even become more confused by doing the practical". (Student 9).

2. Another factor contributing towards the students' vague sense of awareness, and one which is probably closely related to the previous one, is the mechanical way in which they appear to be encouraged to carry out the practical work. The necessary equipment is laid out on the bench in front of them, as is all the necessary apparatus and solutions; the laboratory schedule outlines the procedures necessary, tells the student where to put what and how much to add at what point:

"When I think of it I don't know any of the reasons why we add various drugs and things really. I just
do the experiments and that's it - it doesn't really
go any further than that, and it should do really“.
(Student 5).

This particular student worried that it could all just be
her fault rather than anything to do with the way the
laboratory is run; there may of course be some truth in this,
but it seems to be too widespread a phenomenon to be
completely her "fault". The mechanistic behaviour which is
often apparent when one watches the students at work in the
laboratory only confirms her perception, and the lack of any
intrinsic interest generated for the practical work must
surely add to the adoption of a routine, mechanised attitude
to what they are doing:

"I think really you're just following the instructions
and you just do it ... If you sort of push a needle
here (demonstrating) - it just says "put a needle there"
and you don't think what would happen. You just do what
the practical(schedule) says. It's not all that
interesting; we're not really aware of what is going on,
possibly because of the video-tapes. If it was made more
interesting ..." (Student 7).

Having to adhere strictly to the practical work schedule is a
common comment:
"I didn't at the time precisely understand what I was doing. I followed through the schedule".
(Student 8).

The practical work schedule is obviously an essential component of the teaching process in the laboratory, but when students are compelled, for one reason or another, to follow what it says in a more or less mechanical fashion then perhaps the integral role it plays has to be reassessed in an effort to eliminate such unthinking usage.

3. The third possible explanation for the students' apparent lack of understanding of awareness of what they are doing in the laboratory is concerned with the questions of the aims of the laboratory classes - as perceived by the students.

There is considerable agreement amongst the students that, as far as they are personally concerned, one of the main aims of the laboratory work is to get the "correct" results so as to allow them to write a "good" report of the laboratory work - a report which is graded, each grade counting towards their Part I final grade. To this extent the students are chiefly concerned not with understanding their laboratory work, but with getting it done as quickly as possible, getting out of the laboratory and writing their report. The motivating factor is the assessed laboratory report, understanding what she is doing is less important:
"I don't know about anyone else, but I never even think about the physiological side of what I'm doing until I get out, away from it. I'm just thinking of getting the results that are wanted while I'm there.

(Student 9).

And the student goes on to explain what she means by "getting the results that are wanted" : as far as she is concerned, the assessed laboratory report is the aim worth striving towards and her main endeavour in the laboratory is to get the results that are needed to write a good report so that she will receive a good grade. Put crudely, the laboratory work is a necessary means to that end.

The specific point that I wish to make here is that the student may not be very concerned about understanding what she is doing in the laboratory; her main concern is to get the work done so as to allow her to complete the laboratory report, which counts toward her final grade.

In any case, the students feel that there is little understanding involved in performing the practical work; the understanding occurs when they interpret the results and write the laboratory report. Ninety-five percent of the students agree that this is the case (see Appendix I) - in fact the understanding required for the laboratory report seems to be, again like the assessment, more important than the practical work itself:

"It's all right doing the experiment and knowing that adrenalin increases ... acetyl-choline shuts something off."
It's not until you come to write it up you discover why it's doing it. It's more important than doing the experiment". (Student 6).

Which, of course, is not to say that the practical work is in no way important; but it certainly seems to take second place to the writing of the laboratory report, as I shall indicate later in the section dealing with the laboratory reports.

Corroboration

These reasons for the students lack of awareness while carrying out the laboratory work have, of course, been formulated by a systematic analysis of the field notes, the interview protocols and the questionnaire results: they are grounded in the students' perception of the reality of the laboratory milieu. However, their existence is also established by the field notes of conversations with the technical staff in the laboratory. As informants, the technicians played a vital role in helping me become aware of the many undercurrents of opinion about the way in which the laboratory is run: they seemed to be the "frustrated" "malcontented" informants of Dean et al (1969). In such a role, one technician corroborated many of the points discussed above:

Observational Note

Technician - overflowing with comments and ideas. I made a general remark about the heart perfusion experiment being pretty tricky to set up. Technician felt it wasn't
so bad: "If they would only think ahead to what they are to do. They have to get that heart out quickly and set it up on the apparatus; but they sit there not realising that. And they can't generalise from one experiment to another. They don't ask what this piece of equipment is doing, where the Ringers is going from one point to another. They wouldn't recognise a heart profusion apparatus again if they saw it - they wouldn't say "Ah, that's for a heart profusion technique". They just come in and sit down and have a bit of a skive watching TV, then start on the work following the schedule and doing what it says without thinking about what they are doing or what's happening. They just want to get something to write down and remember. They want to get out quickly, they're not worried about learning techniques".

The technician's perception of the students at work in the laboratory substantiates my own observations and those held by many of the students themselves.

Implications

Of course, such a situation has implications for the learning of manipulative skills in the laboratory. The students' lack of awareness of what they are doing is determined by at least three factors of the learning milieu, as we have seen; and these three factors do little to contribute towards the accomplishment of the effective learning of the procedures being taught in any one practical class.
We shall see later that the students think the video-tapes useful for demonstrating the practical techniques necessary for carrying out the laboratory work, but there is no indication at any point that the students actually ever learn the techniques involved, as the technician quoted above points out. Simply, there appears to be a certain amount of "mindless" imitation of the experimental techniques demonstrated in the video-tapes; this is obviously very important in the process of manipulative skill learning (cf Kempa 1974). But for manipulative skills to be retained there has to be a cognitive contribution from the individual involved (qv Cason 1975, Fitts 1964, Welford 1968), a period when the student actively thinks about the skill she is learning and practices it, reformulating her cognition of the skill with practice. She has to be ready or "set" for learning the skills (Simpson 1967, MacLay 1969), otherwise little learning will be accomplished.

There is little indication that any of this is occurring in the laboratory, indeed every piece of information points to the opposite occurring. The students are not "set" for learning the manipulative skills, they do not consider the learning of the skills to be a necessary part of their laboratory work. Consideration has to be given to this attitude if skill learning is to be achieved, and methods of improving the laboratory learning milieu have to be devised to accomplish this. (These theoretical points are discussed in the chapter on the Taxonomy)

Summary

There is a general lack of awareness of understanding of what they are
doing as the students carry out the laboratory work. At least three factors contribute towards this:

1. There is too much to do in the time given to be fully aware of the reasons for the laboratory work.

2. The laboratory is run in a rather "mechanistic" way, which does not foster student understanding.

3. To the students, most of the understanding occurs after the laboratory class, when they are completing the laboratory report; the grade given for the report is the important aim - so understanding while in the laboratory is not high on their priority list.

3.3.7 The visual impact of the video-tapes

Although the students may feel only vaguely aware of what they are doing in the laboratory, there is some evidence to suggest that the visual aspect of the video-tapes have impressed themselves upon the students, to the extent that the students' awareness is increased. This visual impact of the video-tapes is obviously very important in the learning situation, as we shall see.

The visual image

The strength of teaching by video-tape surely lies mainly in the visual image, the moving picture which relates to our everyday experience of life. If used properly and effectively, the moving
visual image can capture the students' attention and interest in areas of education usually considered too routine to have any inherent interest value e.g. Kenneth Galbraith's recent series on economics, produced for broadcast television. Here, no matter what might be said about the particular concept of economics being discussed, the innovative production strategy of the series proved an interesting and stimulating vehicle for the transmission of the message.

Educational television can capitalise on the impact of the visual image; even when one considers the rather desultory levels often attained by such programs (qv Neads 1977) you are still aware of the force of the moving form in transmitting the educational intent. Also the retention of knowledge via television can, of course, compete easily with "traditional" forms of learning (qv Kempa 1974). Kempa (1974) has also indicated that manipulative skills can be learned easily from television by imitation. Imitation is an important factor in learning laboratory manipulative skills - but what extra role, if any, does the visual image of teaching such skills by television have on the students' ability to perform the skills effectively?

Half of the students involved in the interviews, at one time or another, alluded to the unique training effect of television. The condensed focussing on laboratory equipment and its manipulation, the sharp images of demonstrated techniques brought to the student via a small television screen, often have a purely visual impact, of which the student is completely unaware. One student in particular described this when I asked her if she ever tried to think back to the videotapes whilst carrying out the laboratory work:
"I think you have images in your mind; pictures of what he was doing. If it's an experiment with a spirometer, what's been put where. I think you tend to have a flashback. I think they (videotapes) do help in a way ... you don't realise till you are doing your experiment, and you think "I remember that bit, they were doing that there ...", but when you've actually been watching it you don't think about it." (Student 7).

Obviously the video-tape is having an unconscious impact on the student's memory, and if the student was reporting truthfully, the visual images of the video-tape were "imprinted" on her mind and were later being "recalled" at the appropriate stage of the experimental procedure as she performed the laboratory work.

How common is this experience of "images in your mind", of "flashbacks"? It certainly seems to be potentially very important in the laboratory learning situation. I asked the class if they experience flashbacks of parts of the video-tape while carrying out the experimental work, and if so how often. Twenty-six students (see Appendix 1) said they did experience "images in their mind" as they were carrying out their work; half of these did not experience it very often but the other half admitted to it having occurred "often" and "many times". This seemed very promising - its importance was articulated by several students:

"If you can visualise what happened on the tape ... like how Dr. "Black" fixed the organ bath or whatever, then
you're not going to stick your bit of organ in the wrong hole!" (Student 3)

and again by another student who consciously set out to remember the visual messages in the tape and relate them to the instructions for carrying out the experiment in the laboratory schedule; when asked if she ever thought back to the tapes:

"I try to, yes. And then I'll ... read through my schedule again and I'll try to superimpose the tape onto my schedule. It sometimes works, it sometimes doesn't". (Student 4)

Summary and implications

The occurrence of such a phenomenon as "flashbacks", even if only experienced by half of the students, is of sufficient educational importance and interest to warrant further consideration and is therefore treated as a "significant issue" in Stage 2 of the study, which we will come to later.

3.3.8. The Laboratory Report

To complete this chapter, some consideration has to be given to the final product of the students' laboratory work: the laboratory report. Having viewed the video-tape and carried out the practical work, the students are now required to analyse their results and write a laboratory report in their own time.
The report

After each laboratory class the students write a report of the work done in the laboratory which is then handed in to a lecturer or demonstrator for assessment. These reports are written on blank spaces on the pages of the laboratory schedule (see Appendix 2); on these pages are questions relating to the practical work, in one way or another, which have to be answered. Some questions relate to the students' laboratory results, often requiring an interpretation of the results; some relate to more theoretical issues associated with the topic of that laboratory class. When the report has been assessed, the student receives it back with a grade marked on it; each grade counts towards the students overall Part I grading accounting in total for 9% of that grading. Since there are about 25 practical classes for which reports are required, each report counts for about 0.33% of the overall 9%.

I have already indicated, to some extent, the students' view on the laboratory reports, but what role do the laboratory reports play within the course? During the interviews with the students it very quickly became clear that the writing of these reports is a major part of the students work on the laboratory course: to some students just as important as the practical class itself. In fact, I have already shown that when questioned about their level of understanding when carrying out the practical work 95% of the students (Appendix 1) said that most of the understanding does not occur in the laboratory but outside, when they come to interpret the results and write the laboratory report. So in terms of learning and comprehension, the students are nearly unanimous that the laboratory reports are extremely important.
An analysis of the interviews showed that all these students, at one time or another, offered some comment on the role of the laboratory reports in the physiology course. An analysis of their comments (qv Table 3.6):

<table>
<thead>
<tr>
<th>Points relating to writing laboratory reports</th>
<th>Discussed by student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time involved</td>
<td>1, 2, 3, 4, 7, 8, 10</td>
</tr>
<tr>
<td>Faking results</td>
<td>1, 2, 3, 7, 9, 10</td>
</tr>
<tr>
<td>Assessment</td>
<td>1, 2, 6, 9, 10</td>
</tr>
<tr>
<td>&quot;Learning bonuses&quot;</td>
<td>1, 3, 6, 7, 8, 9, 10</td>
</tr>
</tbody>
</table>

indicates that the main reason for writing the reports is because they form part of their assessment:

"I suppose the main reason why the reports are written up is because they count towards your degree". (Student 6)

if this was not the case then they would not be handed in:

"I think if it (report) wasn't part of your assessment it probably wouldn't get handed in". (Student 1)
Because the reports have to be handed in each week, the students are very conscious of them being a vital part of their continual course work, but again, mainly because they are graded:

"... it's something that has to be done every week. It's sort of continual course work. I feel, if I miss one or two, it's going to make a big hole in your course work ... I mean, if you don't hand them in you don't get a mark, it's a load of marks missed". (Student 2).

The time involved

Much time is devoted to completing the reports; one reason for this is because they require a considerable amount of time devoted to them to answer all the questions; and another reason is undoubtedly because they are graded, and as such come high in the students' study time allotments, the attitude being that by spending a lot of time on them the student will receive a high grade:

"If you want a good mark for every practical, then you're liable to spend more time on every practical". (Student 4)

When questioning a lecturer about the amount of time that the staff expect each report to take, one of the students was told "about an hour, no more". But each student devotes at least three hours to each report, sometimes as much as seven or eight hours on difficult ones (Student 1), because they feel that time and effort beyond what is minimally required should be given to them so as to ensure a good
"The proportion of time recently that I've spent working on physiology practicals has been more than the time I spend on any other work ... I think I've probably been taking them too seriously". (Student 8)

Most students seem to "take them too seriously", if time and effort is any indication of that. One student feels they "tend to take priority over my own subject" (Student 10, Nutrition student), and another feels much the same:

"I'd like to think that I could spend the same amount of time on my other subjects ... I feel I can't, there's just no time". (Student 4)

A not inconsiderable amount of this time is spent in searching through physiology books (especially Samson & Wright, the recommended text) for answers to questions; looking up journals to locate articles on particular experiments and searching out other students who may be able to throw light on some problem. But the major motivating force behind all this energy is the final grade, which goes towards their overall assessment.

Some consequences of assessment

This devotion to work for the sake of a grade seems to have two consequences, one undoubtedly beneficial to the students, the other amounting to an inditement of the educational system. Let's look at the latter consequence first of all.
Faking results

The detrimental consequence is the encouragement to fake or falsify laboratory results in an effort to obtain a higher grade. It is the awareness that results which are not "expected" are marked down:

"sometimes you simply don't get a good mark because your results aren't what was expected". (Student 2)

so to ensure a good grade, the results have to be doctored if they are not the "expected" ones:

"you seem to get a better grade if you put what's expected to happen rather than what did happen". (Student 1)

so:

"you just fiddle your results". (Student 7)

Of course, the students are quite aware that this should not be the case, but circumstances appear to force them into adopting such strategies, so as to obtain the desired grade. At least two circumstances seem to force this upon the students: lack of adequate feedback from the lecturers on their laboratory work, and their own inability to adequately deal with results which do not "conform" to published expectations. There is a feeling that there would be much less "faking" if the students were given good constructive criticism on their reports and if they were shown how to deal with "results that don't come out well", (Student 7). As it is, it appears that feedback to them is minimal. I would like to quote at length one particularly perceptive student's comment on this issue which substantiates many of the points made above and which, I
think, is a true representation of the students' attitudes to this issue:

"We often find that, if because the equipment isn't working or because of our faulty technique we don't get good results, there's a substantial part of the mark knocked off. We all started off handing in our results, however bad they were ...... after a while when you realised you were getting D's if you put in your own results and A's if you fiddled them and put in a set of perfect results - you began to feel, well you think "Why not fake the results, what's the point" ...... If they are not going to tell you why you got it wrong in the first place, and secondly they mark you down and it all counts towards your degree ...... and that's what you're here for after all ...... But you know, you'd much rather hand in your own results and get a bit of constructive criticism ...... I don't see there's any point in marking them if they're not going to put any comments on them". (Student 3)

The learning bonuses

The other consequence of putting so much work into the reports, and which is of obvious benefit to the students, is what I term a "learning bonus". The time and effort is paid off by the students receiving several learning bonuses, which may or may not have been intended aims of having the students write the reports.

Increased knowledge

One of the learning bonuses which is probably an intended learning outcome
of writing the reports is an increase in the students' knowledge and ability to develop that knowledge:

"They really help me learn ..... the theories behind them you learn". (Student 7)

Writing the report helps the student synthesise her knowledge of the topic:

"It sometimes ties things up, pulls things together". (Student 2)

and also resolve any uncertainty which she may have about the practical work:

"I think most of the time you tend to straighten out your ideas about how a thing works .... by the time you read up what you've got to read up to answer the questions you've fairly straight on the ideas that are behind it ... you do the reading you might not do otherwise". (Student 9)

The search through books

"I work from books .... lots of physiology books .... there's a lot of hunting around in books". (Student 8)

to find good, theoretically based answers to questions posed in the schedule increases the student's knowledge and her ability to grasp points which may have been conceptually problematic in the laboratory.
Student co-operation

The other learning bonus is one which I feel is probably an unintended outcome of writing laboratory reports, and that is the co-operation between students on writing the reports. Reports are handed in individually for marking, but often they are the product of several students having got together, pooled their resources (results, books, individual abilities) and worked out the answers to the questions:

"We pool all the books and resources ... someone will explain it to me in simple terms, rather than in technical terms in the book, and I do the same for other people". (Student 10)

this is seen as a good, acceptable strategy which allows the student to discuss her work with other students:

"If they saw some of the ways the results get churned around between people .... I think it's quite good really because you DO get to discuss it with other people". (Student 6)

Each student brings her own particular strengths and abilities into the interpretation of results and solving of problems:

"... we get our ideas straight on one prac ... her strength's (talking of flatmate) in a totally different field from mine .... everyone swaps results". (Student 9)
These two 'learning bonuses' are obviously quite a substantial positive outcome of writing laboratory reports, and as such can only lead one to commending them.

It may be remembered that considerable time is devoted in each tape to a theoretical discussion of the practical work: the concepts and theories behind each class are investigated in the theory sections of the tapes. It might therefore be asked why the students have to spend apparently so much time reading up on the theory when they come to write the report. I think that the need to do this is another indication of the ineffectiveness and superfluousness of the theory sections; if they were effective then surely the students would not have to spend quite so much time searching the theory literature after the laboratories in an effort to complete their laboratory reports?

Summary

The laboratory reports involve a great deal of the students' time the main motivation for which is the fact that they are assessed. Students results are often faked so as to obtain a good report grade; but having to write the report has its benefits: namely an increase in knowledge which might otherwise not be gained and a willingness to co-operate with other students in solving problems.

3.4 Emerging Issues

In Chapter 1 I outlined the general illuminative evaluation strategy which this study would be following, pointing out that the open-ended
enquiries of the initial stages would give rise to focussing on important issues emerging from these enquiries. The general appraisal of the teaching and learning in the laboratories constitutes the "open-ended enquiries" of the illuminative approach: what are the emerging issues arising from this appraisal to which we shall give special attention in Stage II of the study?

3.4.1 Issue 1

The video-tapes

There are three areas for exploring the role of the video-tapes in the laboratory:

1. Individual tape analysis: Stage I considered the students' attitudes to the general role of all the tapes; but it seems necessary to substantiate some of the students' comments about the tapes by an analysis of individual tapes. This is necessary before any systematic work can be done on the development of the tapes.

Specific areas which have emerged from Stage I and which are worthy of further investigation include:

(a) more detailed information on the theory sections and on the demonstration sections,
(b) an indication of students' ability to concentrate while viewing the tapes,

(c) information on the reproducibility of some experiments demonstrated in the tapes; whether or not students feel they have to rush through their work, if they have enough time and the difficulty of some experiments.

Analysis of these issues should provide extra information necessary for systematic tape evaluation.

(2) Systematic tape evaluation: The information from Stage 1 and from the Individual Tape Analysis will provide the necessary details for guiding new tape productions. This is the second area worth exploring, i.e. the structuring and production of a new video-tape using the above information as a guide to its production. The tape should be evaluated systematically so that we can gain feedback on its intended aims and their effectiveness.

(3) Assessing the visual impact of the video-tapes: The phenomenon of "flashbacks" or "images in the mind while carrying out the laboratory work" has been shown to be a potentially powerful learning strategy in the laboratory situation. Its occurrence and perceived usefulness will be investigated.

3.4.2 Issues 2&3, The Learning Overspill of the Laboratory Course

I have indicated, to some extent, the ramifications of the learning process
involved in the laboratory course: that much of the learning for the course does not occur in the laboratory classes themselves, but outside the laboratory when the students come to write their laboratory reports; that writing these reports is perceived by the students as being a necessary exercise so as to receive a grade; that the grade is the important aim and as a consequence the writing of the report is given much more time and intellectual effort than the lecturers think necessary, producing faking of results, but also a substantial increase in knowledge for the student and an acknowledgement of the need to co-operate with other students in analysing data, solving problems and writing the report.

All of these points are worthy of further exploration, their existence implies that the laboratory course has far reaching effects on other aspects of the students' academic life; effects on the overall degree course (because of the enormous amount of time the students seem to put into this one aspect of their degree course); and effects on what might be termed the students' overall university education. The consequences of faking results for their attitudes to knowledge, scientific writing and training; the effect of the assessment procedure on their attitudes to learning; the consequences of acknowledging that student to student co-operation is vitally important; their attitudes generally to what their university education, of which the laboratory course is an integral part, is really providing them with.

These two related issues - the effect of the laboratory course on the overall degree course, and the effect of the laboratory course on the students' conception of a university education - will be considered separately in chapters 5 and 6 in Stage 2 of the study.
3.4.3 Issue 4 The taxonomy

As was pointed out in the Introduction to the Study, the development of a taxonomy for defining objectives in the psychomotor domain was originally to have been a major aspect of this research study, but because it became clear in the early stages of the field work that the teaching and learning system under investigation was functioning poorly, it was considered unwise to develop such a taxonomy from that system. Instead, a taxonomy would be developed from existing ones and would be offered for consideration, with the understanding that it would have to be tried out in the laboratory and modified accordingly.

In this light, the taxonomy may be considered to be an issue emerging from the original study proposal. The proposed taxonomy will be presented in Chapter 7 along with an example of its use in the physiology laboratory.

Each of these issues will be considered in detail in the following chapters which make up Stage 2 of the study.
CHAPTER 4

ISSUE ONE : THE VIDEOTAPES
4.1 Introduction

This chapter is concerned with issue one, arising from Stage I of the study i.e. the Video-tapes. There are four sub-concerns in this issue, viz

1. Individual tape analysis/evaluations (section 4.2)

2. Systematic tape production and analysis (section 4.3)

3. The laboratory schedule (section 4.4)

4. Assessing the visual impact of the tapes (section 4.5)

Each sub-issue will be considered separately.
4.2 Individual Video-tape Evaluations

Stage 1 of the study indicated several areas of discontent with the video-tapes; these were attitudes to all the video-tapes in general. Specific tape analysis was needed to determine if these attitudes are held for each tape, or if they are the manifestation of the students' general feelings about being taught by video.

Specific issues arising from Stage 1 included:

1. The reproducibility and difficulty in performing some of the experiments demonstrated in the tapes.

2. The issue of feeling compelled to rush through the laboratory work, perhaps needing more time.

3. Attitudes to the theory sections and demonstration sections of the tapes: specifically the students interest level; attention, comprehension and enjoyment of each of these two sections. Also, what they thought of the clarity of explanation, amount of information, length and speed at which ideas were developed in each section.

4. The students' ability to concentrate while watching the tape, and the reasons for loss of attention.

As well as this, more detailed information about the tapes would help in the systematic development and evaluation of the new "research" tape (to be described later in this chapter).
There were therefore two aims behind the analysis of individual tapes:

1. To provide detailed information (as outlined above) on specific tapes so as to corroborate students attitudes to the tapes generally.

2. To provide extra information for the development of the new "research" tape.

4.2.1 The evaluation form

An evaluation form was developed to achieve these aims; it was based on some of the questions asked in the questionnaire in Stage 1 and on some of the important issues arising (qv Appendix 2.1). The form was distributed to each student prior to their viewing the video-tapes, over the period of about one term. Eight video-tapes were evaluated in this way, the information from each evaluation being derived from different numbers of students since class numbers often varied and also because for some tapes (tapes 4-8) fewer forms were returned.

4.2.2 The Evaluations

The eight tapes evaluated were:

<table>
<thead>
<tr>
<th>Tape Description</th>
<th>Number of students returning evaluation form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forearm Plethysmography</td>
<td>23</td>
</tr>
<tr>
<td>Estimation of Systemic Blood Pressure</td>
<td>33</td>
</tr>
<tr>
<td>Skin and Peripheral Circulation</td>
<td>52</td>
</tr>
<tr>
<td>Starling's Law</td>
<td>11</td>
</tr>
</tbody>
</table>
I will concern myself mainly with tapes 1, 2 & 3 since these are the ones which produced the highest returns. The results were analysed in the following ways. The results of each question in the evaluation forms returned for tapes 1, 2 & 3 were separated into three categories: high, medium and low, and a chi-square analysis performed on this data to determine goodness of fit. The results from tapes 4 - 8 were similarly categorised, but low returns did not lend themselves to statistical analysis and so the meaning of these data is interpreted more subjectively.

Since I wanted to compare the "acceptance" of the theory section of each tape with the "acceptance" of the demonstration section, the eight questions concerning the theory section were repeated for the demonstration section. To compare these results and determine if there was any difference between them I used a t test to compare the data from each question in the theory section with the corresponding question in the demonstration section.

The statistical results are given in Appendix 2.2 and a summary analysis of the eight tape evaluations is given in Table 4.1.
Table 4.1  Summary Analysis of the eight video-tape evaluations

<table>
<thead>
<tr>
<th>Tape</th>
<th>Forearm Plethysmography</th>
<th>&quot; 2 Estimation of Systemic Blood Flow</th>
<th>&quot; 3 Skin and Peripheral Circulation</th>
<th>&quot; 4 Starling's Law</th>
<th>Tape 5</th>
<th>Carriage of Carbon Dioxide</th>
<th>&quot; 6 Effects of Exercise</th>
<th>&quot; 7 Gastric Functions</th>
<th>&quot; 8 Oxygen-Haemoglobin Dissociation Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAPE</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>SUMMARY OF ALL 8 TAPES</td>
</tr>
<tr>
<td>Did the tape make the experiment easier than it was?</td>
<td>YES</td>
<td>M YES</td>
<td>NO</td>
<td>YES</td>
<td>M</td>
<td>YES</td>
<td>NO</td>
<td>M YES</td>
<td>4 YES</td>
</tr>
<tr>
<td>Was it difficult to perform the experiment?</td>
<td>YES</td>
<td>M NO</td>
<td>NO</td>
<td>YES</td>
<td>M</td>
<td>YES</td>
<td>M</td>
<td>NO</td>
<td>3 YES</td>
</tr>
<tr>
<td>Did the students have to rush through the work?</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>M</td>
<td>M</td>
<td>NO</td>
<td>6 NO</td>
</tr>
<tr>
<td>Could the students have done with more time?</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>5 NO</td>
</tr>
<tr>
<td>Was it interesting?</td>
<td>Th</td>
<td>D</td>
<td>Th</td>
<td>D</td>
<td>Th</td>
<td>D</td>
<td>Th</td>
<td>D</td>
<td>Th</td>
</tr>
<tr>
<td>Did it hold the students' attention?</td>
<td>M YES</td>
<td>YES YES</td>
<td>M YES</td>
<td>YES YES</td>
<td>M</td>
<td>M</td>
<td>NO YES</td>
<td>M YES</td>
<td>M YES</td>
</tr>
<tr>
<td>Was it comprehensible?</td>
<td>YES YES</td>
<td>YES YES</td>
<td>YES YES</td>
<td>M YES</td>
<td>M</td>
<td>M</td>
<td>YES YES</td>
<td>YES YES</td>
<td>YES YES</td>
</tr>
<tr>
<td>Was it enjoyable?</td>
<td>M M</td>
<td>M M</td>
<td>M M</td>
<td>NO M</td>
<td>NO NO</td>
<td>NO NO</td>
<td>NO NO</td>
<td>NO M</td>
<td>M M</td>
</tr>
<tr>
<td>Was it clearly explained?</td>
<td>YES YES</td>
<td>YES YES</td>
<td>YES YES</td>
<td>M YES</td>
<td>M</td>
<td>M</td>
<td>YES YES</td>
<td>M YES</td>
<td>M YES</td>
</tr>
<tr>
<td>Was there too much information?</td>
<td>M M</td>
<td>M M</td>
<td>YES M</td>
<td>M NO</td>
<td>M M</td>
<td>YES M</td>
<td>YES M</td>
<td>M M</td>
<td>3 YES</td>
</tr>
<tr>
<td>Was it too long?</td>
<td>YES M</td>
<td>YES YES</td>
<td>YES M</td>
<td>M M</td>
<td>M M</td>
<td>YES M</td>
<td>YES M</td>
<td>M M</td>
<td>5 YES</td>
</tr>
<tr>
<td>Were ideas developed too quickly?</td>
<td>M M</td>
<td>M M</td>
<td>M M</td>
<td>M NO</td>
<td>YES M</td>
<td>M M</td>
<td>M M</td>
<td>YES M</td>
<td>1 YES</td>
</tr>
<tr>
<td>Was it easy to concentrate?</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>NO</td>
<td>NO</td>
<td>M</td>
<td>M</td>
<td>2 NO</td>
</tr>
</tbody>
</table>

M = moderately (ie neither YES nor NO)
Th = theory section
D = demonstration section
4.2.3 Discussion

The demonstrations in four of the tapes appear to make the practical work seem easier to perform than the students found it to be when they came to do it in the laboratory. There is a suggestion that two of the others may, in fact, make it seem slightly easier than it actually is also (see Table 4.1). This seems to corroborate the students' general feelings about the reproducibility of the demonstrations, as was pointed out in the foregoing chapter. Three of these experiments were in fact difficult to perform in the laboratory, viz those demonstrated in tapes 1, 4 & 6, the others being moderately easy or easy.

None of the experiments necessitated the students rushing through the work, as was suggested by the students in Stage 1 of the study. The students may have had to rush somewhat in two of these experiments, but there is little indication that they felt pushed. Similarly with the amount of time needed to do the work (see Table 4.1). It should be pointed out that these evaluations are of eight tapes out of about 40 that the students view throughout their laboratory course; there may be other practicals during which the students do have to rush and could benefit from more time.

Theory vs Demonstration

The comparisons between the theory sections and the demonstration sections of the tapes is certainly corroboration of the earlier attitudes to these tape sections. All the demonstrations but one were considered to be interesting, in comparison to only two theory sections (see
Table 4.1). None of the theory sections held the students' attention very effectively, while six of the demonstration sections did (the other two being moderately attention gaining). Both the sections seemed to be comprehensible to the students, and both were always only moderately enjoyable to view. Similarly, both sections in all the tapes were moderately or well explained. The amount of information in the theory sections was considered too much in three tapes, but never so in the demonstration sections. Similarly, five of the tapes were thought to have theory sections which are too long; but none of the demonstrations was ever thought to last too long. Generally speaking, ideas were never developed too quickly for the students to grasp in any sections in any of the tapes.

Only two of the tapes seemed to generally cause problems of concentration, the others being rated fairly easy to concentrate on while viewing them, although, as I shall show, concentration levels are often determined not by the tape as such, but more by environmental laboratory factors.

4.2.4 Appraisal

Little discussion of these results is necessary since, on the whole, they do corroborate many of the points raised in Stage 1 of the study. The only anomaly is the difference between the students' attitudes to carrying out their work as described in Stage 1, and the results here of asking them if they felt they had to rush after viewing their eight tapes. Perhaps all the tapes would have to be similarly evaluated before anything very definite could be said on this issue; however I am of the opinion that there are indeed many laboratory classes during
which the students do have to rush somewhat to get the work done, as was suggested by the students in Stage 1. But at this point all that can be said is that, as far as the laboratory classes associated with these eight tapes are concerned, the students did not have to rush to get the work completed.

Environmental factors

Turning to the environmental factors influencing concentration while viewing the tapes, an analysis of two hundred and nine evaluation forms provides some indication of these factors. Table 4.2 presents the results of this analysis. The most common distractions are the uncomfortable sitting positions while viewing the tapes, uncomfortable headphones, distractions by other students and distractions by technicians. Twenty-two other less common distractions were offered by the students returning the evaluation forms.

Little can be done to reduce distractions by other students at work in the laboratory, nor indeed can much be done about the technicians being a distraction; these are laboratory factors with which everyone has to put up with. However, the uncomfortable sitting positions could be alleviated by investing in high chairs with back supports instead of the present high stools, which force the students to slouch uncomfortably over the benches while watching the tapes. Likewise with the headphones: perhaps several types of headphones could be made available to the students to allow them to choose the ones most comfortable to them individually. The other factors indicate how widespread the factors are which can determine a
Table 4.2   Concentrating while Viewing the Tapes

Students' ability to concentrate while watching the video-tapes:

<table>
<thead>
<tr>
<th></th>
<th>Very High</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>38</td>
<td>114</td>
<td>49</td>
<td>8</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>N = 209</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Distractions due to: Number of times referred to

1. Uncomfortable sitting position  87
2. Uncomfortable headphones  82
3. Distractions by other students  47
4. Distractions by technicians  21
5. Others:
   Equipment on bench  1
   Not interesting tape  5
   Tape too long  5
   Student's mood  2
   Know it already  5
   Poor tone quality on headphones  1
   Faulty VT reception  5
   Extraneous noise  3
   Lecturer's voice  1
   Dizziness  1
   Whine of TV's  2
   Demo's on other benches  2
   Headache  2
   Thinking of other things  1
   Tired  6
   Eyestrain  1
   VT uninspiring  1
   Long-winded VT  1
   Boredom  3
   Distasteful demo  1
   TV induced epilepsy  1
   Sound too low  1
student's level of attention; little can in fact be done to alleviate these distractions, but they do indicate that there are many of them.

4.2.5 Summary

The evaluation of eight video-tapes provides suitable information to corroborate the students' earlier comments about learning from the tapes generally. Specifically, although clearly explained, the theory sections are again considered to be too long and to provide too much information; their interest level, ability to hold the students' attention and "enjoyability" are all held to be minimal. The students confirm their earlier opinion that the tapes often make the experimental work look easier than it actually is. The demonstration sections are interesting, keep the students' attention, do not contain too much information and are of an acceptable length.
4.3 Systematic tape production and analysis

4.3.1 Introduction

This sub-concern follows directly from the findings of both Stage 1 and from the preceding evaluations of individual video-tapes: the data from these was used as the basis for the development of the new "research" video-tape and its accompanying laboratory schedule. This section of the chapter can be divided as follows:

(a) The relevant literature on the production of video-tapes for teaching laboratory work.

(b) Producing and Evaluating the new "Research" video-tape.

(c) The Laboratory Schedule.

4.3.2 The Literature on Producing Video-tapes

Introduction

No systematic analysis of the production of the physiology laboratory video-tapes had taken place prior to the present study. The content of the tapes had been devised by the lecturer concerned, who had also decided on what equipment was to be included in the demonstrations in the tapes and the way in which the tape should be structured. No scripts were written for the tape production; a running order of events was all that the tape producer had in advance of producing the
tape. Graphics, captions and so on were all prepared in advance.

On the day of the production the lighting would be set up in advance, but the producer often knew only the barest outline of the sequence of events, having to improvise as the tape recording progressed. The lecturer never read from a script, relying on his knowledge of the subject and his own ideas about teaching to carry him through the recording.

I mention this as background information to the following literature review on tape productions, and also to indicate the differences in the "usual" production strategies and the ones used in producing the "new" video-tape, which will be described after the literature reviews.

Producing video-tapes

The strategies used for producing laboratory teaching video-tapes vary considerably depending on who is making the tape, why and for whom. Insufficient information is provided about production strategies when authors describe the way in which they employ video-tapes to enable a critical appraisal of the worth of each strategy.

I shall therefore offer a summary of information on three aspects of production, viz, (1) the method of production, (2) the time taken to produce a video-tape, and (3) the optimal duration of such tapes.

1. Method of Production

This can be split into (a) the sequence of events leading up to the recording of the tape, and (b) the style of teaching employed
(a) **Sequence of events leading up to the recording**

Pantello (1975), Lightfoot (1978), Fisher (1974b) and Wetmore (1971) all use a logical preparation strategy in which the personnel involved write a script and plan the sequence of shots and use of equipment; once this is done the program is recorded in the TV studios.

Pantello (1975) emphasises that much cutting to omit mistakes occurs in their productions; Lightfoot (1978) describes how the visual component of the tape is recorded first and then the sound track is dubbed on later. This is considered a flexible and reliable technique. Although Emkey (1978) does not describe production techniques as such, he does point out that he found it necessary and useful to carry out the experiment to be taped before taping it, so as to get some idea of what it is like to perform and how long it takes to complete.

Once the experiment is recorded, the tape is considered ready for use in the teaching program. Few authors discuss tape evaluation - either formative or summative, except perhaps as part of a larger evaluation of the laboratory course. But little, if any, systematic individual video-tape evaluation is conducted.
Wetmore (1971), however, sees student evaluation as being a vital part of the 12 steps that he describes for producing video-tapes; the final script used by him includes comments and ideas offered by students in the earlier tape trials.

Rouda (1973) employs a micro-teaching technique for producing laboratory video-tapes, in which the students involved are video-recorded carrying out the experiment and allowed to view the recording afterwards to analyse their performance. In a sense this is using student evaluation comments to help produce the tapes.

(b) Style of teaching in the video-tapes

The authors cited above convey the information of the tape by what might be termed the "conventional" way, i.e. in a way similar to lecturing, but using the facilities of the medium to do so.

Two other techniques of teaching by video-tape have been tried out. Piscapo (1973) and Leith (1969) employed programmed learning techniques in the production of teaching video-tapes. Leith was preparing a tape for children's TV lessons and found that programming the lesson so as to have the student watching and listening to the tape, and then carrying out some task, e.g. answering a question – all in the style of a linear program – was a very good use of the medium.
Piscapo employed the technique somewhat similarly, but to teach laboratory skills. He devised programmed sequences of specific skills to be carried out in the laboratory so that the student viewed a section of the tape, carried out that part of the skill, viewed the next bit, carried that out and so on until the complete skill was performed. The skill seems to have been broken down into its component parts, and each part taught separately with time for the student to practice it.

Earl (1977) used backward chaining in the teaching of a biology frog dissection. The technique to be used is first demonstrated straight through at usual speed; this is followed by a second demonstration which is given step-by-step in reverse sequence, i.e. by backward chaining. The students are given an illustrated handout which describes the script and diagrams of the various steps involved in the technique. Earl comments that this technique of teaching by video-tape was considered very effective and as such demonstrated the effectiveness of backward chaining in instructional films.

Both programmed sequences and backward chaining in instructional video-tapes are examples of exciting and apparently effective uses of the medium. However, it is clear that most instruction in video-tapes is of the "conventional" lecture type.
2. The time taken to produce a video-tape

The time taken to finally produce a video-tape obviously varies considerably depending on who is producing the tape and for what purposes.

Again, all authors do not give details of the time involved, and those who do often indicate the time involved in preparing one part of the tape only, e.g. the time in the recording itself. Also, the time put into preparing an instructional video-tape may be reflected in the quality and effectiveness of the final product - I have no way of relating these two factors together; so, all I can offer are some examples of the time involved in producing a variety of quite different tapes.

Lightfoot (1978) required 2-3 hours of tape recording to produce a 30 minute video-tape; he had written the script in advance and had prepared all the equipment necessary. Emkey (1978) took 8 hours in total to make a video-tape lasting about 25 minutes. This time involved all the preparations necessary. Moss (1971) took about 4½ hours, while Wetmore (1971) required 3-5 hours for all the stages of producing tapes lasting 3-5 minutes.

Where quality and professionalism is a major factor, much more time is required in the preliminary stages. Fisher (1974b) indicates that to write an audio-script requires 3-10 hours, and anything up to 50 hours is needed to write the video-script. And this is before going into the TV studios.
Most individuals will be using limited resources, equipment and facilities for the production of their video-tapes (e.g. using a simple portable camera); in such circumstances it seems reasonable to say that about 8 hours at least is required to produce the final product.

3. The optimal duration of video-tapes

This is a difficult aspect of video-tape production to assess properly; the length of a tape will be determined by what is to be taught as much as anything else. Wetmore (1971) produced tapes lasting only 3-5 minutes; these tapes were used to instruct students in routine laboratory techniques, and nothing else. The students viewed the tapes when they wanted to learn the technique, other instruction being given by demonstrators and so on. Emkey (1978), Fisher (1974b) and Lightfoot (1978) all produced tapes which had content other than just the demonstration of techniques. As such, their tapes lasted considerably longer than Wetmore's, generally between 10 - 30 minutes. But each author points out that the upper limit was normally below 25 minutes. Simpson (1973) used video-tapes lasting no more than ten minutes, since anything longer became too difficult for the lecturer to produce.

So, with respect to science laboratory video-tapes most authors recommend tape duration of below 25 minutes to achieve best results.
Summary

Most video-tapes employ a "conventional" teaching style similar to live lecturing. The time taken to produce such a tape varies considerably, but with limited resources is probably about 8 hours for a 20 minute tape. Most authors produce video-tapes lasting less than 25 minutes.

4.3.3 Producing and evaluating the new "Research" video-tape

The laboratory evaluation described in Stage 1 of the study and the subsequent individual tape analyses described earlier in this chapter indicate that, from the students viewpoint, the video-tapes are deficient in certain aspects - specifically the main points raised are:

1. The tapes are too long.

2. Although relevant perhaps to the laboratory work, the theory content of the tapes is too lengthy, contains too much information and is of minimal interest to the students.

3. There is concern over the reproducibility of some experiments, and also some students have difficulty in performing some of them.

4. The most relevant and interesting sections of the tapes are the demonstration sections. It is felt that on the whole sufficient time is devoted to these sections, but there is an indication that perhaps more time should be devoted to them.
This section of the chapter considers these points as part of a description of the process of the development and evaluation of the new video-tape to be used for teaching in the laboratory. What follows is a case study of the development of this tape which will illustrate the dynamics of an educational technologist, lecturer and TV producer working together to produce a teaching video-tape (qv also McConnell, 1978).

I have chosen to document the evolution of the tape in this manner so as to indicate the processes leading to the recording of the tape and its uses in the laboratory.

**Conceptualising the process**

Because the production of the "new" tape was to involve a systematic production technique involving the lecturer running the physiology laboratory, the University's TV producer and myself - culminating in an evaluation of the new tape, I considered it necessary to try and follow some consistent, predetermined strategy to help conceptualise the whole process.

Coldevin (1973) proposes a model for systematic television research, which is produced in a slightly modified form in Figure 4.1. This model deals with four stages of video-tape production, viz, planning, production, dissemination and evaluation, and as such requires little description.

In producing the present video-tape I did not intend to adhere to this
Figure 4.1 A model for Systematic Video-Tape Production and Research (after Coldevin 1973)
model in every detail, nor in fact would circumstances have allowed me to do so. It was used solely as a guide to the tape production; a guide which would help conceptualise the whole process, point to areas of concern and suggest the sequence of events.

**Background to the Production of the Tape**

With the laboratory evaluation findings and Coldevin's model in mind, the next step was to discuss the production of the new tape. I had circulated a report on the evaluation of the laboratory (Stage 1) to the lecturer involved in teaching in the lab, the university's television producer who had produced most of the video-tapes so far and to my supervisor; written comments on the report were conveyed to me by the latter two.

Discussions about the effectiveness of the tapes followed at which all four of us were present. The first meeting (McConnell, June 1976) focussed on the evaluation study report and the recommendations which I had made in it. Three main issues were discussed:

1. **tape length** - the report indicated clearly that the tapes are considered to be too long; we agreed that in future the tapes should be shorter in length, which could be accomplished by at least reducing or omitting the theory sections;

2. "reproducability" of the demonstrated experiments and the "professionalism" of the finished product - there was some concern amongst the students that some of the demonstrated experiments could not easily be reproduced in the physiology
laboratory. The cause of this concern stems partly from the way in which the tapes are produced; a "definitive" version of the experimental work is always presented in the tapes so as to clarify the procedures involved and present the demonstration in a clear, precise manner - thus utilising the medium to its fullest. However, to the student viewing the recorded demonstration for the first time and subsequently carrying out the experiments in laboratory conditions which are not easily controlled, this "definitive" version where nothing is seen to go wrong is sometimes a travesty of their reality where so many aspects of the experimental work fail: to them, the demonstration cannot be reproduced in the lab. We therefore felt that in future tapes this concern could be alleviated to some degree by including a note in the tape on possible difficulties which the students may encounter when carrying out the experimental work.

3. Student interaction with the tapes - part of the cause of the "boredom" experienced while viewing the tapes is probably due to the fact that the students are required to sit passively for the duration of the tapes, and there is little or no active involvement. With the inclusion of some student interactions with the tapes, and the inclusion of instructions to be carried out while watching the tape and the posing of questions which require some active thought - the effects of boredom should diminish, as well as the possibility of more learning also occurring! Future tapes should take these points into account.
The following meeting continued these discussions, but addressed itself specifically to the aims and objectives of laboratory work (and therefore also the aims of the video-tapes), with special attention to the teaching of the psychomotor skills.

The aims of the video-tapes obviously determine to a large extent the role of the practical work demonstrations in them, which has implications for the production of new tapes. We felt that the psychomotor skill training demonstrated in the tapes could be considered on two levels:

(i) It is necessary to have skills so as to be able to carry out particular experiments and achieve certain predefined "results" ie the skills are a means of obtaining cognitive aims.

(ii) Skills can be learned to a fairly sophisticated level which would be acceptable in professional spheres. Here the emphasis is on the acquisition of specific skills as an end in themselves.

It seemed obvious that level (i) was a necessary process in laboratory education and reflected the present situation in the physiology lab. Level (ii) should certainly be emphasised much more: this would have to be achieved in future video-tapes and should be reinforced by greater emphasis being given to psychomotor skill acquisition in the laboratory schedule which accompanies the video-tape.

There was also general agreement that new tapes should concentrate
much more on portraying the immediate lab skills and practical
work necessary to carry out the day's laboratory work, and that
the lengthy theory introductions should be excluded, or at least
reduced in length.

**Analysing an Existing Tape**

Our next meeting (McConnell, October 1976) consisted of analysing
an existing video-tape which we had decided to re-make to determine,
in a fairly subjective but informed manner, the effective and
ineffective aspects of the tape. This involved a very critical
look at the length of the tape (involving questioning the relevance
of certain parts of the tape); camera-angle shots; equipment
used in the demonstrations; graphics employed and the amount of
student interaction with the tape. The main points arising from
this analysis were that the new tape should be shorter - lasting
about twenty to twenty-five minutes at the most (the original runs
for forty minutes); the use of graphics should be improved, and
more thought should be directed toward maintaining student interest.

These meetings had allowed us to voice our opinions about teaching
and learning in the physiology laboratory, with particular reference
to teaching by video-tape, and come to some agreement on what we
felt were important issues in the effective running of the laboratory.
This was not an easy process and the problems involved when indi-
viduals with different backgrounds get together viz: educational
technologists, a lecturer running a laboratory course and a TV
producer, to discuss problems of producing "effective" teaching
video-tapes should not be unduly played-down. As might be expected,
we each had quite definite and fairly different conceptions of the
role of video-tapes in teaching, so that any conclusions arrived at were to some extent a reflection of our willingness to come to terms with the problems involved and produce working solutions to the production of video-tapes rather than statements of general unanimous agreement which we all wished fervently to put into action. This is an important point which I would like to emphasise since it has some bearing on the subsequent course of events, which will be described below.

"Shredding" the Existing Tape

With the preliminary theoretical analysis finished, the job of thoroughly analysing the existing tape so as to be in a better position to produce the new one had to be accomplished. This was done by myself and the TV producer of the AVA Unit. Special thought was given to:

(a) Analysing the structure of sequences - did they make sense logically, how did they relate to each other?

(b) Determining alternative ways of teaching each section which, we hoped, would be better than the existing ways. This involved considerations of camera angles best suited to clearly showing the techniques being demonstrated; would diagrams of certain pieces of equipment help the students in their understanding of how the equipment functions, rather than just a still of the piece of equipment being shown; would it be more effective to use slides to illustrate certain conceptual points rather than just discuss them (eg slides of interference patterns on the Haemocytometer cover-slip)?
(c) Deciding at which points student attention could be actively stimulated. For example, requiring the students to handle a piece of equipment as its function is being explained in the tape; thinking of suitable questions to pose to the students as they watch the tape; the special use of captions, and so on.

(d) Analysing the video-tape discourse to determine ways of condensing it. A recording of the audio-component of the tape was made which was then transcribed, and a critical analysis of the content performed. "Redundant" language (e.g. unnecessary repetition) was eliminated and a shorter version was written, which formed the basis of the video-tape production script. (The script for the new "research" video-tape is given in Appendix 2.)

Structuring the New Video-tape

From the analysis of the existing tape, a structure and production strategy for the new tape was devised. A novel element in the production of this tape was to be the use of a script. Scripts had never previously been used in the production of the tapes and it was felt by myself and the producer that this "innovation" could considerably help clarify production procedures and the general teaching effectiveness of the tape since it would force a logical, previously thought out structure on to the tape content, instead of allowing such a structure to more or less emerge during the time of the studio production. (The literature survey cited earlier also indicates the real necessity of using a script.)

On the basis of the analysis of the audio component of the existing
tape and with the help of the existing student laboratory schedule, the script was written (see Appendix 2). An additional strategy was employed to help give clarity to the script, and that was the analysis of the skills to be taught in the tape by hierarchical task analysis (Annett et al, 1971). This allows a task to be broken down into its subordinate components, giving an indication of the number of sub-tasks which have to be considered when teaching the "executive" task. An example of this is given in Fig. 4.2

The laboratory class for which the tape was being produced was concerned with experiments on blood. One of these experiments is a red cell count. The principal task of carrying out a red cell count is initially broken down into its four main sub-tasks viz obtaining a blood sample; diluting the blood; transferring the blood to a haemocytometer and finally examining this under a microscope. Each of these four tasks is broken down in turn into its component tasks, with each level being simpler than the previous one. The level to which you break the principal task down is determined subjectively on the basis of your knowledge of the level of sophistication that the trainees have already accomplished. The trainer has to ask the question "what is the probability without training of inadequate performance?" (Stammers & Patrick); the answer to this determines the lowest level of the hierarchical task analysis i.e. the point where training stops.

As someone not fully expert in the techniques to be used in the haematological experiments - but who had the job of devising a video-tape to teach these techniques - the hierarchical task analysis
Hierarchical Task Analysis: an example of the analysis of one of the tasks taught in the video-tape
provided a method of becoming acquainted with them by allowing a logical analysis of their psychomotor structure, an analysis which also helped provide a basis for devising the running order of sequences in the script for the video-tape.

Using these three strategies - the analysis of the audio component of the existing video-tape, the existing student laboratory schedule and the hierarchical task analysis of the techniques to be taught - the script was written. It included every detail of the video-tape production viz the running order of the verbal component, when and where the graphics would be used and all instructions to the presenter (e.g. when to refer to a caption, when to illustrate a point by reference to a piece of equipment and so on). The tape was to be presented in four sections, corresponding to the four experiments to be carried out. The changes and additions to be incorporated into this re-make tape, were included in the script; a discussion of the precise nature of these will be held over until the evaluation section below.

Producing the New Video-tape

Having done the groundwork for the tape production - discussed at length the aims of the tapes and the "philosophy" of teaching portrayed in them; analysed in detail the existing video-tape and produced a comprehensive script for directing the tape - it remained to produce the tape in the University TV Studios. This proved more problematic than had been anticipated; part of the problem was that the presenter in the tape had never worked from a script before, and felt constrained and somewhat restricted by having to adhere to one now. Also, at this late stage of production there were still problems of conflict of purpose and aims amongst those involved in producing
the tape which had obviously lain dormant since the last group meeting, but which came to the surface fairly quickly when we started to produce the tape in the studios. Essentially, the presence of these problems resulted in the tape being much longer than had been planned; however, most of the production points relating to the educational strategies decided upon were successfully incorporated and we felt that, although not reflecting our intentions completely, the end product was sufficiently favourable to allow its experimental use in the physiology laboratory.

Evaluating the New Video-tape

There are a variety of ways in which TV programmes of this nature can be evaluated, e.g. by testing the students post-viewing knowledge and ability to carry out the experiments and comparing these results with those produced by similar pre-viewing tests: a gain is attributed to the learning which has taken place from viewing the tape. Along with this, control groups could be used with which to make comparisons.

I decided not to adopt such an approach, for three reasons:

1. the logistics of setting up such experimental situations were too great and would have undoubtedly provoked comments from the students about being used as 'guinea pigs'.

2. perhaps more importantly, the literature on such controlled experiments abounds with results of "no significant difference" (Williams, 1975; Entwistle 1975).
3. most importantly, I wanted feedback about the effectiveness or otherwise of the production strategies and treatments of the tape so as to help in the production of future tapes, and perhaps the re-make of the "new" tape. This was the main concern of the evaluation.

Choosing an Evaluation Method

Deciding on the best evaluative method was a crucial aspect and was given considerable thought. The technique used to evaluate the tape had to be responsive to the particular production strategies employed and had to give precise information about the effectiveness of the teaching techniques used in the tape. It had to be a technique which would permit the students to speak freely, openly but in detail about the teaching effectiveness of the tape, but also had to be capable of allowing an analysis of specific aspects of the tape such as the use of special graphics, the incorporation of slides to aid comprehension, close-ups of difficult manipulative skills and so on.

Stimulated Recall

The technique of stimulated recall seemed to fit these needs fairly well. This technique had been used in a variety of research situations (qv Bloom, 1953; Siegal et al, 1963) and a report of its use as an analytical tool in evaluating individualised instructional material has been written by the author (McConnell, 1978b).

Essentially, it involves evoking the thoughts and reactions to the video-tape which occurred at the time the students viewed the tape.
This is achieved by confronting the viewers with a series of sections taken from the video-tape (viewed within the previous twenty-four hours) and asking them to recall the thoughts which they had had during the original viewing. The sections chosen are termed critical points and exemplify particularly important and novel aspects of the tape, such as the use of a special visual aid, the superimposition of data or labels over a diagram or the use of split screens. In any case, the critical points are chosen to assess and evaluate their impact on the students and to discover their usefulness as teaching strategies.

Seven critical points were analysed in this way, with sixteen students taking part in individual stimulated recall sessions; each one was tape-recorded and transcribed later for analysis.

**Students' Instructions**

The following are the instructions which were given to each student at the beginning of the stimulated recall session. The students were not told that the video-tape had been specially made for research purposes, but they of course did know that the schedule was of a re-designed type (this will be discussed later).

**Instructions:**

"I am interested in your attitudes to the video-tapes which are used for teaching in the laboratory. I am about to show you several extracts from the video-tape that you viewed yesterday in the lab. I will describe each extract before I show you it, and when I do show
you it I would like you to think back to yesterday when you were watching the tape in the lab - put yourself back in that position - and try to think of what was going through your mind as you watched the tape.

I am interested in knowing ANY of the thoughts that passed through your mind as you watched each of these parts of the tape. Please feel free to mention anything that you can remember."

Each critical point was then shown in turn, with the author again going over the underlined parts of the instructions before and after the student viewed each point, and again if and when clarification was needed by the student. No student had difficulty in carrying out this task.

The Analysis of the Critical Points

The teaching content of each critical point will be described along with the main TV teaching techniques used; this will be followed in each case by a description of the main points arising from the students' stimulated recalls and a brief discussion.

Critical Point One: Haemocytometer Grid

1. Close-up of haemocytometer to show its structure

2. Diagram of the grid on the haemocytometer trying to indicate the various squares on the grid and pointing out that the student (S) should use the centre square for counting the cells
3. Superimposition of the dimensions of the squares over the grid as being explained

4. Summary of all the dimensions of grid at end

Main TV teaching techniques used:

1. Close-up haemocytometer

2. Diagram of grid

3. Superimposition of grid dimensions over grid

The main factor emerging from the analysis of the stimulated-recall protocols is confusion over comprehension of the description of the equipment to be used (see Table 4.1). Despite close-ups of the haemocytometer, some students were not sure just where to put the blood - in the side channels or on the "platform"? This particular part of the tape, in reflection, was performed fairly quickly, and although the structure of the haemocytometer may have been carefully presented on the screen, little emphasis was given as to where exactly the blood should be placed.

There was similar lack of comprehension concerning the whereabouts of the grid on the haemocytometer - this was obviously not clearly indicated, and when students came to look for the grid under the microscope they were generally unsure just where to start looking and spent some time trying to find it. Also, there was some confusion over which part of the grid they were looking at on the screen and
Table 4.1 The Students' Main Comments on Critical Point One

<table>
<thead>
<tr>
<th>Students' Comments</th>
<th>No. Students making comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confusion over figures of grid: going too quickly</td>
<td>12</td>
</tr>
<tr>
<td>Grid on TV did not look like own: difficulty in finding the squares etc</td>
<td>9</td>
</tr>
<tr>
<td>Checked measurements on VT into schedule</td>
<td>4</td>
</tr>
<tr>
<td>Couldn't see the relevance of measurements etc, therefore got bored and lost attention</td>
<td>3</td>
</tr>
<tr>
<td>Didn't pay attention because not new method</td>
<td>2</td>
</tr>
<tr>
<td>Couldn't determine from VT where to put blood</td>
<td>2</td>
</tr>
<tr>
<td>Tried to visualise from VT what it would be like under microscope</td>
<td>1</td>
</tr>
<tr>
<td>Questioned own ability to do technique</td>
<td>1</td>
</tr>
<tr>
<td>Tried to relate VT to schedule, consequently got lost</td>
<td>1</td>
</tr>
<tr>
<td>Why on VT when all in schedule?</td>
<td>1</td>
</tr>
</tbody>
</table>
which part they were to use themselves in their practical work — the confusion was mainly concerned with the exact "square" to be used — it was not clear if it should be a large square or one of its constituent squares; this problem was only settled afterwards, when the demonstrator assisted those with problems.

Attention was high — although some students complained about the abundance of figures and dimensions which, at the time of viewing, seemed fairly irrelevant, especially since they were in the schedule anyway.

Summary:

1. The close-up of the haemocytometer was fine

2. The explanation of the grid dimensions was rather confusing — students were not clear what part of the grid they would be seeing under high-power

3. Attention was lowest when figures and dimensions of the grid were being given.
Critical Point Two: Putting the Cover-slip onto the Haemocytometer

1. Close-up of the technique involved to show clearly the correct method of placing the cover-slip onto the haemocytometer

2. Checking for interference patterns - S should be able to see these patterns on the slide if the cover-slip has been put on correctly. A slide of interference patterns is shown also.

3. Diagram of haemocytometer with cover-slip on - trying to indicate the importance of having the cover-slip on properly so that the height between grid and cover-slip is 0.1 mm, which is vital for all later calculations

Main TV teaching techniques used:

1. Close-up haemocytometer and cover-slip

2. Slide of interference patterns

3. Diagram of cover-slip on haemocytometer

A factor which first emerged at this critical point, and one which reappeared at later points, was the effect that the video demonstration had on the students' attitude to their own ability to perform the method being demonstrated. Five students commented that they had "asked" themselves if they would be able to put the cover-slip onto the haemocytometer properly, without breaking
it (see Table 4.2). Apparently, this appeared to be fairly easy on the tape, but these students knew from previous experience with using cover-slips that they might have difficulty in performing it correctly. What this means in terms of their confidence in carrying out the practical work generally is obviously difficult to determine, but as we shall see, this questioning of their own ability occurs often enough to warrant some attention in the presentation of techniques on the screen.

As well as this, there was confusion over the actual procedure involved in placing the cover-slip on the haemocytometer - was it slipped on from one side? Dropped on from the top? Or what? The diagram of the cover-slip on the haemocytometer was commented on favourably and seemed to help some students.

Loss of attention was mainly due to boredom with the same thing being shown on the screen far too long, and some students "switched off" during the sections on measurements - the justification being that they could look these up in the schedule later on. As it was, some of the students did also look at the schedule as they were watching the tape, either taking notes or following descriptions.

Three students examined the haemocytometer on the bench while watching the video, and the slide of the interference patterns caused some students to think of previous work done.

Summary:

1. Some students questioned their own ability to carry out the experimental work in the manner demonstrated on the video
2. The demonstration of placing the cover-slip on the haemocytometer was not clear.

3. When the same thing is on the screen far too long (eg in this case the diagram of the cover-slip on the Haemocytometer), students' attention may be lost through boredom.

Table 4.2 The Students' Main Comments on Critical Point Two

<table>
<thead>
<tr>
<th>Students' Comments</th>
<th>No. of students making comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of attention</td>
<td></td>
</tr>
<tr>
<td>(a) during measurements diagram</td>
<td>9</td>
</tr>
<tr>
<td>Confused:</td>
<td></td>
</tr>
<tr>
<td>(a) over where to put the blood</td>
<td>7</td>
</tr>
<tr>
<td>(b) why/how cover-slip is put on</td>
<td></td>
</tr>
<tr>
<td>(c) over meaning</td>
<td></td>
</tr>
<tr>
<td>Interference rings produced active thought</td>
<td>7</td>
</tr>
<tr>
<td>Questioned own ability to carry this out in lab</td>
<td>5</td>
</tr>
<tr>
<td>Wrote 0.1 mm into schedule</td>
<td>4</td>
</tr>
<tr>
<td>Looked clear on VT - but not when student came to do it</td>
<td>2</td>
</tr>
<tr>
<td>Didn't understand parts - but OK since could be read-up later</td>
<td>2</td>
</tr>
<tr>
<td>Looked at haemocytometer on bench/schedule</td>
<td>3</td>
</tr>
<tr>
<td>Imagined self putting cover-slip on</td>
<td>1</td>
</tr>
</tbody>
</table>
Critical Point Three: Looking at the slide under the microscope and counting the Red Blood Cells

1. Caption of low-power magnification, to give idea of what to expect

2. Caption of high-power magnification; zoom into centre square; trying to indicate what grid will look like under HP and how to locate the centre square for counting the cells

3. Explanation of how to count the cells in a group of 16 "small" squares - problems of bordering cells etc

Main TV teaching techniques used:

1. Caption of low power magnification

2. Caption of high power magnification

Again, students' own ability to perform the experiment as well as it was demonstrated on the video was questioned. "I'll never get the red blood cells to look as good as those!"

There was some confusion over the exact number of squares needed in the cell count, and with the exact part of the grid to be used for the cell count (see Table 4.3). However, this section provoked some active thought, mainly in trying to work out how to count the cells before it was explained on the video; wondering about what
Table 4.3: The Students' Main Comments on Critical Point Three

<table>
<thead>
<tr>
<th>Students' Comments</th>
<th>No. of Students making comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of attention, due to:</td>
<td></td>
</tr>
<tr>
<td>(a) same thing on screen for too long</td>
<td>9</td>
</tr>
<tr>
<td>(b) grid</td>
<td></td>
</tr>
<tr>
<td>(c) presenter on screen too long</td>
<td></td>
</tr>
<tr>
<td>Missed</td>
<td></td>
</tr>
<tr>
<td>(a) section on sub-stage condenser</td>
<td>7</td>
</tr>
<tr>
<td>(b) warning on clumping</td>
<td></td>
</tr>
<tr>
<td>Questioned own ability to carry this out in lab</td>
<td>6</td>
</tr>
<tr>
<td>Confused over</td>
<td></td>
</tr>
<tr>
<td>(a) number of squares to be used in counting</td>
<td>4</td>
</tr>
<tr>
<td>(b) sub-stage condenser (where is it?)</td>
<td></td>
</tr>
<tr>
<td>Actively thought about RBC calculations and clumping</td>
<td>3</td>
</tr>
<tr>
<td>Thought: RBC are concave</td>
<td>3</td>
</tr>
<tr>
<td>Looked through schedule</td>
<td>3</td>
</tr>
<tr>
<td>Amused at obvious faking at looking down microscope</td>
<td>1</td>
</tr>
</tbody>
</table>
constituted "clumping"; and how to deal with borderline cells.

Attention was beginning to wane at this point: seven students who professed to having lost attention could not say what caused this - they just "switched off" - while five others lost attention through boredom with the same thing being shown on the screen for too long, specifically with the grid being shown far too long and with the presenter appearing for too long.

Three students used the schedule while viewing the tape; mainly for checking measurements and for following descriptions. "Active thought" was provoked in three instances - where the student knew that she would have to do a calculation later and therefore actively paid more attention as the presenter described how to perform it; and in one instance where the video-tape production stimulated the students' attention level.

Summary:

1. Students' ability to perform the experiment as well as it was portrayed on the screen was questioned by some students

2. Attention lost in sections where same thing was on screen for too long.

3. Some confusion over the grid square to be used.
Critical Point Four: Pipetting Bulb

1. Bulb shown - S requested to examine one on bench

2. Diagram of bulb cross-section - with an explanation of how the three valves function

3. Practical explanation of pipetting Drabkins reagent and cautions

4. Cleaning pipette and necessity of washing hands

Main TV teaching techniques used:

1. Close-up bulb pipette

2. Diagram of bulb (cross-section)

3. Presenter pipetting

At this critical point, two factors influenced students' reactions to the video. The first factor was related to time - the tape had been running for some time by now, and no doubt the students were feeling slightly tired of sitting on a high stool, watching a small screen. Loss of attention and concentration as reported in the stimulated recall, was high which seems to suggest that the students were indeed beginning to feel tired (see Table 4.4). However, another factor should not be neglected: this loss of attention was also
Table 4.4 The Students' Main Comments on Critical Point Four

<table>
<thead>
<tr>
<th>Students' Comments</th>
<th>No. of students making comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switched off - not new material</td>
<td>13</td>
</tr>
<tr>
<td>Diagram good - made student think about procedure</td>
<td>4</td>
</tr>
<tr>
<td>Bored - too long/ wanting to get started</td>
<td>4</td>
</tr>
<tr>
<td>Paid attention to valve 2 warning</td>
<td>3</td>
</tr>
<tr>
<td>Actively tried to remember how to use bulb</td>
<td>3</td>
</tr>
</tbody>
</table>
partly due to the fact that the demonstration of the use of the bulb-pipette was, generally, not new to the students; most of them had used a bulb-pipette before, and they tended to "switch-off" because of this. Nevertheless, the level of "active thought" at this point was also high - students were stimulated to consider the use of the bulb-pipette, especially after the special comment concerning valve 2, which apparently was new to them. Students commented that, although they had used a bulb-pipette before, no-one had ever taken the time to explain exactly how the valves functioned, and the diagram shown on the screen which accompanied the description was thought to be very helpful and effective. This is evident also in the fairly high occurrence of "Increased Attention" due to the detailed technique being described - but only when the diagram was on display.

However, for the student who felt she knew all of this before, boredom set in, and in fact at least one student commented, after watching the critical point during the stimulated-recall session, that she could not remember having seen this part of the tape at all in the lab!

Summary:

1. Loss of attention was very high: due to the length of the tape (students taking a "natural" break?) and to the fact that this part was, generally, not new to them

2. Diagram of bulb-pipette was very useful and worthwhile
Critical Point Five: Taking blood from a subject's ear-lobes

1. Description of lancet and how to use it - close-up of ear-lobes and how to clean and pierce it - trying to indicate the psychometer and "personal" skills involved

2. Collecting blood into pipette - close-ups, indicating a certain degree of difficulty involved

3. Transferring the blood into Drabkin's - blowing and sucking method; vital not to swallow!

**Main TV teaching methods used:**

1. Close-up ear-lobes and piercing

2. Close-up of collecting blood

3. Mixing blood and Drabkin's

It is interesting to note that at this point, the questions which the students were asking themselves while viewing the tape in the lab were numerous - the highest level of all the critical points - while the level of attention was also very high ie loss of attention was low (see Table 4.5). This high level of questioning and high level of attention may have been a "natural" consequence of having had a "break" in the previous part of the tape - critical point four - where attention had been quite low. However, it may also have been due to the rather vivid demonstration in this part. All students
### Table 4.5 The Students' Main Comments on Critical Point Five

<table>
<thead>
<tr>
<th>Students' Comments</th>
<th>No. of students making comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Donor looked terrified&quot;</td>
<td>10</td>
</tr>
<tr>
<td>Lost attention</td>
<td>4</td>
</tr>
<tr>
<td>Thinking about</td>
<td>4</td>
</tr>
<tr>
<td>(a) which end of tube should be used</td>
<td></td>
</tr>
<tr>
<td>(b) tube contaminating ear</td>
<td></td>
</tr>
<tr>
<td>(c) how presenter would do technique</td>
<td></td>
</tr>
<tr>
<td>Questioned own ability to carry this out in lab</td>
<td>2</td>
</tr>
<tr>
<td>Used thumb in laboratory</td>
<td>1</td>
</tr>
<tr>
<td>Wondered how she would react to ear-piercing</td>
<td>1</td>
</tr>
</tbody>
</table>
commented on the "terrified" look on the blood-donor's face, and they were obviously keenly interested in seeing if the ear-piercing would be as gruelling as the donor seemed to imagine it would be! Thus attention was high and students were asking themselves just how they would react to having their ears pierced; how deep an incision they should make and other related questions. However, this increase in attention level and questioning also acted to take the students' minds off the actual techniques being demonstrated - ten students said that, in one way or another, they had found the vividness of the demonstration distracting, causing them to miss the techniques being demonstrated.

Nevertheless, for those who were not so distracted, the details of the extraction of blood were deemed very good, and the presenter's apparent difficulty in eventually getting enough blood was thought to make the technique look very realistic - apparently a comforting rare occurrence.

Summary:

1. The vivid portrayal of the donor tended to distract students' attention from the techniques being demonstrated

2. Students' attention very high.
Critical Point Six: Colorimetric Reading and Calculations

1. Diagram of standard curve - indicating method of reading from the curve and interpolating own sample reading

2. Head and shoulder shots interspersed with captions on
   (a) Haldane Standard and explanation
   (b) Oxygen Carrying Capacity and explanation
   (c) Normal OCC for male and female

   basically, trying to indicate how to use the various readings/measurements taken.

Main TV teaching techniques used:

1. Diagram of standard curve

2. Head and shoulder shots and captions

In contrast to the previous critical point, critical point six is characterised by a very high "loss of attention" and very few instances of questions being asked (see Table 4.6). By this time, the students in the lab had been viewing the tape for at least 30 minutes - fatigue and boredom were bound to be evident. On top of this, the tape at this point dealt with fairly theoretical aspects of doing calculations on the measurements previously obtained. Apart from the description of how to interpolate results on the graph - which was thought to be a "waste of time" by some students - (and, incidentally, the demonstration of the colorimeter which was different to the one on the lab-bench) -
Table 4.6  The Students' Main Comments on Critical Point Six

<table>
<thead>
<tr>
<th>Students' Comments</th>
<th>No. of Students making comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of attention: getting bored by now tape too long</td>
<td>14</td>
</tr>
<tr>
<td>Didn't pay attention since not going to have to do this in lab (all theory)</td>
<td>10</td>
</tr>
<tr>
<td>Good graph of standard curve: caused active thought</td>
<td>3</td>
</tr>
<tr>
<td>Bewildered by graph/figures</td>
<td>2</td>
</tr>
<tr>
<td>Only listened to what had to be done in the lab</td>
<td>1</td>
</tr>
<tr>
<td>Caption up too long</td>
<td>1</td>
</tr>
<tr>
<td>Different colorimeter used in lab</td>
<td>1</td>
</tr>
<tr>
<td>Drew graph</td>
<td>1</td>
</tr>
</tbody>
</table>
this section was of shots of the presenter interspersed with captions illustrating calculations. This was undoubtedly the main reason for students' loss of attention (along with the time factor). It was thought that time was being wasted when the presenter was "on the screen"; the captions seemed to be "up" too long, one student commenting that he had read them before the presenter had! The attitude was that all of the calculations being discussed were in the schedule, and that the students could worry about the results and theory afterwards - so they "switched off", because, as one student put it, "I wasn't going to have to actually do that in the lab."

Two other factors affected students' attitudes to this part of the tape: one was that the teaching at this point was too fast - so those who tried to follow it eventually gave up and left it till later, to look up in the schedule; the other was that other students were beginning to start on their practical work, and attention was on them.

Summary:

1. Loss of attention reached a peak at this point: due to time factor (tape had been running for at least 30 minutes) and the fact that theory was being discussed

2. Graph of standard curve good
Critical Point Seven: Differential White Cell Count

1. Oil immersion technique - close-ups of blood-smear on the microscope and illustration of oil-immersion technique.

2. Caption illustrating tracking - description of method of counting the cells

3. Caption of blood-smear and an explanation of the different white cell types (main types)

Main TV teaching techniques used:

1. Close-up of slide on microscope platform

2. Caption on tracking

3. Caption of blood-smear

Attention at this point was regained; several reasons may be suggested for this: the previous critical point six was unusually boring, so that anything following it (this section) would catch the students attention; this section was concerned with demonstrating and discussing a method of taking a blood smear, which was a contrast to the other techniques.

Whatever the reasons, attention was higher, although the students were beginning to wonder just how long the tape was to be (see Table 4.7). Some students actively didn't pay attention, one reason given was
Table 4.7 The Students' Main Comments on Critical Point Seven

<table>
<thead>
<tr>
<th>Students' Comments</th>
<th>No. of students making comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lost attention:</td>
<td>9</td>
</tr>
<tr>
<td>too long</td>
<td></td>
</tr>
<tr>
<td>headphones hurting</td>
<td></td>
</tr>
<tr>
<td>had done this before</td>
<td></td>
</tr>
<tr>
<td>bored</td>
<td></td>
</tr>
<tr>
<td>Asked: will I find 200</td>
<td>3</td>
</tr>
<tr>
<td>Couldn't see the difference between the different WBC</td>
<td>3</td>
</tr>
<tr>
<td>Confusion - count RBC also?</td>
<td>2</td>
</tr>
<tr>
<td>Active thinking:</td>
<td></td>
</tr>
<tr>
<td>about WC</td>
<td>2</td>
</tr>
<tr>
<td>nice bit of photography (objective hitting oil)</td>
<td>1</td>
</tr>
<tr>
<td>this will be harder than it looks</td>
<td>2</td>
</tr>
<tr>
<td>presenter is cheating using an oil dropper</td>
<td>1</td>
</tr>
<tr>
<td>careful with oil</td>
<td>1</td>
</tr>
<tr>
<td>RED for oil immersion</td>
<td>1</td>
</tr>
<tr>
<td>about microscopy - need good imagination for this!</td>
<td>1</td>
</tr>
<tr>
<td>will have to do good staining</td>
<td>2</td>
</tr>
<tr>
<td>about scanning technique</td>
<td>2</td>
</tr>
</tbody>
</table>
that students who had previously viewed this tape said that they would never actually have enough time to do this part of the experiment, so these students didn't bother viewing this section; and others "lost" attention. Three students mentioned that they were getting worried about the time, and didn't pay attention because of this. During the recall-session, several students said they could not remember having seen parts of this section in the lab, and one student started to think of what had been discussed earlier in the tape (in preparation for doing the practical work), couldn't remember, looked through the schedule and consequently lost attention.

When the students were paying attention to the tape, there were a few problems of comprehension: there was some confusion over identifying the different white blood cells; and were they to count both red cells and white cells? However, the sections on scanning the slide and performing the oil immersion demonstration were stimulating and produced some "active thought".

Again, several students questioned their own ability to carry out the practical work to the standards set in the tape.

Summary:

1. Generally speaking, this section appeared to be fairly well received but obviously the time factor contrived to distract students' attention from it

2. Some confusion over which cells to count

3. Students questioned their own ability to perform experimental work.
Summary Analysis

Table 4.8 presents a summary of the complete analyses along with the evaluation comments which are directed towards improving the video-tape.
### Table 4.8 Summary Analysis of the Seven Critical Points, and Evaluation Comments

#### CRITICAL POINT ONE: Haemocytometer Grid

<table>
<thead>
<tr>
<th>Section</th>
<th>Outline</th>
<th>Evaluation Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Close-up of haemocytometer</td>
<td>Fine</td>
</tr>
<tr>
<td>2</td>
<td>Diagram of Grid</td>
<td>Explanation of grid dimension is confusing; students are not clear which part of the grid they will be seeing under high power</td>
</tr>
<tr>
<td>3</td>
<td>Superimposition of grid dimensions over grid</td>
<td>Attention is lowest when figures and dimensions of the grid are being discussed</td>
</tr>
</tbody>
</table>

#### CRITICAL POINT TWO: Putting the coverslip on to the haemocytometer

<table>
<thead>
<tr>
<th>Section</th>
<th>Outline</th>
<th>Evaluation Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Close-up of haemocytometer and cover-slip</td>
<td>Needs improving - describe and illustrate the STEPS in the technique. Students rather unsure of own ability to do experiment as demonstrated: how can we boost their confidence?</td>
</tr>
<tr>
<td>2</td>
<td>Slide of interference patterns</td>
<td>Visuals OK. Active, relevant thought stimulated; students relating interference patterns to previous knowledge</td>
</tr>
<tr>
<td>3</td>
<td>Diagram of cover-slip on haemocytometer</td>
<td>Diagram is &quot;useful&quot; but the students &quot;switched off&quot; - is this section necessary in the VT (already in lab schedule)?</td>
</tr>
</tbody>
</table>
### CRITICAL POINT THREE

**Looking at the Slide under the Microscope and Measuring the Red Blood Cells**

<table>
<thead>
<tr>
<th>Section</th>
<th>Outline</th>
<th>Evaluation Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Caption of low-power magnification and high-power magnification</td>
<td>Fine - except some confusion over which part of the grid should be used for the cell count</td>
</tr>
<tr>
<td>2</td>
<td>Explanation of how to count the cells</td>
<td>Some confusion over the exact number of cells to be used for the RBC count. Loss of attention. Students question own ability to perform the technique as demonstrated</td>
</tr>
</tbody>
</table>

### CRITICAL POINT FOUR

**Pipetting Bulb Demonstration**

<table>
<thead>
<tr>
<th>Section</th>
<th>Outline</th>
<th>Evaluation Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Close-up of pipetting bulb and diagram of how the pipetting works</td>
<td>Diagram very useful and worthwhile - but students losing attention due to (a) &quot;Fatigue&quot; from watching tape for 20 mins and (b) not new knowledge</td>
</tr>
</tbody>
</table>

### CRITICAL POINT FIVE

**Taking Blood from a Subject's Ear-lobe**

<table>
<thead>
<tr>
<th>Section</th>
<th>Outline</th>
<th>Evaluation Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Close-up of ear-lobe, piercing and collecting the blood</td>
<td>Students' attention very high but vivid demonstration may detract from the techniques being demonstrated? Difficulty in extracting blood makes demo more &quot;realistic&quot;</td>
</tr>
</tbody>
</table>

### CRITICAL POINT SIX

**Colorimetric Readings and Calculations**

<table>
<thead>
<tr>
<th>Section</th>
<th>Outline</th>
<th>Evaluation Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diagram of standard curve; discussion of indices</td>
<td>Diagram is a good aid, but students quickly lose attention during discussion of theory - include this only in lab schedule? (time factor again)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section</th>
<th>Outline</th>
<th>Evaluation Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demonstrating the oil-immersion technique; captions of &quot;tracking&quot; and of the blood smear</td>
<td>Confusion over which cells were to be counted: both RBC and WBC? Sections on scanning and performing the oil immersion are stimulating and produce &quot;active thought&quot;</td>
</tr>
</tbody>
</table>
Discussion

Coldevin's model for video-tape production and research incorporates a loop for modification and re-cycling of video-tapes on the basis of evaluation findings; the above main findings from the analysis of the stimulated-recalls provide such information, which allows modifications to be incorporated into a re-make of the tape: precise feedback on the effectiveness of the teaching aids incorporated into the tape should provide the necessary background to re-designing and producing the tape, as well as giving an indication of useful strategies for inclusion in new tapes.

At least four areas for improvement can be discerned:

1. **Distracting Shots/Sequences**
   
   For example Critical Point Five: Close-up of an ear-lobe; piercing and taking blood
   
   This whole section appeared to be very distracting because of the vividness of its presentation; the students focussed in on the subject's face and got caught up in the psychological stress of a subject having his ear pierced. The techniques being demonstrated were missed as a consequence. Obviously the portrayal of a "real" situation was overdone here and could easily be modified in a re-make of the tape.

2. **Redundant Information**
   
   For example Critical Point One: Superimposition of the grid - dimensions over the grid
   
   Superimposition is a technique frequently used in video-tapes; it is generally assumed a good attention-getting teaching aid.
Here, however, it was ineffective because the subject matter being discussed was considered unnecessary for carrying out the laboratory work - so the information presented in the super was disregarded and as in Critical Point Two (3), the students just "switched off" until information relevant to that day's work was presented.

3. Improving Demonstrations

For example Critical Point Two (1): Close-up of the Haemocytometer and cover-slip

Stimulated recall analysis suggests here that the presentation of this technique is not clear enough for the students to grasp it quickly; an improvement might be an illustration of the technique in a step-by-step manner - a strategy which may also reduce the students' feeling that they will not be able to perform the technique adequately.

4. Eliminating Confusion

For example Critical Point Three (2): Explanation of how to count the cells

When there is confusion in understanding a technique, the students cannot be expected to perform it adequately; analysis of this tape gives an indication of when and where confusion arises, and just why there is confusion: information which can easily be taken into account when re-designing the tape.

Emphasis has deliberately been put on the way in which the tape evaluation findings can be used to pin-point deficiencies in the tape; but the
"evaluation comments" above also present information about teaching strategies which are effective and which, it can be assumed, will be just as effective when included in the tape modification or in the production of a new video-tape.

A Video-tape Evaluation Tool

I have indicated how the information from the stimulated recall protocols can be used to provide specific information about each critical point and how this can be used to point to areas for improvement in the tape.

What use can be made of the protocols for the development of future video-tapes? By organising the data from all the critical points in all the stimulated-recall sessions, categories of student responses and attitudes can be generated. A condensed analysis of this data is given in Table 4.9.

Three main categories of responses emerge viz Active thinking; Loss of Attention and Thoughts After Doing the Practical Work.

If these categories are construed as being typical of the sort of categories which could be produced from a similar stimulated-recall analysis of any video-tape used in the lab, then they could be used as an efficient way of analysing similar stimulated-recall sessions of other tapes. Of course, new categories and sub-categories could be added if and when they occur, increasing the comprehensiveness of the categories as an evaluation and feedback tool. The benefits to
Table 4.9  A Video-tape Evaluation Tool

1. ACTIVE THINKING

1. Increased Attention
   - Because a calculation has to be done later
   - Because the student is lost
   - Caused by the video-tape
   - Because a detailed technique is being described

2. Asking Questions
   - On the methodology
   - On comprehension of description of equipment
   - On own ability to carry out the work
   - Because confused
   - On the VT production techniques/method of teaching etc
   - Is this distracting?
   - General

3. Using Lab Schedule
   - Checking measurements done on VT
   - Following descriptions
   - Taking Notes
   - Thinking BACK to schedule (read previously)

4. Thinking about Carrying Out the Work
   - Visualising doing the practical work
   - Thinking about how to do the work
   - Examining equipment on the bench

5. Relating VT to Previous Study/Work
   - Thinking back to school/previous work
   - Thoughts on previous physiology teaching

2. LOSS OF ATTENTION/CONCENTRATION

1. Consciously NOT paying attention
2. Too many figures and calculations
3. VT too long
4. Bored/not interested
5. Because all in schedule
6. Due to VT production
7. Too much detail/theory
8. Same thing on screen for too long
9. VT too saturated after a time
10. Know it already/obvious
11. Difficult to look at small screen for long
12. Because will not have to do until after lab
the VT producer or evaluator of the tape are obviously potentially great - a great deal of information about the teaching in the tape, the use of production techniques and so on could be obtained which could help improve that particular tape and also act as a springboard for thinking about VT productions in general.

An analysis of the present video-tape using these categories will give some idea of their potential.

In the evaluation tool (Table 4.9), the distribution of responses at each critical point is shown as well as the total number of responses in each category. Comparisons between critical points can be made which can throw light on the effectiveness of the teaching strategies used at each point (as in fact I have already indicated in the preceding section). Also, comparisons of total responses between tapes can be used to evaluate the overall effectiveness of several tapes.

The sub-divisions of the categories produce much more detailed information on students' reactions to the VT. A detailed analysis of the students' thoughts, actions and reactions can be made; the effectiveness of the VT in stimulating the students to pose themselves questions while viewing the tape can be addressed by looking at sub-category 2 - "Asking Questions" - of the category on Active Thinking. If the tool was used to analyse similar stimulated-recalls of other VT's then the student responses to this sub-category would obviously differ.

The detailed information about the types of question being posed by the students eg questions on the methodology of the experiment; on the students' own ability to carry out the work as performed on the VT
and so on, can be directly related to the teaching strategies and production techniques used throughout the tape e.g. the techniques demonstrated at critical points 2, 3 and 4 all seen to be construed as being potentially difficult to perform by the students themselves; strategies for dealing with students' "fears" can be devised and incorporated into new tapes.

Of particular interest are the questions relating to the VT production techniques, which formed a considerable part of the students' questions. By referring to the detailed analysis of each critical point, the VT producer and evaluator can get an idea of the sort of questions being asked about the production techniques, their relevance to what is being taught at each point, the frequency with which students posed similar questions, and so on - all of which can be brought together and used to build up a picture of the usefulness and effectiveness of these production techniques which could prove extremely useful as guidelines in the production of future video-tapes.

The individuals involved in the evaluation and production of the tapes will be interested in all aspects of their improvement; consequently, they have to have some indication of the students' level of attention and concentration while viewing the tapes otherwise there is little assurance that much is being learned. The evaluation tool can indicate patterns of student attention whilst viewing the tape: in the present case, Category 2 - Loss of Attention/Concentration - indicates a high loss of attention at points 2, 3, 4 and 6. At critical point two, as we have seen, students quickly lost attention whenever there were too many figures or calculations to be considered: this was related
to the fact that most of this information was, in any case, already in the lab schedule and the students knew they could leave it until later.

Such information as this can provide the evaluator with an indication of why the students' attention was lost while viewing the tape, and every effort can therefore be made to ensure that the causes are minimised in future productions.

Analyses such as this can also point to other flaws in the tape, as listed in the Evaluation Tool itself, and to idiosyncratic teaching behaviours which have been incorporated into the tape and which, when assessed, are shown to be less than effective in encouraging student learning eg particular verbal mannerisms and idiosyncratic phraseologies were often commented on and considered distracting. Again, these can be taken into consideration in future tape productions and their incidence eliminated, or at least reduced.

This is just an indication of the possible uses to which the evaluation tool can be put: its effectiveness in providing detailed, constructive information has already been shown in the analysis of the present video-tape. Unfortunately no follow-up work to re-test the tape after the evaluation was possible since it is used only once a year, and this research was completed by the following year. But there is no reason why the evaluation comments should not prove useful in a re-make of the tape.
4.3.4 Summary

This section on the production and analysis of the new video-tape indicates that the systematic production and evaluation of a video-tape can produce a wealth of detailed, relevant information about the effectiveness of the teaching strategies and production treatments employed in the tape, information which can be used in a re-make of the tape. The research method used to evaluate the tape - Stimulated Recall - has been shown to be a very versatile analytical tool which is extremely responsive in assessing the students' attitudes to the tape, and one which provided the data for developing a general evaluation tool for use in producing and evaluating other tapes.
4.4 The Laboratory Schedule

4.4.1 Introduction

Each video-tape used in the lab has an accompanying set of instructions - the lab schedule - which outlines the procedures of the experiments to be carried out. Along with the production of the new "research" video-tape a new format lab schedule was also produced and evaluated.

4.4.2 Some theoretical Considerations

Planning in Advance

If students can read the lab schedule in advance of the lab, then they have the chance of trying to understand what the lab work is about and to plan how to carry it out. Few students in practice do this; so it is wise to assume that students coming into the lab have not read the schedule in advance; and once in the lab, the pressure to get through all the experiments in time often prevents them taking time initially to sit down, read the schedule fully and try to understand it. It is no surprise therefore to discover that out of the 61 students questioned in stage one of the study, only ten felt very aware of what they were doing while carrying out the lab work:

"Very often there is so much to do in the time you've got, that you're spending every minute you've got thinking "what's the next stage of the experiment?", you don't really have time to think any further than that."
If the student could be helped to plan the lab work in advance of doing it, then some of the problems of confusion and lack of awareness associated with the pressure of inadequate time (as described in stage one) could be solved.

Shaping Behaviour through Plans

A plan can help students structure their work and assimilate into their schemata a strategy for carrying out that piece of work (Miller, 1960). Associated with the concept of plan (defined as "any hierarchical process in the organism that can control the order in which a sequence of operations is to be performed" (Miller op cit p16)) is the idea of labels which are incorporated into the plan. A label can be a heading to part of the practical lab work or any construct onto which sets of instructions etc can be fixed so that they can more easily be assimilated by the students - they are easily recalled, and as a consequence the information associated with them is more accessible to the student. The instructor can facilitate the construction of a plan by a variety of methods which essentially try to shape the students' behaviour into enacting the plan, thus helping them carry out their work.

The work described here is an attempt to do that - to help students plan their lab work. In the lab the students are given an introduction to the lab work on video-tape; they then carry out the work with the use of a lab schedule which outlines the methodology and other instructions. I was interested in doing, and analysing the results of, two things:
1. re-designing the lab schedule in a way which would help the students plan their work better

2. trying to relate the schedule to the instruction given in the new "research" video-tape. I tried to set the Method Section of the schedule out in a way that corresponded closely to what was demonstrated in the video-tape, and also organise the method procedure into a series of easily understood and remembered steps so that the students could see how the experiment was broken down into steps, and read and retain them.

The Design of the Lab Schedule

The original lab schedule is lacking in instructional design; it is poorly laid out; the contents are crammed together; spacing between paragraphs is poor; headings etc are not clearly indented so as to attract attention; there is little distinction between instruction and theory; spaces for answers are poorly indented. The Method instructions are provided in long paragraphs which can be difficult to read and grasp easily; the copies are roneos and as a consequence are not very clear; the description and methodology of one experiment runs immediately into the next.

I consider these to be instructionally lacking. What are the features of the re-designed schedule?

Each experiment, presented as a discrete part of the whole practical by starting it on a new page, has a clear heading followed by a
definition of the aim of the experiment. Immediately after this is a section stating what the main parts of the experiments are which the student will have to carry out. There follows the Materials section and a Background section, when necessary. The layout of the Method section is based on a hierarchical-skills analysis of the main parts of the experiment (described earlier); each part has a descriptive heading (where appropriate) followed by a series of step-by-step instructions.

Concern was also given to such things as paragraph spacing; clearly spaced headings/sub-headings; indentation of the Method steps to catch the eye; the copies were printed and not roneo-ed.

These are the organisational and instructional changes which are designed to facilitate the planning of the students' lab work. (A copy of the original and new schedule is given in Appendix 2.4.)

4.4.3 Did the Schedule Help Students in Planning and Carrying Out Their Lab Work?

Information concerning the effectiveness of the new schedule was gained from 18 students who completed a questionnaire (a copy of which is given in Appendix 2.4) and who took part in short interviews.

The aim of each experiment was stated at the beginning of the instructions to the experiment to help the students focus their attention on each part of the practical; this could act as something like a selective filter for their attention, focussing their mind on to the oncoming work. The students agreed (in the questionnaire and interviews) that the aim helped them remember what that part of the lab was about
as they were doing their experimental work (Table 4.10). With an aim stated at the beginning of each experiment:

"you know what you were supposed to be doing, rather than just a heading then the method. You knew why you were doing it. In lots of things you don't know why you are doing it."

The section stating what the students were required to do during the experiment (ie stating the main parts of the experiment) also helped them clarify their work. The main steps were stated in an instructional form, so that the student knew exactly what he would have to do to perform the experiment. Later, the Method section then organised each step into its components in a hierarchical order. Stating the main parts of the experiment acts, in a sense, like an advance organiser (Ausubel, 1968). The general statements are read in advance of the detailed ones, preparing the student at a general level for the more detailed and complex directions in the Method. They get an overall idea of what they are going to have to do in the experiment which helps them organise their thoughts in advance of carrying it out.

When they come to do the experimental work, having it set into steps definitely helps them (qv Table 4.10). It was remarked of the traditional schedule

"Sometimes its not really clear what you've got to do and you have to keep reading it through and through and there's so much more to take in"
Table 4.10 Results of the Questionnaire on the New Schedule Accompanying the New Video-tape

<table>
<thead>
<tr>
<th>1</th>
<th>The inclusion of the AIM at the top of each section of the schedule helped me to remember what each part of the lab was about</th>
<th>Agreement (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SA</td>
</tr>
<tr>
<td>1</td>
<td>1 14 2 1 0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>The explanation of what was to be done during each part of the practical viz &quot;During this Practical You Will Have To&quot; (i) Helped me clarify what I was required to do (ii) Helped me remember the demonstration in the video-tape</th>
<th>Agreement (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SA</td>
</tr>
<tr>
<td>2</td>
<td>3 13 2 0 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 8 6 4 0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>The Materials Section: (i) It was useful to have the &quot;Materials required&quot; listed</th>
<th>Agreement (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SA</td>
</tr>
<tr>
<td>3</td>
<td>1 6 6 5 0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>The Method Section: Setting the method out into steps (i) Helped me carry out the experimental work (ii) Helped me recall the demonstration in the video-tape (iii) Helped to clarify the procedures/techniques involved</th>
<th>Agreement (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SA</td>
</tr>
<tr>
<td>4</td>
<td>6 12 0 0 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 10 4 1 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 11 1 0 0</td>
<td></td>
</tr>
</tbody>
</table>

Key: SA Strongly Agree
A Agree
Un Unsure
Dis Disagree
S Dis Strongly Disagree
but, in comparison, with the re-designed schedule:

"You know you've done number one, and then number two. And if you don't understand number two I think it's more clear just to read it through rather than to have to read the whole paragraph through again."

Several strategies for reading the Method section and carrying out the experiment were used by the students:

<table>
<thead>
<tr>
<th>No. of students (N = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Read step - DO; Read next step - DO</td>
</tr>
<tr>
<td>2. Read step - DO and look ahead at next step</td>
</tr>
<tr>
<td>(and so on)</td>
</tr>
<tr>
<td>3. Read all steps through once - go back</td>
</tr>
<tr>
<td>read step - DO; read step - DO</td>
</tr>
<tr>
<td>4. Read through several times then DO</td>
</tr>
<tr>
<td>from memory</td>
</tr>
<tr>
<td>5. Read through once then DO from memory</td>
</tr>
</tbody>
</table>

Those students who used number three strategy, after having read the method steps once, went back and started off by re-reading the first step again which gave them enough information to start the procedure, occasionally perhaps glancing at the Method later if really necessary, but generally relying on their first reading - as those using strategy five did. Generally then, students found that they could carry out
most of the experiments by reading the steps through once, remembering this and later perhaps referring back to the steps. Each step gave instructions on how to perform a discrete part of the method which was easy to understand and perform. It is perhaps worth noting that in terms of training procedures, splitting the instructions into discrete hierarchical steps accords with the literature on skill training.

4.4.4 Did the Schedule Help Students Recall the Video-tape Demonstration?

One of the aims of stating the main parts of the experiment at the beginning was to try and facilitate the recall of the demonstration in the video-tape - it was thought that these statements would "trigger off" the student's memory and help her remember the general outline of the taped demonstration. Eight students said that this did help them remember the demonstration; some could also visualise parts of the demonstration after reading this:

"I think when you read that you can actually visualise him, actually what he did when he was there with the subject who was donating the blood ... you read through that and you could generally go back and think 'Yes, well how did he do it?' I found that that did jog my memory, what actually was being done"

Once the students' memories have been "jogged" into thinking about the video-tape, the detailed step-by-step instructions in the Method section, which correspond closely with the way in which the method was demonstrated on the tape, prove to be good stimulators for recalling specific techniques and methods demonstrated in the video-tape (qv Table 4.10):
"You sort of see that written down and you can remember him doing it and you can sort of copy the actions as it were - recall the actions"

again, it was possible also to visualise the demonstration given by the lecturer:

"he did it very much so in steps ... so I could visualise him doing certain steps that I was reading about"

Would this have happened in any case, whether or not the method was given in a step-by-step fashion related to the video-tape? It would seem not, at least not as frequently or as obviously - it appears that it is the very simple way in which the steps are written, together with their direct correspondence to the method in the video-tape which helps the student remember and recall the demonstration. This is in contrast to the usual Method section in the schedule where instructions are not broken down into steps, but are run together in a paragraph, often making it difficult for the student to understand what is required of her, and doing very little to actively stimulate the recall of the video-tape:

"The week before, even although I was reading through the schedule you weren't thinking about the tape at all really you know, not as much as with this one (new schedule); the steps made it clearer ... because the week before, the way the schedule was laid out didn't really point out directly to the tape".
4.4.5 General Comments

What reaction was there generally to the other features of the re-designed schedule eg paragraph headings; indentation of method steps; starting each experiment on a new page, and so on?

A short semantic differential was designed to assess the students' "feelings" to the new schedule in comparison with the original one. It consisted of six bipolar statements which were rated on a seven-point scale (see Appendix 4). An individual score of 30 and above was considered as indicating a positive attitude to the schedule:

<table>
<thead>
<tr>
<th>Semantic Differential (N = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Score (30 above)</td>
</tr>
<tr>
<td>Medium Score (29-18)</td>
</tr>
<tr>
<td>Low (17)</td>
</tr>
</tbody>
</table>

13 students 2 students 0

All but two students were clearly very positively oriented in their overall attitude to the re-designed schedule (qv Table 4.11). It was considered easier to use, more precise and more satisfying than the usual lab schedule. The more pleasant layout and higher degree of organisation, seemed to also make the lab work easier:

"It's not in great long paragraphs. It splits it up more, so that you're not overwhelmed by looking at a whole page of garbled instructions .... It's just not so visually daunting"

The simple idea of starting each experiment on a new page also contributed to the positive effect of the schedule:
"Yes it was nice to have - when you've finished an experiment and you go on to another, to turn over a page and say 'right! that's done!' and start on a new page on a new part of the experiment. That was nice, instead of carrying on in the same page"

Simple, but obviously quite effective!

| Table 4.11 The Students' Ratings of the New Lab Schedule Compared with the "Regular" Ones: Semantic Differential |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| The new format lab schedule is:                 |                                                 |                                                 |
| Easier to use                                   | More difficult to use                          |                                                 |
| Vaguer                                          | More precise                                   |                                                 |
| More frustrating                                | More satisfying                                |                                                 |
| Makes the lab work easier                       | Makes the lab work more difficult              |                                                 |
| Has a more pleasant layout                      | Has a less pleasant layout                      |                                                 |
| Is more organised                               | Is more disorganised                            |                                                 |

<table>
<thead>
<tr>
<th>Easier to use</th>
<th>More difficult to use</th>
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<tbody>
<tr>
<td>7</td>
<td>7</td>
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<td>1</td>
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</table>

<table>
<thead>
<tr>
<th>Vaguer</th>
<th>More precise</th>
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<td>3</td>
<td>4</td>
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<tr>
<td>7</td>
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<th>More frustrating</th>
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<td>1</td>
<td>3</td>
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<tr>
<td>7</td>
<td>4</td>
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<table>
<thead>
<tr>
<th>Makes the lab work easier</th>
<th>Makes the lab work more difficult</th>
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<tr>
<td>1</td>
<td>7</td>
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<td>4</td>
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</table>

<table>
<thead>
<tr>
<th>Has a more pleasant layout</th>
<th>Has a less pleasant layout</th>
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<tbody>
<tr>
<td>2</td>
<td>7</td>
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<tr>
<td>5</td>
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<table>
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<th>Is more organised</th>
<th>Is more disorganised</th>
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<td>4</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
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</tbody>
</table>
4.4.6 Conclusions and Summary

1. The statement of the aim of the experiment followed by advance organisers giving details of the main parts of the experiment help focus the students' minds on to the work and help them plan in advance. Arranging the Method section into steps clarifies the procedures and makes them easier to read, understand and perform.

2. By stating the main parts of the experiment at the beginning of each experiment, and following this with step-by-step instructions, recall of the video-tape demonstrations is facilitated; this is obviously of great help to the students as they are carrying out their experimental work.

How useful is the re-designed schedule? The evidence of the questionnaire results and the interviews with the students (as well as, it should be said, informal discussions with technical staff who think the new design an improvement on the existing one) suggests that on both counts - in helping the students organise, plan and carry out their work, and in facilitating recall of the video-tape - the re-designed schedule has gone some considerable way in helping the students perform their lab work. As Cowan (1977) points out, knowing something of what is going on in the students' minds, as has been reported here, has important consequences for the teacher's future instructional designs.
4.5 Assessing the Visual Impact of the Tapes

4.5.1 Introduction

The third sub-concern of the issue of "Video-tapes" is that of the assessment of the visual impact of the tapes.

It will be recalled that in Stage One of the study the students were questioned on the occurrence of what several of them had termed "flashbacks" ie a mental image in the student's mind of part of the video-tape as they are carrying out the lab work which "helps" them in performing the task at hand. Of the students questioned, 26 said they had experienced a flashback at some time (13 often; 13 not very often); the other 36 said they had never experienced this (as assessed by the general lab questionnaire - see Appendix 1).

Although equivocal, these results suggest that the phenomenon of flashback is sufficiently widespread to warrant further investigation, especially if it can throw some light on the way in which the students learn from the video-tapes. This is obviously a potentially important aspect of the teaching and learning process in the lab since the students learn the laboratory techniques from viewing the video-tapes. The important question is "How useful are flashbacks in helping the student learn the laboratory skills?" I shall answer this question after introducing the main literature on the subject of visual memory.

In this present sub-concern, I was mainly concerned with determining as definitely as I could if in fact students DO experience flashbacks. Sixteen students were questioned and cross-questioned about flashbacks (which were explained to them as being "images in the mind recalled
from the video-tapes". All the students interviewed clearly understood what a flashback entailed; they were not questioned on the form a flashback takes or exactly what detail is present in them. Ten of the students had experienced flashbacks, five had not and one was unsure if she had. The video-tape to which all reference is made is the "research" video-tape on Experiments with Blood, which has been described in the previous section.

4.5.2. Visual Memory

In studies of visual perception and visual memory, psychologists suggest that there are two main forms of memory associated with visual perception:

1. Iconic Storage

2. Integration of Snapshots (Neisser, 1967)

Iconic Storage

Iconic storage, or visual information storage (VIS), lasts for about 1-2 seconds. While it does last, the subject can focus and refocus on different parts of the image (or field) and construct figures of this. These can be named and the names stored in what is termed a verbal or auditory storage system. Sperling (1962; 1967) has hypothesized several models for this storage, which essentially deals with short-term memory. The following is the simplest form:
The light image impinging on the retina is momentarily stored in the visual information store, and by a process of verbal rehearsal it comes to be stored in the auditory information store. Further rehearsal retains it in the AIS from which it can be recalled.

**Integration of Snapshots**

As Neisser points out, it seems obvious that visual memory does not stop with the icon; we can preserve much more than we have time to describe. And what we do preserve is usually an "integrated" snapshot of a sequence of visual stimuli which somehow is stored in our long-term memory "Integration of Snapshots". The visual image associated with the Integration of Snapshots is "something SEEN (like a real object) when nothing in the immediate or very recent sensory input appears to justify it".

This seems to be, basically, what some of the students are experiencing after having watched a video-tape.
There is a wide range of visual imagery: from eidetic imagery—where the image can be described in detail, can be scanned and generally can be examined as one might examine a concrete object (Haber & Haber, 1964); to ordinary visual memory where detail is lost, scanning is impossible and examination difficult. In all cases though the important factor is that the subject has a visual image of something called-up from memory.

Visual Memory Studies

The classical type of visual memory study carried out by psychologists deals mainly with short-term-memory (STM), where the S is presented with a series of letters or numbers which, when removed, he or she is asked to recall. The S is generally thought to recall the figures via the rehearsal mechanism and the AIS described above ie the S recalls it non-visually. (Coltheart, 1972.)

Flashbacks appear to differ from this in at least two respects: they occur, generally, after a long time and do not therefore involve just the STM; and they are visual-images of figures, not letters. The students are presented with a motion picture of someone carrying out an experimental procedure - this as such cannot be stored in the AIS in the way numbers are. Yet, students can recall parts of the tape VISUALLY in their minds. How can this be explained?

The student may attribute a verbal construct to the tape sequence (or object in the tape) being perceived; this may be rehearsed via the AIS and then stored in the long term memory. If recalled, it may trigger off a visual image of part of the video-tape ie a flashback. For example:
Students have reported experiencing flashbacks to the tapes of a sequence where the ear-lobe is pierced to obtain a blood sample. When watching this video-tape section on how to pierce a subject's ear-lobe, the student may label the sequence "piercing" (for example). The method of piercing, although demonstrated visually, may be verbalised by the student and stored in the LTM as a sequence of descriptive events which, when recalled, cause the student to have a flashback as she is about to carry out the ear-piercing on her subject.

But are the students conscious of having actively verbalised and stored the tape sequences? This is not likely. Experimental work by Haber and Erdelyi (1967) suggests two other possibilities: if the subject is conscious of having seen part of the tape then, if she is a visualiser, she can recall the image. However she may initially be quite "unaware" of having paid attention to the video-tape section which constitutes her flashback (unaware in the sense that she does not consciously try to ensure that she remembers it), but when she is carrying out the experimental procedure the cues provided by the equipment being used, or the particular situation she is in, may trigger off her "memory" and cause her to recover into "conscious awareness" the visual image of the video-tape. Haber and Erdelyi's subjects could recover perceptual material of which they were initially unaware; and the authors state that much of this "below conscious material" continues to exert a significant influence on the subjects' behaviour.

So it appears that visual-imagery may occur even when the student is not aware of having processed the visual information contained in the video-tape.
4.5.3 How Useful are Flashbacks?

To what extent are these visual-images or flashbacks useful to the student as she is carrying out the laboratory work? Neisser (1967) suggests that memory images are not "useful sources of information for recall". "It seems safe to say that ordinary visual images do not often play a critical part in purposive remembering" (p.156) "they serve probably a symbolic function". However the type of images he is discussing are different from the flashbacks recorded by the students. He describes images which are symbols of thought processes, not mental pictures of something previously perceived, as the physiology students experience. The students' flashbacks are images of parts of the video-tapes which have been previously perceived. When questioning students about the flashbacks they experience as they are carrying out the lab work, the following was fairly typical of the way in which they described them:

"You could remember back to the different pipettes you are using. I think that helped. Rather than just seeing it in the schedule you did remember what it was for. I remember seeing the small blood pipette, the one with the bead in it - thinking about that and Dr Howland turning it around with the bead in it."

In the students' opinions, the flashbacks do seem to help them in some way to carry out their experimental work. The levels of visual-imagery which occur vary from a quick, momentary flashback to images which remain for fairly long periods and which can be seen in some detail.
As an example of the latter type of flashback, and to provide an illustration of the usefulness of these visual images, I will discuss the interview of a female student who appeared to be particularly adept at recalling visual-images.

One Instance of Flashback

Although the interview relied on introspection and did not include any strict experimental procedures, it will be worthwhile to discuss it in relation to a well controlled experiment conducted by Haber and Haber (1964) on the occurrence of eidetic imagery, a form of visual-imagery particularly rich in realism. Generally, eidetic imagery has four characteristics:

1. The visual image persists after stimulation

2. The image is relatively accurate in detail

3. It is coloured positively

4. It is capable of being scanned

(Haber and Haber, 1964)

During the interview, it became clear that the student approximated fairly to these criteria (assuming her statements to be relatively true). Her flashbacks enabled her to recall (consciously) visual-images of the tape during the course of the laboratory class:

Excerpt from interview:

Interviewer - "You can actually see a picture in your mind?
Student - Yes.
I - Is it a little shot that flashes up in your mind?
S - Yes. I can't remember the whole tape, I can remember specific things. For instance, when he showed that heparanised tube.
I - Yeh?
S - He kept moving it around. And also the pipette, I remember him moving that.
I - You could actually see that in your mind?
S - Yeh."

and more strikingly, the visual-image could be recalled a day later during the interview:

I - "Were there any other shots?
S - Er, I can remember the person, the subject.
I - Piercing the ear?
S - Piercing the ear. I remember that bit. I remember him stabbing his thumb - I can see that too.
I - Um .... You can see that just now, if you thought about it?
S - Yes.
I - How do you see it? Do you have to close your eyes to see it?
S - No, I can see the picture, (with my eyes open). ... If I'm sort of looking at the wall, I can switch off actually concentrating on the wall, and just see the picture."

Although all detail in her visual-images was not retained, she could visualise certain parts of the tape in detail:

I - "... and can you see details in the picture?
S - Em, I don't see the picture absolutely perfectly
I - Yes
S - I remember that heparanised tube that he had
I - Yeh?
S - But I can't remember the background of it - I can't remember what's behind it.
I - So, you can see the main thing, the heparanised tube?
S - Yeh
I - But you can't see everything in detail; you couldn't describe the background of things that were lying on the bench?
S - No."

The third and fourth criteria can be taken together. Since the video-tapes are in monochrome only it is not possible to determine if our student visualised colour positively; but there is indication that her images were positive, and not negative as in an afterimage. She also appears to be able to scan her visual-images without the image moving as she does so:

I - "And the picture, would you say it was a true picture or a sort of negative of what was shown on the tape?
S - Er, no. It's actually what I see on the tape.
I - And as you bring this to memory and you're watching it in your mind, can you sort of scan the picture; look around it and look over it from one end to the other without it moving? I'll explain that a bit better. If you look at a light bulb, then look away you often get an afterimage; you can see that it's on your retina. And if you try to look across the bulb, it moves ....
S - I see what you mean.
I - because it's just there on your retina, you can't scan it because as you do that it moves as well. But with this image, can you scan it, can you look across it?
S - Yes - I can move about, yes ... I can move about
I - But you could look across it without it moving?
S - Yes."

I am not suggesting that this student is an Eidetiker, that she experiences eidetic images. (What evidence there is tends to suggest that it is only some children (≈ 8%) who experience eidetic imagery (Haber and Haber 1964) although Neisser (p.149) mentions work indicating its occurrence in adults). I merely compared this student's fairly introspective analysis of her flashbacks with eidetic-image characteristics to indicate how fruitful these flashbacks may be for the student.

Discussion

This phenomenon of flashback could be used as an effective strategy for learning from the video-tapes by encouraging the students to consciously give certain parts of the tape their attention and make an effort to recall those parts of the tape later when they are carrying out the experimental work themselves.

This could be achieved in a variety of ways: one possible way would be to draw the students' attention specifically to certain skills or techniques being demonstrated in the video-tape, say by replaying the important part of the demonstration after the initial exposure and drawing the students' attention to the specifics of the
technique, and so helping her to retain that image for recall later as a flashback.

In the lab schedule, at the point where the instructions for carrying out the technique occur, an instruction could be included encouraging the student to recall the technique as it was demonstrated in the video-tape: in a sense stimulating flashbacks to the tape.

In 2(c) above ie The Laboratory Schedule, I indicated how useful the strategy of relating the lab-schedule to the video-tape is; the recall of the video-tape demonstration was clearly facilitated by the step-by-step instructions in the schedule which corresponded closely with the way in which the demonstration was portayed in the video-tape. There is good reason to believe that the inclusion of instructions in the lab schedule to help stimulate the recall of flashbacks would be a beneficial learning strategy also.

Such "stimulated flashbacks" could be an important aim of the process of teaching and learning in the laboratory, and as such could effectively be included as an objective at Level 4, Guided Response, of the taxonomy which is proposed in Chapter 7.

4.4.5 Summary

The evidence of flashbacks provided in this section suggests that these visual images of parts of the video-tapes do play a useful role in helping the students carry out their practical work. Although not visualised in every detail, the flashbacks do seem to contain
enough detail to allow the students to visually remember a specific experimental procedure, piece of equipment or caption from the videotape which helps them in their work.

4.6. Summary of Chapter 4 and Appraisal

This chapter considers Issue I emerging from Stage 1 of the study i.e. the role of the video-tapes in the lab. Three areas of concern are investigated (i) individual video-tape analyses; (ii) the systematic production and analysis of a new-video-tape, and (iii) the visual impact of the video-tapes.

The systematic analysis of the teaching effectiveness of existing video-tapes provides confirmation of earlier beliefs (Stage 1) that the tapes are too long and focus too much on presenting theory information rather than in presenting an exposition of lab procedures. The literature on video-tape productions adds weight to these findings.

These details form the background to the systematic production and analysis of the new video-tape - a "research" video-tape which is used for teaching in the lab and then analysed in detail to determine the effectiveness of the production strategies and techniques for promoting learning. A tool for evaluating video-tapes is developed from these outcomes and is offered for use in future productions and evaluations.

The students' lab manual (schedule) which accompanies video-tapes is re-considered and a new format proposed, based on presenting advance organisers and step-by-step instructions to facilitate student learning. This new format helps students organise, plan and carry out the practical work as well as going some way in helping them recall important
parts of the video-tape.

The recall of visual information and images from the video-tapes is considered and is seen to be potentially very useful for promoting learning in the lab; some students are adept at recalling visual images and it is suggested that other students could be trained to do this; suggestions for facilitating this are given.

In this chapter, I have tried to indicate the effectiveness of teaching by video-tape in the physiology lab. No doubt there are many questions left unanswered and the outcomes of the chapter pose other questions which could be investigated at a later date.

The evaluation tool will have to be tried out in future tape productions and evaluations; and the relationship between the lab schedule and the tapes which they accompany should be investigated further: can the schedule be used in a more integral way to facilitate recall of lab procedures taught in the tapes? Can there perhaps be some form of integrated programming of the two? Is the present logical teaching format the only way to present the information on the tapes (the best way?)? And how can the students be encouraged to recall visual images from the tape while carrying out their lab work?

These questions and the many other ones posed in the body of this chapter, are worthy of future consideration if the effectiveness of the video-tapes in the physiology lab teaching and learning situation is to be increased.
CHAPTER FIVE ISSUE 2

THE LAB COURSE AND THE OVERALL DEGREE COURSE
This chapter is concerned with elaborating upon Issue 2 of part I of the evaluation study, i.e. the relationship between the physiology lab course and the other areas of study in the human biology degree course, as perceived by the students.

The question being posed is, "How do the students view the physiology lab course in relation to the other subjects being studied as part of their degree course?"

At the time when this study was conducted the students were studying four other subjects concurrently with physiology. They were: anatomy, genetics, biochemistry and psychology. It was therefore with these courses that the students were asked to view and compare the physiology lab course.

Method

The method chosen to obtain the students' views was the repertory-grid technique, a technique of attitude, or construct, elicitation devised by George Kelly (1955) as part of his theory of personal construct psychology.

Before describing the repertory-grid technique, it may be useful to consider the theoretical background in which it is grounded.

Personal Construct Psychology

Kelly's conception of the human kind as expressed in his theory of personal construct psychology (Kelly 1955) is that of the person as a
"scientific" thinker, able to think about and construe his or her own world in his or her own particular way. His initial concern was with the usefulness of personal construct psychology in the clinical psychology setting, and he employed the theory and the accompanying methodology (repertory-grids) in the context of working with individual patients in the clinical setting. The repertory-grid technique allowed him to tap the psychological constructions of his patients and so gain an insight into the way they construed their environment—hence the personal in personal construct psychology (although since this initial concern with the individual, the theory and methodology have been successfully applied to groups also (see Fransella & Bannister 1977)).

Kelly defines the term construct as follows:

"A construct is like a reference axis, a basic dimension of appraisal, often unverbalised, frequently unsymbolised and occasionally unsignified in any manner except by the elemental processes it governs. Behaviourally it can be regarded as an open channel of movement, and the system of CONSTRUCTS provides each man (sic) with his own personal network of action pathways, serving both to limit his movements and to open up to him passages of freedom which otherwise would be psychologically non-existent."

(as quoted in Fransella & Bannister, 1977, p3)

Constructs are bi-polar, generally one viewpoint versus another viewpoint, e.g. pleasant-unpleasant. They are discriminations, not labels (Fransella & Bannister 1977) and can be elicited from persons by means of repertory-grids (described below) which facilitate in the process of discriminateing between elements of the particular subject of concern (e.g. people; physical objects; teachers; TV programmes, and so on). The role of the repertory-grid is described by Fransella &
"The purpose of grids is to inform us about the way in which our system is evolving and its limitations and possibilities. The results of the grid have often been looked on as a map of the construct system of an individual, a sort of idiographic cartography as contrasted with, say, the nomothetic cartography of the semantic differential .... To the extent that a grid gives us a map of an individual's construct system, it is probably about as accurate and informative as the maps which Columbus provided of the American coastline. At that, it may be a good deal more sensitive to the nature of the person than the kinds of psychological instrument we have tended to use to date."

(pp 3-4)

Within the general, overall methodological philosophy of this evaluation study, Kelly's repertory-grid technique is particularly acceptable in as much as it allows us to view the students' perceptions of their degree course FROM THEIR PERSPECTIVE: "It is an attempt to stand in others' shoes, to see their world as they see it, to understand their situation, their concerns" (Fransella & Bannister, 1977, p 5).

Repertory-grid technique has been used in a variety of areas, including clinical settings (Bannister 1965; Rowe 1971); psychology (Smith and Leach 1972); teacher evaluation (Elliott 1969; McConnell and Hodgson 1979; Perrott et al 1976; Olson 1979); teachers' views of pupil performance (Nash 1973) and student learning (Pope and Shaw 1979).

The Process of Construing

In an educational setting, the process of construing might be employed in relation to gaining an insight into students' attitudes to teachers, or towards courses, or text books, or methods of studying
any other aspect (or element) of the university or school context.

The student is asked to consider three similar elements (3 teachers of their choosing; 3 text books, etc.) out of a pre-specified total number of elements, and say in which way two of them are similar and different from the third. This characteristic shared by the two similar elements defines one and of a bi-polar evaluative scale (termed a construct), and the contrasting characteristic distinguishing the third defines the other end of the scale. Having done this, the student is then asked to evaluate all the other elements on this scale (using some form of likert type or other rating scale). Different trials of the elements are worked through in the same fashion, with new bi-polar constructs being elicited each time; all the elements are evaluated on each one of these new constructs, so finishing up with a completed grid with elements along the columns and constructs along the rows linked by a matrix of numbers. Figure 5.1 is a simplified example of an imaginary completed grid used for construing five teachers, using a five point scale in the evaluation of the teachers on the constructs.

Analysis of Repertory-grids

There are many ways of analysing repertory-grids, ranging from Kelly's own "by hand" method (Kelly 1955) to the sophisticated statistical methods requiring computer time developed by statisticians: there are many varieties of these available (see Slater 1965; 1968; 1972a, 1972b; 1973; Chetwynd 1973).

The analysis of the-present repertory-grids was performed using a programme called Prefan, part of the Grid Analysis Package (Chetwynd -
Figure 5.1

<table>
<thead>
<tr>
<th></th>
<th>Dr. Brown</th>
<th>Ms. White</th>
<th>Mr. Black</th>
<th>Miss Green</th>
<th>Mr. Gold</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.2</td>
<td>1</td>
<td></td>
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<tr>
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<td>0.5</td>
<td>4</td>
<td>1</td>
<td>0.4</td>
<td></td>
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<td>0.5</td>
<td>0.5</td>
<td>0.1</td>
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<td></td>
</tr>
<tr>
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<td>0.1</td>
<td>4</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
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<td>0.5</td>
<td>3</td>
<td>2</td>
<td>0.1</td>
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<td>0.4</td>
<td>0.5</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.4</td>
<td>1</td>
<td>0.5</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

Rating scale: 4 | 3 | 2 | 1

- Good | Bad
- Pleasant | Rude
- Boisterous | Placid
- Talkative | Quiet
- Sociable | Aloof
- Knowledgeable | Not
- Gives notes | Doesn't

Imaginary ratings of the elements (teachers) on the constructs

Bi-polar constructs

° denotes the original triad used for eliciting the construct
Prefan analyses grids aligned by element, and treats all the grids as one long array. It provides a computer output similar to that of Ingrid 72 (Slater 1972), a method for single grid analysis.

Basically, Prefan analysis repertory grids in terms of their principal components (similar to "factors" and "clusters") providing the statistical data upon which one can analyse the relationships between elements, between constructs and between elements and constructs (Slater 1964; 1973).

All the students start with the same elements - here genetics; physiology lab; anatomy; biochemistry and psychology - and the program analyses the set of repertory grids elicited from the group as a whole.

Student Instructions for completing the repertory-grid

Each student completed the repertory-grid in an individual session with the author. The student was told the purpose of the study, given a copy of the instructions for completing the repertory grid and a ready made-up copy of the blank grid along with an attached form with the five elements (genetics, physiology lab, anatomy, biochemistry and psychology) already printed on it.

The instructions were read out loud to the student as he or she read their own copy. Any difficulties in comprehension were dealt with; the instructions were again read out loud as the student read his or her own copy once more and began to complete the exercise. It took each student about one hour to complete the exercise to their satisfaction.
Thirteen students were randomly chosen to take part in the study. The student instructions and an example of the repertory-grid are given in Appendix 3.

**Results**

The complete results of the Prefan analysis are presented in Appendix Three, example copies of two students' completed repertory-grids are also included, along with the author's interpretation of the 130 constructs elicited from all the students.

Figure 5.2 is a composite diagram showing the relations between the elements, the constructs and the relations with each other. The first component lies on the horizontal axis and accounts for 38.7% of the total variation of the students' views of the five elements (subjects) of the degree course. The second component lies on the vertical axis and accounts for 29.1% of the variation; so in all, components one and two account for 67.8% of the total variation.

The elements were placed on the diagram by taking their loadings on the first two components as co-ordinates (see computer output, Appendix 3) with reference to the origin of the two components. Similarities and differences are determined by the distances between them. Elements 2 and 3, the physiology lab and anatomy, are therefore viewed as similar in their effects, as are elements 1 and 4 (genetics and biochemistry). Element 5, psychology, is not related to any of the others.

The relations between the constructs are shown by drawing a circle of
convenient radius around the distribution of the elements, with its centre at the origin. The ratio of the loadings of each construct on components 1 and 2 (see Appendix 3) defines a direction from the origin of the graph which is plotted on the circumference of the circle, with opposite poles of the constructs projecting from the circumference (Slater 1973). Slater summarises thus:

"In short, the diagram shows the relations among the elements and among the constructs, and their relations with each other as well. The plane it uses is the one where they can be shown with maximum accuracy. The degree of accuracy depends on how much of the variation recorded in the grid is observed by the latent roots of the first two components."

(Slater 1973, p 17)

(In this case, 67.8% of the variation is recorded by the latent roots of the first two components.)

All of the 130 constructs are plotted round the circumference of the circle, with major groupings at each pole of the two components. Only those constructs most closely associated with the elements are considered here.

Tables 5.1, 5.2, and 5.3 list the constructs most closely associated with the elements. Figure 5.3 summarises these results diagrammatically.

The Students' Views of the Five Courses (Elements)

What follows is a narrative analysis of the students' views of the five courses (elements) based on the constructs most closely associated with each course, as listed in Tables 5.1, 5.2 and 5.3. Direct quotations from constructs are placed in quotation marks; numbers
Table 5.1 Constructs most associated with the Physiology Lab Course and Anatomy

| Constructs (36) | 8 9 11 16 17 18 19 20 27 28 29 30 31 33 36 37 43 51 57 60 63 67 68 71 72 74 75 77 79 81 84 88 100 106 122 125 |

Construct 8 Has 'hard' standpoint - discussion difficult since opinions don't exist - only facts

Construct 9 Blocks of work Can: look at all terms/concepts and fully understand without having to worry about other parts of degree course

Construct 11 Links-up with other parts of course

Construct 16 Time Limited - emphasis on finishing experiment

Construct 17 Helps 'explain' other course subjects

Construct 18 Involves experimentation - helps in understanding lectures

Construct 20 Learn many techniques in short space of time. VT take up lot of time

Construct 27 Involves writing reports. Can refer to at exams. good

Construct 28 Well organised Supervisors available and interested

Construct 29 Involves little thinking - boring

Construct 30 Demonstrators 'push' you. Have to get definite results. encouraged to work

Construct 31 Looks at workings of body - interesting

Construct 33 Furthers interest in course as a whole

Construct 36 Involves a high work load; write-up required

Construct 37 More useful since total knowledge in it is still limited

Construct 43 Enjoyable and interesting

Construct 51 Makes understanding of body more complete

Construct 57 Students treated as adults
No overlap of work with other modules - good
Involves the body
Should get more time - very important to Human Biology
Sensibly presented and taught
Has similarities to other subject areas
I enjoy PLC
Interesting
Prefer to study this - like the lectures and practicals
Makes me aware of functioning of body
Interesting - sometimes mathematical which I enjoy
Favourite subject - would like to work in
Keen on this . become more involved in it
Lecture material can be applied in lab-: we learn more
Important to have lab work
Brings together a whole field of study .: more enjoyable
In Human Biology Department, and with lecturers we are familiar with
Well organised - practicals and lectures relevant to each other
Lab. exciting, well prepared and easily linked to practical problems

Table 5.2 Constructs most associated with genetics and biochemistry

Constructs most associated with genetics and biochemistry 1. Components oneand two

<table>
<thead>
<tr>
<th>Constructs</th>
<th>1 4 6 32 34 38 39 42 44 46 48</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>49 50 53 55 58 61 62 82 91 92</td>
</tr>
<tr>
<td></td>
<td>94 96 101 102 103 104</td>
</tr>
</tbody>
</table>

Construct

1 Involve chromosomes - not whole body .: not so enjoyable
4 Involve mathematics (pet rate)
6 Link up with other subjects
32 Boring
34 Only lectures - difficult to remember what each part means
38 Involve understanding of brain - less understanding involved in others
39 Lectures boring
42 Not so enjoyable since involve chemistry & chemical formulae not so interesting
44 Lecturers make it uninteresting
46 Lecturer makes it uninteresting
48 Lecturer spoils it
49 Dislike - very difficult :: not interesting
50 Practicals badly organised - do not help in understanding lectures
53 Totally irrelevant to Human Biology course - not kept interested in these, no variety
54 Not well presented or built into course - loss of interest
55 Presented badly - take no account of previous knowledge - treat students like kids. Do not make you feel you have gained knowledge :: not so enjoyable
58 Not related to rest of course - too abstract
61 Put across in boring way - labs only demonstrators :: little involvement :: not interesting
62 Boring - problems not discussed clearly
82 Very confusing - too much to learn and take in
91 Difficult to grasp - not dealing with 'concrete' objects as in Physiology and Anatomy
92 Abstract - results difficult to understand. Cannot see direct results as in Physiology or Anatomy
94 Not pleasant - have to learn formulae - cannot discuss the subject. Can discuss other subjects and work together as group
96 Don't have to evaluate results :: Boring
101 Not distinct - have less connections
102 Just lab work :: not so interesting
Abstract lab work - but results may be interesting
Concerned with details that cannot readily be seen - makes it less interesting

2. Components one and three

a) Biochemistry

Constructs

10 Have to produce lab reports - this is hard work
21 Supervisors not helpful; work boring/disillusioning
22 Interesting - involving all the students
27 Involves writing reports - can always be referred to. Therefore useful
32 Boring
34 Only lectures - difficult to remember what each part means
45 Too many chemical reactions
74 Lectures interesting - but no fluency in course
82 Very confusing - too much to learn and take in
111 More enjoyable - relates directly with Human Biology

b) Genetics

Constructs

12 Looks at structure. Atmosphere not clinical.
15 Easy going atmosphere
26 Sham - involves time but no effort or enthusiasm
44 Lecturer makes subject uninteresting
46 Lecturer makes subject uninteresting
**Table 5.3**  Constructs most associated with Psychology

<table>
<thead>
<tr>
<th>Constructs</th>
<th>3 13 14 22 23 35 73 75 78 83 85 86 97 105 112 114 115 118 119 120 123 127 128 129 130</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Does not deal with facts (\ldots) don't know where you are in exam</td>
</tr>
<tr>
<td>13</td>
<td>Involves 'interactions' with people, not objects (-) never finishes</td>
</tr>
<tr>
<td>14</td>
<td>Not linked to any other part of degree courses</td>
</tr>
<tr>
<td>22</td>
<td>Interesting and involve all students</td>
</tr>
<tr>
<td>23</td>
<td>Practicals a farce (-) stupid experiments. Poor impression of psychology. Little purpose discernible (-) not scientific or logical</td>
</tr>
<tr>
<td>35</td>
<td>Looks at behaviour of man (-) not so easy to apply to rest of course. as (-) other subjects are</td>
</tr>
<tr>
<td>73</td>
<td>Don't like (\ldots) difficult to learn</td>
</tr>
</tbody>
</table>
Easily bored by psychology - difficult to understand theories
Makes the course more interesting since different to all other subjects
Requires you to go out and meet public as part of course
Can be studied on its own
Relaxed because concepts involved are more familiar
Little practical work
Not so enjoyable as other subjects
Does not interrelate with the other subjects
Involves aspects not directly related to Man - not so applicable to Human Biology
Involves aspects not directly related to Man - not so applicable to Human Biology
Least preferred because not so applicable
Interesting, with direct application to Human Biology - involves less 'drudgery' than other subjects
Problems difficult to solve. Requires much thought and reading
Practical and enjoyable - never feel rushed as in Physiology/Anatomy
Variety - not always straight lecture - discussions, questions, etc.
Way it is often presented - difficult to relate to Man
Figure 5.3: Summary diagram of the first two components of variation in the students' views of the five parts of their degree course

(components 1 & 2 account for 67.8% of the total variation)
following certain descriptions refer to the constructs from which the descriptions are taken.

Physiology Lab and Anatomy (Table 5.1)

The students' positive attitude to both the physiology lab course and the anatomy course comes over strongly when the constructs for these courses are compared with those for the other three courses. They are 'enjoyable', 'interesting', 'preferable', 'favourite', 'exciting', and especially in relation to the physiology lab course the students are 'keen on it' in comparison to the others.

These two courses link up with other parts of the degree course and bring together the whole field of study (11, 51, 71, 100). The students feel that they make one aware of the functioning of the body (77), and make an understanding of the body more complete and in general further one's interest in the degree course as a whole (51, 33).

Focussing on the physiology lab course indicates that the labs are thought to be well prepared and easily linked to practical problems (125); the fact that they are presented and taught by lectures with whom the students are familiar seems to be an important attribute in their favour (106) (the other three elements are not so taught), and the lab supervisors (demonstrators) are "available and interested", which again is not the case in the other lab situations (28). The physiology lab practicals and lectures are thought to be relevant to each other, and it was commented that the lab experimentations help in understanding the lectures (122, 84, 18).
However, the work load involved in each lab ("many techniques are learned in a short space of time") means that time is limited: and because the students have to produce "definite" results the work tends to involve little thinking (which can be boring) (29) and the emphasis therefore shifts to finishing the experiments so as to have all the information necessary to write the lab report (16). Discussion of the work completed in the lab (as opposed to writing the lab report) seems to be difficult: the work is construed as having a "hard" (factual) standpoint, one in which opinions do not exist, only facts, thus in the students' eyes making discussion and exchange of ideas about the work difficult (8).

Genetics and Biochemistry (Table 5.2)

Although the analysis of the students' construction of the five units in their degree course is being derived from an analysis of components one and two (constituting 67.8% of the total variation), it is necessary also to refer to the data provided by the interaction of components one and three to fully describe the way in which they construe genetics and biochemistry since both of these load heavily on component three (see Appendix 3).

Components One and Two (Table 5.2.(1))

Like their attitude to physiology and anatomy, the students hold strong views about genetics and biochemistry, when viewed from the interaction of components one and two. However, their attitude to these two courses is strongly negative. These two courses are not enjoyable or interesting, and in fact are construed as being boring.
The constructs used to express their attitudes to genetics and biochemistry run to a long list of criticisms which clearly indicate the students' unhappiness with these two courses when compared to the other three (as can be seen in Table 5.2).

In general, these two courses do not involve the study of the whole body, as do physiology and anatomy: this seems to be a very important yardstick held by the students for determining the "worth" of any course involved in their overall degree course. Genetics and biochemistry are not related to the rest of the course (53, 54, 58), and in fact are thought to be "totally irrelevant to the Human Biology course" (54).

They are too abstract and difficult to grasp since they are not dealing with the concrete, as do anatomy and physiology (91, 92, 101, 103); similarly, lab results are more difficult to understand and one cannot "see" the results directly (91), again as can be done in the other two subjects. There is too much to learn (82), it is put across in a boring and confused way with no variety present (32, 39, 44, 46, 50, 82) and involves the students very little (61).

Finally, the practicals are thought to be badly organised and do not help in the comprehension of the lecture material (50, 61, 102).

Components One and Three (Table 5.2: (2))

When component one is aligned with component three (see Appendix 3) genetics and biochemistry no longer have the strong relationship seen
in Figure 5.3. Table 5.2(2) lists the constructs now associated with these subjects. Genetics is seen as both boring (56) and interesting (121, 125), indicating particular views of individual students. The easy-going atmosphere of genetics (15) is rot scientific (25) and in fact the course is thought to be a sham, involving students time but not their effort or enthusiasm (26). This is in contrast to its requirement for thought and reading (127) and its application to human biology (123). Somewhat apparently conflicting constructions, but I think to be expected to some degree since the repertory-grid method allows for individual expression.

Biochemistry is similarly construed as boring (32), interesting (22), confusing (82) and enjoyable (111). The supervisors are not helpful (21); there is no fluency in the course (74), the work is boring and disillusioning (21) and there is too much to take in (82).

Psychology (Table 5.3)

Psychology is very much out on a limb in terms of the way the students have construed the five elements of their degree course (see Figure 5.2). Attitudes to it are less strongly worded and there is less consensus of opinion compared to the two groupings of the other four elements.

In general it is interesting and involves all the students (22, 83, 123, 128). It has variety (129) – teaching is not always by "straight" lectures, but involves discussions and other methods; it "makes the (degree) course more interesting", because it is different to the other subjects (83). Familiarity with many of the concepts being taught (compared to the other subjects) makes psychology "relaxed" (17).
And although the "problems" in it are difficult to solve (127) (this, I think, refers to the resolution of issues taught in psychology, rather than problems of a mathematical or chemical nature) and require much thought and reading, the course involves less "drudgery" than the other subjects (123).

Unlike the other four elements which deal with "objects", psychology involves interactions with people (13): the students have to go out and meet people as part of the course and study the behaviour of "Man", which does not occur in the rest of the courses (35, 85). Psychology can be studied very much on its own (86); it is considered not to be linked to any other part of the degree course (14).

However, for some students who perhaps are less inclined to the study of a social science like psychology, it is considered difficult to learn and understand (73, 75), partly because it deals less with facts and more with hypotheses and other (perhaps) less "concrete" notions of knowledge (3, 75, 114).

Some aspects of the course are thought not to be directly related to "Man" (i.e. the study of "Man" as construed by Human Biologists): for example, the study of experiments with rats and pigeons; these are the parts of the course least preferred because the students feel they are not applicable to their degree course (23, 120). Similarly, the practicals are considered to be a "farce"; they are not "scientific" or based on any "logical" premise - there seems to be little purpose discernible in them (23).
Discussion and Conclusions

The results of the Prefan analysis of the students completed repertory-grids provide a clear indication of their views of the five subjects which they were studying as part of their Human Biology degree course.

Several interesting points emerge from the analysis which tell us something of the way in which these students view their degree course. The most striking aspect of the analysis is the separation of the five subject-elements into three distinct groupings; anatomy and the physiology lab course are linked together and are viewed in quite similar ways; genetics and biochemistry are also linked together and viewed in a similar manner (at least on the two main components: one and two), but in quite the opposite way to anatomy and physiology; and psychology is separated from all of the other subjects and is construed in quite a distinct way (see Figs. 5.2 and 5.3).

The basis on which the subject-element groupings stands is defined by the constructs associated with them. It would seem that the students' associate anatomy and the physiology lab course more closely with the overall degree course than any of the other subjects: these two subjects deal with the study of the "whole body" and are the integrating subjects in the overall course, bringing much of the students' knowledge together into a view of human biology with which they identify. Genetics and biochemistry do not focus on the study of the "whole body", and generally speaking are not presented in a way which suggests they are an integral part of the study of human biology, and so to the students have less positive meaning and relevance to their primary concern of studying human biology. Such a
view is of course arguably rather tenuous - but the point being made by the students is that the study of human biology has much more to do with the study of anatomy and physiology than with the study of genetics and biochemistry.

Of course other factors are determinants of this view. Construing genetics and biochemistry as "too abstract", and too difficult to grasp (because they do not deal with the concrete, "visible" aspects of the human body, as do anatomy and physiology) suggests that, to some extent at least, the students find these two subjects more difficult to study; this may lead to the negative way in which they are viewed. It is not possible to say why this is so from the present study.

Finally, the isolation of psychology within the element space and the constructs associated with it tends to suggest that this is a subject which is not in the mainstream of the students' thinking in respect to human biology. Here is a subject which involves quite a different learning strategy than the others, and involves the study of "behaviour" rather than the more "scientific" aspects of the study of anatomy, physiology, genetics, etc. which predominate in the course. Consequently, it is enjoyed and appreciated by some students who find it a refreshing change to their mainstream studies, and is viewed indifferently and thought slightly irrelevant by those students whose main interests may be with the more concrete, "scientific" aspects of the course.

Besides providing an insight into the students' views of the five subjects being studied, these results also confirm some of the
previous findings concerning the physiology lab course, as discussed in the earlier chapters. The view that the physiology lab course is a major element in the overall degree course surfaces again here; the students perceive it as a sort of core to which the rest of their work can be linked. It brings together (along with the lecture component) the whole field of study and is perceived as directly relevant to the degree—much more so than any of the other subjects. Similarly, the suggestion that it involves little thinking is voiced here also.

Relation to the Physiology Lab Evaluation

In relation to the overall evaluation study of the physiology lab course, what do the results of the present study tell us?

Firstly, I think that these results indicate that when the physiology lab course is compared by the students to genetics, biochemistry and psychology, it is construed in positive, accepting terms: it stands out well in comparison. It is enjoyable and interesting, links up with the lecture course, is well prepared and organised and acts as an integrating subject around which knowledge from other aspects of the degree course can be developed.

There are, however, several misgivings about it:

(a) there is some suggestion that it involves little thinking; this was also reported in previous sections of the study where I suggested that this may be due to the way in which the lab work is presented, in a cook-book fashion with everything being laid out and organised for the students, thus requiring minimal initiative on the students' part.
it is viewed as a "hard", factual subject where "discussion is
difficult because opinions do not exist, only facts". It is
perhaps difficult to believe that this is, indeed, the case: there
is always room for discussion in any university course. But of
course the students may perceive this course as factual and
having little room for discussion - which appears to be the case;
we can only ask why they perceive it in this way. Several inter-
linked possibilities exist:
i) if the course is taught in a "closed", factual way then the
students might believe that it is made up of a series of proven
truths which have been established beyond doubt, and therefore
out of the realm of discussion.

ii) similarly, if the students are not encouraged to question what
they are being taught they may never develop a discursive
attitude to it.

iii) if little or no time is made available to the students for
reflecting about their work and discussing it, then they might
never perceive it in any way other than consisting of material
to be learned; facts to be accumulated. There is some suggestion
that this may be happening: both in the present chapter and the
earlier ones, students have referred to time in the lab (and in
the course generally) being limited; the emphasis in the lab is
often on getting the experiments finished in the given time
rather than in taking time to reflect on the work and discuss it.

iv) similarly, if they are required to accomplish other activities
which might prevent them finding the necessary time in which to
reflect and discuss the work with their peers. Earlier in the evaluation reference was made to the disproportionate amount of time which is required to write the lab reports. There was some indication that the students do take part in discussions when writing these reports, but it seemed that these discussions focussed mainly on determining the "correctness" of results obtained in the lab, and other issues more directly relevant to obtaining a good grade for the report than participating in a scholarly discussion of the content of the lab work, theories being taught and techniques being developed. So again, there may be little time in which to discuss their work.

(c) the time taken up by watching the video-tapes in the lab reduces the time available for completing the lab work. This confirms the views of the students who took part in the earlier sections of the evaluation, who thought the tapes were too long.

Summary

This chapter considers the students' views of the physiology lab course in relation to the other subjects studied as part of their degree course.

Physiology and anatomy are viewed similarly as being interesting and enjoyable. They are viewed as interrelating subjects, linking easily with the rest of the degree course. Physiology labs are well prepared and organised; however, the pressure of time and the "hard", factual standpoint which makes discussion difficult are criticisms levelled at the course.
Biochemistry and genetics are not enjoyed by the students. There is a strong, negative attitude to the way they are taught and their lack of relatedness to the overall degree course; they are considered to be more abstract than the other parts of the course.

Psychology presents variety to the course, allowing diversity of opinion. Some aspects of it cannot be directly related to the rest of the degree course, e.g. studies on rats and pigeons.

Viewing the results in relation to the physiology lab evaluation indicates that:

(a) When compared to the other subject areas, the physiology lab course is viewed in positive, accepting terms and acts as an "integrating" subject around which knowledge from other aspects of the degree course can be developed.

(b) Misgivings about the physiology lab course revolve around:

(i) the suggestion that it involves little thinking;
(ii) the view that it is a "hard", factual subject with little room for discussion;
(iii) the attitude that the time taken to watch the video-tapes reduces the time available for completing the lab work.
CHAPTER 6

ISSUE THREE

THE ROLE OF THE LABORATORY COURSE IN THE

STUDENTS' UNIVERSITY EDUCATION
6.1 Introduction

This chapter is concerned with issue three arising from Stage One of the study i.e. the role of the laboratory course in the students' university education.

In Stage One of the study I indicated how important the laboratory course is in the students' overall degree study load: the analysis of the students' attitudes to working in the laboratory indicated that they spend a considerable amount of time in the laboratory; that they also devote many hours researching at home or in the library for the laboratory report, as well as discussing amongst themselves the various questions in the report. This process of carrying out the laboratory work and writing the reports is clearly a major part of the students' curriculum, and one which we have seen, they consider to be of some importance in the overall development of their degree course.

In this chapter I want to determine what affect - if any - the laboratory course has had on the students' perceptions of their overall university education: does it change their attitudes to their education in any way? To accomplish this I had to define, to some extent, what a university education is so that the students' perceptions of the effect of the laboratory course on it could be gauged. I therefore decided to define it in terms of "the aims of a university education" as defined by university educators. Because this study is only part of a larger evaluation study, I had to limit its scope somewhat. I therefore chose to only investigate the affect of the laboratory course on the students' attitudes to those aims which they held to be important.
6.1 Some Preliminary Questions

To be able to determine the effect of the laboratory course on the students' education (as defined by the aims) three questions have to be considered:

1. What were the students' attitudes to the university aims BEFORE taking the laboratory course?

   to determine if the laboratory course has had an affect on the students' attitudes to the aims it is necessary to know what the students' aims were before taking the course

2. What were their attitudes to the aims AFTER taking the laboratory course?

   this will indicate if there has been a change in attitude, and what that change is

3. What affect did the laboratory course have on the change in the students attitudes to the aims?

   by confronting the students with the change that has occurred and asking them to consider the affect the laboratory course might have had on this change, I should be able to answer this question (as well as indicate which aims were actually achieved during the laboratory course).
Each of these questions will be considered in turn, but before doing this I will discuss the methodologies employed in this part of the study.

6.3 Methologies

This section of the chapter will consider

a) the method of choosing the university aims

b) choosing an appropriate method of assessing the students' attitudes to them

c) choosing a method of analysing (b)

6.3.1 Choosing the university aims

The aims used were derived from four areas:

i) the Surrey University prospectus

ii) lists of the aims of science education (qv Beard R. 1973; Cowan J. 19)

iii) documents and papers on the aims of universities (Brosan et al. 1971; Brosan 1971; Carter 1971; Francis 1978; Fulton 1971; Hiblett & Pole 1972; Maset 1974; Oliver & Shaver 1966; Weinsten 1975)

iv) statements on the aims of universities made by 32 participants at the Surrey University Teaching and Learning course of 1976 (kindly made available by Vivien Hodgson, course evaluator).
Initially, I made a list of possible aims, which ran to over four hundred; these were reduced to about two hundred. I then categorised these into the four areas of the aims of public education proposed by Downey (qv Stake 1970) viz:

- intellectual aims
- social aims
- personal aims
- vocational aims

Judges (university staff and other research students in educational technology) were then asked to check my categorisations, and several changes were made, shifting aims from one area to another. After this, I chose twenty aims from each area, giving eighty aims in all which would be used in the study. The aims are listed in Table 6.1.

6.3.2 Choosing an appropriate method of assessing the students’ attitudes to the aims

Since I wanted to determine which of the 80 aims were important to the student, and which were not, I had to decide on an scaling technique which would give me this information and which, at the same time, would be easily understood by the students. Asking the students to rate each aim on a Likert scale would have been extremely difficult and tedious for them: it would be difficult to really judge the importance of each aim and hence they would probably have rated them all in a positive way, since all the aims would easily have been of equal importance to them. Ranking 80 aims would also not have been a viable proposition. Q-sorting (Stephenson 1953) offered a suitable solution since it incorporates both scaling and ranking.
Table 6.1  
AIMS STUDY  
THE AIMS OF UNIVERSITY  

PERSONAL

P 1  Have developed a trained mind
P 2  Be generally 'educated'
P 3  Be able to appreciate culture
P 4  Have an understanding of the variety and intensity of human emotion
P 5  Be aware of impulse and other aspects of our affective nature
P 6  Have developed your ability to come to terms with your problems and overcome them
P 7  Be a well developed individual
P 8  Have developed enhanced skills in artistic creation
P 9  Have an all-round development of your personality
P 10 Have developed moral awareness
P 11 Have developed self-reliance
P 12 Have developed an increased awareness
P 13 Have all round accomplishments
P 14 Have broadened your view of life
P 15 Have developed maturity
P 16 Be a sensitive, informed and capable individual who will play a part in keeping our culture (artistic heritage) alive
P 17 Have developed the frame-work for a purpose in life
P 18 Have fully realised your potential - recreational and working
P 19 Be generally 'enriched'
P 20 Have developed a sensitivity for others
Table 6.1 (continued)

AIMS STUDY

THE AIMS OF UNIVERSITY

SOCIAL

S 1  Be imaginative and sensitive to other people
S 2  Have a deepened understanding of yourself and other people, thus enabling you to develop more tolerant attitudes
S 3  Ability to work towards mutually acceptable solutions
S 4  Be socially 'aware'
S 5  Have social confidence
S 6  Ability to accept and practise the highest professional standards of integrity, compassion and service to one's fellow men
S 7  Ability to work at various levels in a non-academic environment
S 8  Have an understanding, and wish to develop, the skills and resources of the human race so as to enable its growth and development
S 9  Ability to speak with authority and give acceptable leadership in some area
S 10 Ability to acknowledge other people's views
S 11 Ability to play a role in the transmission of common standards of citizenship
S 12 Have the necessary skills to enable you to play a satisfying part in society
S 13 Ability to play a part in the rational direction of social affairs
<table>
<thead>
<tr>
<th>Aim</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S 14</td>
<td>Capability of operating with colleagues and other professionals in your future career</td>
</tr>
<tr>
<td>S 15</td>
<td>Ability to communicate with others</td>
</tr>
<tr>
<td>S 16</td>
<td>Ability to play a part in transmitting cultural heritage - the civilisation - of our society</td>
</tr>
<tr>
<td>S 17</td>
<td>Have a better understanding of the world</td>
</tr>
<tr>
<td>S 18</td>
<td>Ability to work as part of a team</td>
</tr>
<tr>
<td>S 19</td>
<td>An understanding of working conditions and the effects of our organisation on society at large</td>
</tr>
<tr>
<td>S 20</td>
<td>An awareness of the moral, social, economic, political and scientific problems of society</td>
</tr>
</tbody>
</table>
Table 6.1 (continued)

AIMS STUDY

THE AIMS OF UNIVERSITY

INTTELCTUAL

<p>| 1  | Ability to obtain information efficiently |
| 2  | Ability to deal creatively with problems encountered |
| 3  | Ability to think creatively, imaginatively and in abstract terms |
| 4  | A wish to acquire knowledge for its own sake |
| 5  | A scholarly concern for accuracy |
| 6  | Capability of intelligent decision making |
| 7  | Ability to study independently |
| 8  | Ability to teach yourself |
| 9  | Ability to derive and formulate the answers to questions without direction |
| 10 | Ability to analyse problems critically and objectively |
| 11 | Ability to reason for yourself |
| 12 | Ability to express thought lucidly and pertinently when required to use the written and spoken word |
| 13 | Be wide in your range of interest in your subject |
| 14 | Development of adaptability, i.e. an ability to cope with changing patterns of knowledge |
| 15 | Development of a habit of disciplined, rational thinking |
| 16 | Enthusiasm for learning |
| 17 | Ability to keep up with the advancement of knowledge in your field and know how to extend it |
| 18 | Realise that the study of a subject has intellectual and scientific value in its own right |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>A real mastery of your subject and its application</td>
</tr>
<tr>
<td>20</td>
<td>Ability to see and comprehend opposing viewpoints without sacrificing your own</td>
</tr>
</tbody>
</table>
Table 6.1 (continued)

AIMS STUDY

THE AIMS OF UNIVERSITY

PRODUCTIVE/VOCATIONAL

V 1 Be a trained specialist required by an industrial society
V 2 Have acquired skills necessary in the performance of socially approved tasks
V 3 Have acquired the skills necessary in the general division of labour
V 4 Have acquired the facts and skills for a vocation
V 5 Have had the opportunity to see at first hand the wide range of employment possibilities for graduates in a modern industrial and commercial society
V 6 Ability to apply and extend academic standards to vocational work
V 7 Ability to apply your knowledge directly to the aims and needs of society
V 8 Ability to contribute to the national industrial research effort
V 9 Have the necessary professional skills
V 10 Be trained for a job
V 11 Be prepared for managerial posts in future work
V 12 Ability to relate technological material to public affairs
V 13 Have acquired the standards, modes of thought and skills appropriate to a field of study
V 14 Ability to apply your knowledge to practical subjects
Table 6.1 (continued)

AIMS STUDY

THE AIMS OF UNIVERSITY

PRODUCTIVE/VOCAIONAL

V 15  Ability to think in the way people in your future professions think

V 16  Capability of practical judgement

V 17  The understanding of the interdisciplinary nature of many professional problems

V 18  Ability to apply knowledge in new situations

V 19  Ability to obtain a high standard of living

V 20  Have a degree of competence in your subject
Q Sorting

Q-sorting is part of what Stephenson calls Q Methodology: "a set of statistical, philosophy of science and psychological principles. With Q, studies are individual, analysing single propositions" (Stephenson 1953). Q techniques deal with the correlational analysis of individuals, as opposed to R techniques which deal with the correlational analysis of tests.

Stephenson emphasises that Q Methodology is grounded in the philosophy of humanists, historians and clinical psychologists and deals with concrete behaviours of individuals: "The total person in action is our concern" (p.2).

Q technique has been used in a wide variety of research studies, ranging from sociology and education to communication and political science. Brown (1968) presents a bibliography of Q technique and its methodology and Cohen (1976) describes some of its uses in the specific field of educational research.

Essentially, Q-sorting consists of forcing the students to decide the relative importance of each aim by sorting them into "priority" bundles. Each aim is presented on a card and the students decide whether or not it is important to them, then place it in one of several bundles ranging from bundles of "most important aims" to bundles of "least important aims". The number of "priority" bundles, and the number ("frequency") of aims in each bundle, is determined by the researcher so that the distribution of aims from "most important for me" to "least important for me" approximates to "normality".
I chose nine bundles, with the frequency of aims as shown below:

<table>
<thead>
<tr>
<th>MOST IMPORTANT AIMS</th>
<th>LEAST IMPORTANT AIMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOR ME</td>
<td>FOR ME</td>
</tr>
<tr>
<td>BUNDLE:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>FREQUENCY OF AIMS</td>
<td></td>
</tr>
<tr>
<td>IN Q-BUNDLES:</td>
<td>4 6 10 12 16 12 10 6 4 (= 80)</td>
</tr>
<tr>
<td>SCORE GIVEN</td>
<td>8 7 6 5 4 3 2 1 0</td>
</tr>
</tbody>
</table>

When this is completed, the researcher scores the results by giving every aim in each separate bundle the same score, as is also indicated in the figure above; so that the aims in bundle one (the most important aims) receive the highest score, those in bundle two the second highest score and so on, down to the aims in bundle nine (the least important aims) which receive a score of 0 each.

The completed Q-sorting of the 80 aims is then ready for statistical analysis, to which I will now turn.
(It is worth emphasising at this point that we are investigating the importance to the students of the university aims; this approach differs from asking the students to state the general importance of the aims; their suitability as goals of education, and so forth).

6.3.3 Choosing a method of analysing the students' Q-sortings

Having ensured that I could distinguish between the important and the unimportant aims of each student by employing Q-sorting, I wanted a method of statistical analysis which would reflect this, but for the whole group of students. Cluster analysis seemed to be the best choice; this essentially draws up correlations and relationships between the scores of each individual student on the aims of Q-sorting. Those students with similar score-profiles are grouped together to form a "cluster" of students; each cluster is different from any other in its attitude to the importance of the aims.

As Entwistle and Wilson point out "In cluster analysis, people who have attributes in common are placed together in groups. Clusters are thus used to describe profiles of scores which have a high degree of similarity" (Entwistle and Wilson 1977, p.123).

It is thought that in the field of empirical research, cluster analysis may offer a major step forward.(Entwistle 1973).
6.4 The Study

A few weeks prior to commencing the laboratory course the human biology students were asked to perform a Q-sort of the eighty university aims of education. Each aim was presented on a separate card and a full set of instructions was followed by each student. The precise instructions given to the students are given below.

6.4.1 Aims Q-sorting instructions

A letter requesting the students' help and explaining the purpose of the research was included with these instructions.

CARD SORTING EXERCISE

"Please read these instructions carefully before carrying out the exercise:

'There are 80 cards with a statement on each card. Each statement is a possible aim which students might hope to have achieved after 3-4 years university education, for example:

To be trained for a job
To be imaginative and sensitive to other people
Ability to apply knowledge in a new situation
A real mastery of your subject and its application etc.

I would like you to consider each aim and decide how important it is for you, and place it in the appropriate 'importance' bundle as shown in the diagram over page. [ie Figure 6.1]"
Figure 6.1  Aims Q-sorting Instructions

MOST IMPORTANT AIMS FOR ME

LEAST IMPORTANT AIMS FOR ME

4 card  6 card  10 card  12 card  16 card  12 card  10 card  6 card  4 card
bundle(1) bundle(2) bundle(3) bundle(4) bundle(5) bundle(6) bundle(7) bundle(8) bundle(9)
So that Bundle 1 contains the cards with your four most important aims, finishing with Bundle 9 which should contain the cards with the four least important aims for you.

You will probably find it easiest to separate the cards into three bundles first of all: the most important aims, the aims you are unsure of and the least important aims. Then you can proceed to sort these into the bundles as shown in the diagram. When finished, please check that each bundle has the correct number of cards in it.

When you have done this, place each bundle in its appropriate envelope [envelopes provided were clearly marked "Bundle 1" etc.] and seal it, and replace the nine envelopes in the large 'return' envelope, and return it to me via internal mail (Internal mail is collected at Court Offices and the Human Biology Department office).

Strict confidentiality is ensured throughout this project.

Thank you for your assistance
David McConnell
Institute for Educational Technology

6.4.2 Cluster Analysis

The result of each student Q-sort was tabulated for later statistical analysis. Twenty-five out of the thirty five students in the human biology class completed a Q-sorting of the aims.
A year later, after having completed the three term laboratory
course the same students who had completed the Q-sorting before were
asked to re-sort the cards; twenty of the original twenty-five offered
to do this. These results were also tabulated for later analysis.

The results of both years were submitted separately to cluster
analysis, using the Cluster Analysis Package - Clustan 1A - devised
by the University of Bradford Computing Laboratory (1975). The
analyses were carried out by link with the University of Manchester
Computer. Several possible cluster analyses are available: Ward's
method was the one chosen for this study.

Since I was only interested in the effect the laboratory course had
on the students' attitude to their important university aims, I had
to distinguish between the "important" aims and all the others for each
cluster of students. I decided that only those aims in each cluster
having a score of 8, 7 or 6 in the Q-sort could be considered to be
important - and only if they occurred at a 60% frequency in each
cluster (i.e. if there were ten students in a cluster then at least six
of them would have to have given any one aim a score of 8, 7 or 6 for
it to be considered "important"). Because of the nature of the Q-
sort distribution this method produced small numbers of "important"
aims in each cluster of students (All the numerical data relating to
this chapter are given in Appendix 4)
6.5 Results

As I pointed out earlier, before establishing what effect the laboratory course has had on the students' attitudes to the university aims I have to establish that a change in their attitudes has taken place over the period of the laboratory course. I shall therefore firstly consider the students aims prior to taking the course; I will then consider their aims after having finished the course. Finally, I will consider the changes which occurred and then discuss the students' perceptions of the role of the laboratory course in effecting these changes.

6.5.1 The students' aims prior to taking the laboratory course

The cluster analysis of the students prior to taking the laboratory course produced three distinct clusters of students on the basis of the scores given to the aims in the Q-sorts. Figure 6.2 is the graphical printout from the computer analysis. The students are arranged on the basis of the score-profiles produced by the Q-sorts, with interconnecting lines indicating their relationships. Deciding on where the cut-off line for distinguishing groups should be is fairly subjective. I finally decided on just above 9.545 - producing three clusters - for several reasons:

i) I subjected the data to several other of the cluster analyses methods in the Clustan package and compared the profiles of each. Although differing in some details, each one suggested there were three distinct clusters of students.
Figure 6.2 Student Clusterings - Pre-lab

Cluster 1

Cluster 2

Cluster 3

Students (N=25)
ii) I also scanned the Q-sort profiles of the students in each cluster to see if the cluster analysis "made sense" in terms of the actual important aims of each student in the cluster: this again seemed to confirm that there were three distinct clusters.

Each cluster will be considered in turn

Cluster 1

Cluster one comprises 14 students and is the largest grouping. Table 6.2 indicates this cluster of students' important aims. Six of the nine aims are from the "Personal" dimension and are concerned with self-development e.g. "Be a well developed individual"; "Have broadened your view of life", and so on. The other important aims are spread between the "Social" and "Intellectual" dimensions, but again emphasise personal aspects of these dimensions. e.g. "Communicate with others"; "Reason for yourself".

It should be pointed out that this cluster of students' important aims ranges over three of the four original categories (all the other student clusters also include aims from more than one category). In trying to characterise these student clusters I had to, therefore, take into account the overall intent of the students' important aims. In the case of this cluster, it is clear that the students' overall concern is with their personal development, so I can characterise them as:

PERSONAL
Discussion

This cluster of 14 students focus its attention on attaining a complex of aims which are very much concerned with the students as developing, maturing adults. Their concept of a university education is of one which not only provides them with a real intellectual training and perspective: one which enhances their ability to reason for themselves and to make intelligent decisions, thus training them in self-expression (intellectual aims which are "traditionally" associated with higher education and which would probably be widely supported by most university teachers) - but also one which looks to the university for some guidance and experience in their own personal and social development.

Table 6.2  Aims Prior to Laboratory Course

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Important Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>P  7</td>
<td>Be a well developed individual</td>
</tr>
<tr>
<td>P  9</td>
<td>Have an all round development of your personality</td>
</tr>
<tr>
<td>P 14</td>
<td>Have broadened your view of life</td>
</tr>
<tr>
<td>P 15</td>
<td>Have developed maturity</td>
</tr>
<tr>
<td>P 17</td>
<td>Have developed the framework for a purpose in life</td>
</tr>
<tr>
<td>P 20</td>
<td>Have developed a sensitivity for others</td>
</tr>
<tr>
<td>S 15</td>
<td>Ability to communicate with others</td>
</tr>
<tr>
<td>I  6</td>
<td>Capability of intelligent decision making</td>
</tr>
<tr>
<td>I 11</td>
<td>Ability to reason for yourself</td>
</tr>
</tbody>
</table>

Characterisation:

PERSONAL
Cluster 2

The second cluster of students has less than half the number in Cluster 1, comprising six students. The important aims for this cluster are: six vocational aims, which express a wish for job training above all else; three personal aims emphasising personal development, and three intellectual aims emphasising the application of knowledge and reasoning - aims which seem to give extra emphasis to the cluster's main interest in an instrumental education (qv Table 6.3). These students are best characterised by:

VOCATIONAL

Discussion

In direct contrast to Cluster 1 this cluster emphasises vocationally oriented aims. The students are certainly not uninterested in their personal development - they emphasise three such aims also emphasised by Cluster 1; similarly, there is some concern over the development of some intellectual aims, especially those dealing with self reasoning and problem solving. But this cluster's main emphasis is on the vocational aspects of a university education, with the dominant emphasis being on job-training.
### Table 6.3 Aims Prior to Laboratory Course

#### Cluster 2 Important Aims

<table>
<thead>
<tr>
<th>Code</th>
<th>Aim Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 7</td>
<td>Be a well developed individual</td>
</tr>
<tr>
<td>P 9</td>
<td>Have an all round development of your personality</td>
</tr>
<tr>
<td>P 15</td>
<td>Have a developed maturity</td>
</tr>
<tr>
<td>I 11</td>
<td>Ability to reason for yourself</td>
</tr>
<tr>
<td>I 10</td>
<td>Ability to analyse problems critically and objectively</td>
</tr>
<tr>
<td>I 19</td>
<td>A real mastery of your subject and its application</td>
</tr>
<tr>
<td>V 4</td>
<td>Have acquired the facts and skills for a vocation</td>
</tr>
<tr>
<td>V 6</td>
<td>Ability to apply and extend academic standards to</td>
</tr>
<tr>
<td></td>
<td>vocational work</td>
</tr>
<tr>
<td>V 9</td>
<td>Have the necessary professional skills</td>
</tr>
<tr>
<td>V 10</td>
<td>Be trained for a job</td>
</tr>
<tr>
<td>V 13</td>
<td>Have acquired the standards, modes of thought and skills</td>
</tr>
<tr>
<td></td>
<td>appropriate to a field of study</td>
</tr>
<tr>
<td>V 14</td>
<td>Ability to apply your knowledge to practical subjects</td>
</tr>
</tbody>
</table>

#### Characterisation

**VOCATIONAL**

### Cluster 3

The third cluster comprises five students. Unlike the other two clusters, this one is not interested in the enhancement of aims directly associated with their personal development (qv Table 6.4). Seven of the twelve important aims are intellectual ones. The other five are
vocational, the emphasis seeming to be on the uses of knowledge. Bearing in mind the large intellectual emphasis and this knowledge orientation of the vocational aims, these aim can be characterised by:

INTELLECTUAL

Discussion

This cluster of students is distinguished from the other two clusters in at least two ways:

i) they do not consider aims dealing with personal development to be an integral, or at least highly important part of their university education.

ii) they emphasise as being important those aims which could generally be described as "purely" intellectual

Their main concern is in developing their intellectual capacities and in relating these to the application of their knowledge in future study.
Table 6.4  Aims Prior to Laboratory Course

Cluster 3  Important Aims

<table>
<thead>
<tr>
<th></th>
<th>Important Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 6</td>
<td>Capability of intelligent decision making</td>
</tr>
<tr>
<td>I 8</td>
<td>Ability to teach yourself</td>
</tr>
<tr>
<td>I 10</td>
<td>Ability to analyse problems critically and objectively</td>
</tr>
<tr>
<td>I 11</td>
<td>Ability to reason for yourself</td>
</tr>
<tr>
<td>I 16</td>
<td>Enthusiasm for learning</td>
</tr>
<tr>
<td>I 17</td>
<td>Ability to key up with the advancement of knowledge in your field and know how to extend it</td>
</tr>
<tr>
<td>I 20</td>
<td>Ability to see and comprehend opposing viewpoints without sacrificing your own</td>
</tr>
<tr>
<td>V 8</td>
<td>Ability to contribute to the national industrial research effort</td>
</tr>
<tr>
<td>V 13</td>
<td>Have acquired the standards, modes of thought and skills appropriate to a field of study</td>
</tr>
<tr>
<td>V 14</td>
<td>Ability to apply your knowledge to practical subjects</td>
</tr>
<tr>
<td>V 18</td>
<td>Ability to apply knowledge in new situations</td>
</tr>
<tr>
<td>V 20</td>
<td>Have a degree of competence in your subject</td>
</tr>
</tbody>
</table>

Characterisation:

INTELLECTUAL
Summary: The Students Aims Prior to Taking the Laboratory Course

In summary, it can be seen that not all students held as important the same aims for a university education; however, on the basis of their Q-sortings of the given aims the students could be grouped into three "clusters", each cluster showing certain groups of aims in common. The three clusters are characterised as:

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Characterisation</th>
<th>Important Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Personal</td>
<td>P7 P9 P14 P15 P17 P20 S15 I6 I11</td>
</tr>
<tr>
<td>2</td>
<td>Vocational</td>
<td>P7 P9 P15 I11 I10 I19 V4 V6 V9 V10 V13 V14</td>
</tr>
<tr>
<td>3</td>
<td>Intellectual</td>
<td>I6 I8 I10 I11 I16 I17 I20 V8 V13 V14 V18 V20</td>
</tr>
</tbody>
</table>

Although no one cluster of students' aims is confined to any one of the few original categories, the aims in each cluster do lend themselves to fairly clear, general characterisation. Clusters one and two do share certain aims in common viz: P7, P9, P15, I11; but it is clear that aims P7, P9 and P15 are more useful vocationally than P14, P17 and P20 and so along with the strong vocational aims of V4, V6, V9 and V10 make Cluster 2 vocationally oriented, whereas Cluster 1's orientation is more strongly toward the personal dimension. Again, even though Cluster 3 - characterised as intellectual with seven strong "I" aims - has five vocational aims, the intent of these aims is clearly related to the students' interest in intellectual pursuits e.g. V14: ability to apply your knowledge to practical subjects; V18: ability to apply your knowledge in new situations.
So, it is clear that, prior to taking the laboratory course, this
group of students comprised three sub-groups who each held
different views of a university education: group one being Person­
ally oriented; group two being Vocationally oriented and group
three being Intellectually oriented.

6.5.2 The Students' Aims After Taking the Laboratory Course

The cluster analysis of the students after taking the laboratory
course also produced three distinct clusters of students on the basis
of scores given to the aims in the Qsorts. Figure 6.3 is the
graphical printout from the computer analysis. The three clusters
were established using the same criteria discussed above; the "cut­
off" point for distinguishing the clusters is at 8.439 (To
distinguish these clusters from the previous ones, they are labelled
1A, 2A and 3A).

Cluster 1A

Five students comprise Cluster 1A (qv Table 6.5) four of the eleven
important aims are personal ones, four are social aims. The other
three aims are of an intellectual nature. This mix of personal,
social and intellectual aims can be characterised as:

Personal/Social/Intellectual

Discussion

None of the clusters prior to taking the laboratory course emphasised
personal, social and intellectual aims in nearly equal proportions:
Figure 6.3 Student Clusterings - Post-lab

Cluster 1
Cluster 2
Cluster 3

Students (N=20)
this cluster of five students is distinguished by their concern for their all round development. The intellectual aims focused on here are fairly unique to this group also, with the trend being for purely academic achievements (e.g. I4) - an attitude which did not emerge in the previous year. The wish for self-reliance seems to permeate the needs of this cluster of students.

### Table 6.5 Aims After Laboratory Course

<table>
<thead>
<tr>
<th>Cluster 1A</th>
<th>Important Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 9</td>
<td>Have an all round development of your personality</td>
</tr>
<tr>
<td>P 11</td>
<td>Have developed self-reliance</td>
</tr>
<tr>
<td>P 14</td>
<td>Have broadened your view of life</td>
</tr>
<tr>
<td>P 20</td>
<td>Have developed a sensitivity for others</td>
</tr>
<tr>
<td>S 1</td>
<td>Be imaginative and sensitive to other people</td>
</tr>
<tr>
<td>S 2</td>
<td>Have a deepened understanding of yourself and other people, thus enabling you to develop more tolerant attitudes</td>
</tr>
<tr>
<td>S 5</td>
<td>Have social confidence</td>
</tr>
<tr>
<td>S 15</td>
<td>Ability to communicate with others</td>
</tr>
<tr>
<td>I 4</td>
<td>A wish to acquire knowledge for its own sake</td>
</tr>
<tr>
<td>I 8</td>
<td>Ability to teach yourself</td>
</tr>
<tr>
<td>I 15</td>
<td>Development of a habit of disciplined, rational thinking</td>
</tr>
</tbody>
</table>

**Characterisation**

Personal/Social/Intellectual
Cluster 2A

Cluster 2A (10 students) emphasises twelve aims as being important. Seven of these are personal aims, the emphasis being on very personal needs; the two social aims seem to reflect this trend as do in fact the three intellectual ones (qv Table 6.6). This cluster can be characterised by:

**PERSONAL**

Discussion

The interesting aspect of the aims of this cluster of students is the predominance of very personal aims related to developing maturity, broadening their view of life, becoming well developed individuals and so on.

Cluster 3A

Five students make up Cluster 3A, which emphasises thirteen aims - six vocational, five intellectual and two social (Table 6.7). I have chosen to characterise them by:

**Intellectual/Vocational/Social**

Discussion

The pragmatic nature of the vocational and intellectual aims predominates here. The vocational aims emphasise two needs - training for a field of study, and the application of knowledge to a vocation. The intellectual aims point to the uses of intellectual pursuits, and the two social ones are concerned with relating to "ones fellow men" and giving leadership.
Table 6.6. Aims After Laboratory Course

<table>
<thead>
<tr>
<th>Cluster 2A</th>
<th>Important Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 7</td>
<td>Be a well developed individual</td>
</tr>
<tr>
<td>P 9</td>
<td>Have an all round development of your personality</td>
</tr>
<tr>
<td>P 11</td>
<td>Have developed self-reliance</td>
</tr>
<tr>
<td>P 14</td>
<td>Have broadened your view of life</td>
</tr>
<tr>
<td>P 15</td>
<td>Have developed maturity</td>
</tr>
<tr>
<td>P 17</td>
<td>Have developed the framework for a purpose in life</td>
</tr>
<tr>
<td>P 18</td>
<td>Have fully realised your potential - recreational and working</td>
</tr>
<tr>
<td>S 5</td>
<td>Have social confidence</td>
</tr>
<tr>
<td>S 15</td>
<td>Ability to communicate with others</td>
</tr>
<tr>
<td>I 6</td>
<td>Capability of intelligent decision making</td>
</tr>
<tr>
<td>I 11</td>
<td>Ability to reason for yourself</td>
</tr>
<tr>
<td>V 20</td>
<td>Have a degree of competence in your subject</td>
</tr>
</tbody>
</table>

**Characterisation**

PERSONAL
Table 6.7  Aims After Laboratory Course

Cluster 3A  Important Aims

S 6  Ability to accept and practise the highest professional standards of integrity, compassion and service to ones fellow men
S 9  Ability to speak with authority and give acceptable leadership in some area
I 10 Ability to analyse problems critically and objectively
I 14 Development of adaptability i.e. an ability to cope with changing patterns of knowledge
I 15 Development of a habit of disciplined, rational thinking
I 17 Ability to key up with the advancement of knowledge in your field and know how to extend it
I 19 A real mastery of your subject and its application
V 6  Ability to apply and extend academic standards to vocational work
V 7  Ability to apply your knowledge directly to the aims and needs of society
V 9  Have the necessary professional skills
V 13 Have acquired the standards, modes of thought and skills appropriate to a field of study
V 18 Ability to apply knowledge in new situations
V 20 Have a degree of competence in your subject

Characterisation

Intellectual/Vocational/Social
Once again, after the laboratory course the students did not all hold the same aims of a university education in common. On the basis of their Q-sorting of the given aims, the students could be grouped into three clusters, which are characterised thus:

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Characterisation</th>
<th>Important Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>Personal/Social/Intellectual</td>
<td>P9 P11 P14 P20 S1 S2 S5 S15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I4 I8 I15</td>
</tr>
<tr>
<td>2A</td>
<td>Personal</td>
<td>P7 P9 P11 P14 P15 P17 P18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S5 S15 I6 I11 V20</td>
</tr>
<tr>
<td>3A</td>
<td>Intellectual/Vocational/Social</td>
<td>S6 S9 I10 I14 I15 I17 I19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V6 V7 V9 V13 V18 V20</td>
</tr>
</tbody>
</table>

As in the situation prior to the laboratory course, no one cluster has aims solely in one of the four original categories. Clusters 1A and 2A share three personal aims - P9, P11 and P14. Cluster 1A, however, also emphasises strongly social and intellectual aims and thus warrants the characterisation Personal/Social/Intellectual. Cluster 2A emphasises four other "P" aims making seven in all; the social and intellectual aims lend emphasis to the overall personal interest, so making it suitable to characterise this cluster of students Personal.

Cluster 3A is the only one to emphasise vocational aims, six in all; there are also five intellectual aims, one of which (I15) is also held by Cluster 1A, and two strongly Social aims, thus suggesting the
characterisation Intellectual/Vocational/Social (with the emphasis on Intellectual and Vocational).

It is clear that after taking the laboratory course the students could be placed into three sub-groups viz: Group 1 Personal/Social/Intellectual; Group 2 Personal; Group 3 Intellectual/Vocational/Social.

6.5.3 Discussion

Figure 6.4 presents the details of the pre and post laboratory clusters, and the movements of students from one cluster to another. It will be convenient to initially consider the changes in the clusters from the pre-laboratory to the post-laboratory period before considering the results in general.

Changes from pre-laboratory to post-laboratory

Cluster 1   Changes

Of the 14 students comprising Cluster 1 (Personal orientation), five moved into Cluster 1A, four into Cluster 2A, three into Cluster 3A and two were "lost" from the sample (i.e. either declined to take part in the post-laboratory Q-sorting or were not available at the time).

The students moving into Cluster 1A were the exclusive members of that cluster; apart from retaining aims P9 14 and 20 and S15 from their pre-laboratory Q-sorting, they exhibited considerable change in their attitude to the important aims. The very strong Personal orientation of the pre-laboratory period gave way to a broader attitude encompassing Personal, Social and Intellectual aims.
Figure 6.4 Pre-Laboratory and Post-Laboratory Clusters, Indicating:

a) that students changed Clusters, pre and post laboratory
b) that the aims of the students changed

PRE-LABORATORY (N = 25)  POST-LABORATORY (N = 20)
(indicating most important aims)  (indicating most important aims)

**CLUSTER 1 (N = 14)**
PERSONAL
P7 9 14 15 17 20
S15
I6 11
V -

**CLUSTER 1A (N = 5)**
PERSONAL/SOCIAL INTELLECTUAL
P9 11 14 20
S1 2 5 15
I4 8 15
V -

**CLUSTER 2 (N = 6)**
VOCATIONAL
P7 9 15
S -
I10 11 19
V4 6 9 10 13 14

**CLUSTER 2A (N = 10)**
PERSONAL
P7 9 11 14 15 17 18
S5 15
I6 11
V20

**CLUSTER 3 (N = 5)**
INTELLECTUAL
P -
S -
I6 8 10 11 16 17 20
V8 13 14 18 20

**CLUSTER 3A (N = 5)**
INTELLECTUAL/VOCATIONAL/SOCIAL
P -
S6 9
I10 14 15 17 19
V6 7 9 13 18 20
Those moving into Cluster 2A (4 students) changed their aims little, retaining many of the Personal ones of the pre-laboratory period, and adding a vocational one (V20) which seems to add more to the Personal orientation than to any change to a Vocational orientation.

The three students moving into Cluster 3A exhibit a complete change of attitude to the aims. Not one of their pre-laboratory aims is retained, and the orientation is swung completely away from Personal to an Intellectual/Vocational/Social one.

Students

Cluster 1 (N = 14)

5 into Cluster 1A: P S I

Personal

4 into Cluster 2A: P

3 into Cluster 3A: I V S

2 "lost"

Cluster 2 Changes

Six students made up Cluster 2 (Vocational orientation). Five of these students moved into Cluster 2A, Personal orientation (one was lost to the study) of their original aims, four were retained viz: P7 9 and 15 and 111. The most striking feature about these five students is their complete loss of interest in Vocational aims from the pre- to the post-laboratory period: in the post-laboratory period they exhibit strong attitudes to Personal aims, not Vocational ones.

Students

Cluster 2 (N = 6)

5 into Cluster 2A: P

Vocational

1 "lost".
Cluster 3 Changes

Of the five students comprising Cluster 3 (Intellectual orientation), two moved into Cluster 3A (Intellectual/Vocational/Social), one moved into Cluster 2A (Personal) and two were "lost" to the study.

The two students moving into Cluster 3A retained five of their pre-laboratory aims viz: I10 and 17 and V13, 18 and 20. However, the aims on which they focused their attention in the post-laboratory period still were within their original categories of I and V, although of course the particular aims changed. They also showed an interest in two Social aims not previously held important by them (S6 and 9).

The student moving into Cluster 2A exhibits greater change, moving from an Intellectual orientation in the pre-laboratory to a Personal one in the post-laboratory period.

Students

Cluster 3 (N = 5) 2 into Cluster 3A: I V S
Intellectual 1 into Cluster 2A: P
2 "lost"

General Observations

Several general observations can be made about these trends:

1. Two-thirds of the students showed strong changes in their orientation to the aims from the pre-laboratory to the post-laboratory period:
a) five students changed from a strong Personal orientation (Cluster 1) to a more diverse Personal/Social/Intellectual one

b) three students changed from a strong Personal orientation to an Intellectual/Vocational/Social one

c) five students moved from a strong "job directed" Vocational stance (Cluster 2) to a strong Personal orientation

d) one student changed from a strong Intellectual stance (Cluster 3) to a strong Personal one.

2. The other one third of the students changed little in their orientation to the aims

a) four students moved from a strong Personal cluster (Cluster 1) to an equally strong Personal one in the post-laboratory period

b) two students moved from a strong Intellectual orientation (Cluster 3) to a similar one in the post-laboratory period (Cluster 3A).

3. Overall, there was a decrease in Vocational aims from the pre-laboratory to the post-laboratory period (especially in strong, job centred vocational aims).

4. There was an increase in Social aims from the pre-laboratory to the post-laboratory period. Only one Social aim - S15 - was evident in the pre-laboratory period, changing to six in the post-laboratory period.
5. There was a "moderate" increase in the importance of intellectual aims from the pre-laboratory to the post-laboratory period.

A summary of the pre and post-laboratory clusters indicates these changes:

<table>
<thead>
<tr>
<th>Pre-laboratory</th>
<th>Post-laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 1</td>
<td>1A Personal/Social/Intellectual</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>2A Personal</td>
</tr>
<tr>
<td>Cluster 3</td>
<td>3A Intellectual/Vocational/Social</td>
</tr>
</tbody>
</table>

6.5.4 Some general considerations

The dramatic changes shown by two thirds of the students suggest that these students were possibly rethinking the purpose of their education in the intervening period of the two parts of this study, leading to a radical refocusing of their position. These strong changes in the importance ascribed to the aims are not from one overall position to another, but from several different positions to several other different positions. There are changes from strong Personal orientations to more diversified ones of Personal/Social/Intellectual and Intellectual/Vocational/Social stances; from strong Vocational (job oriented) and strong Intellectual stances to equally strong Personal ones. All of these changes might be interpreted as struggles toward an increased meaning in the students' university careers, a phenomenon reported by Perry (1970) besides others. Whereas Perry's work was concerned with plotting changes in the way students think about knowledge, authority and "truth", the present study concentrates only on the changes occurring in the students' attitudes to the importance of university aims, but indicates that within this sphere students do also change.
On looking through the literature there seems to be few systematic studies of the changes which occur in students' aims of a university education. However, there are several studies with which the results of the present study seem to compare closely: they are a study of the objectives of students at an Australian university (Katz and Katz 1968); a study of polytechnic students objectives (Oxtoby 1971); a study of students reasons for going to university (Startup 1972) and the generalised results of comparable American studies (Feldman et al. 1969).

Table 6.8 provides a comparison of the aims important to the first year Australian students and those corresponding aims of importance to the pre-laboratory (first year) and post-laboratory (second year) students in the present study. Six aims are important to both the Australian students and the pre-laboratory (first year) students, in the areas of vocational, personal and intellectual interests (and possibly social, if aim 7 is considered - but I think the Australian conception of this is more intellectual than social). The major difference is that the Australian students emphasise social aims which the pre-laboratory students do not.

This situation changes when the post-laboratory (second year) results are compared with the Australian results; the swing to an emphasis on social aims by the post-laboratory students compares more closely to the Australian students' perception of the importance of a university education.
### Table 6.8: Australian Students and the Physiology Laboratory

#### Students Important Aims Compared

<table>
<thead>
<tr>
<th>The eleven most important aims of the first year students in the Australian study (Katz and Katz 1968)</th>
<th>Most closely corresponding aims in present study</th>
<th>appearance of aims as important aims in present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provide vocational training, develop skills and techniques directly applicable to a career</td>
<td>V1 4 9 10</td>
<td>PRE-LAB: (1st year) POST-LAB: (2nd year)</td>
</tr>
<tr>
<td>2. Develop tolerance of the views and opinions of others</td>
<td>S2 10</td>
<td>Yes (Cl 2) Yes (Cl 1A)</td>
</tr>
<tr>
<td>3. Develop students abilities to get along with different kinds of people</td>
<td>S3 14</td>
<td>No Yes (Cl 3A)</td>
</tr>
<tr>
<td>4. Develop students knowledge and interests in community, national and world problems</td>
<td>S13 16</td>
<td>No No</td>
</tr>
<tr>
<td>5. Develop independence</td>
<td>P11 8 6 7 9</td>
<td>PRE-LAB: POSS Yes (Cl 1 2) Yes (Cl 1A 2A)</td>
</tr>
<tr>
<td>6. Develop ability to do significant independent research</td>
<td>J9 17</td>
<td>Yes (Cl 3) Yes (Cl 3A)</td>
</tr>
<tr>
<td>7. Develop ability to take part in discussions</td>
<td>S16 (10?)</td>
<td>S16 (10?) Yes (Cl 1) Yes (Cl 1A 2A)</td>
</tr>
<tr>
<td>8. Provide some understanding of the basic concepts of both the sciences and humanities</td>
<td>P2 7 9 19</td>
<td>Yes (Cl 1 2) Yes (Cl 1A 2A)</td>
</tr>
<tr>
<td>9. Develop students' moral capacities, ethical standards and values</td>
<td>P10 S20</td>
<td>No No</td>
</tr>
<tr>
<td>10. Provide a thorough training in one specific field of study</td>
<td>V13 20</td>
<td>Yes (Cl 2 3) Yes (Cl 2A 3A)</td>
</tr>
<tr>
<td>11. Develop ability to write lucidly and correctly</td>
<td>I12</td>
<td>No No</td>
</tr>
</tbody>
</table>
The importance of vocational and intellectual aims to first year students seems to be a general trend and is noted by Oxtoby (1971), Startup (1972) and Feldman et al. (1967). Only those students in Startup's study emphasised personal aims as being important as well (Startup 1972 p.327); indeed Oxtoby (1971) suggests that in general personal and social aims do not figure high in students important aims.

The only information on change of importance of aims is found in the American studies (Feldman et al. 1969), which indicate that in general by the time students are in their senior year the emphasis on vocational aims has decreased and the importance of intellectual ("general education") aims has increased.

The results of the present study generally concur with the results of these other studies: intellectual and vocational aims are of importance in the first year (pre-laboratory), and by the second year (post-laboratory) the vocational emphasis is reduced and the intellectual one has become somewhat stronger. But there are important differences: there is a very strong interest in the promotion of personal aims by the first year students in the present study, an interest reported by only two other authors (Katz and Katz 1967 and Startup 1972); and there is a strong emergence of social aims in the second year students, a trend not reported by any of the other authors.

The differences in methodology of the studies, cultural backgrounds, student subject areas, and types of institutions which form the back cloth to these studies makes it difficult, and not entirely wise, for comparisons to be made. The emergence of the importance of the
personal dimension in the first year students' education in the present study, and the increase in social aims by the second year are interesting points of departure from the results of the other studies: it seems unreasonable to accept the belief that personal and social aims are of little importance to students (Oxtoby 1971 p.88). The small-scale nature of the present study cautions against generalising from the results, but it would be interesting and worth-while to replicate this study on a larger scale to determine its general veracity.

6.6 What Effect Did the Laboratory Course Have on the Changes in the Students' Attitudes for the Aims?

Having ascertained that there was a change in the students' attitudes to the aims from the period prior to the laboratory course to that after the laboratory course, I can now consider the role that the laboratory course palyed in effecting this change.

This section of the chapter is derived from interviews with the students held after the course had finished. During these interviews we only discussed the students' individual aims-sorting, not the results of the cluster analysis.

6.6.1 Method

Shortly after the students had finished the laboratory course and had completed the aims-sorting for the second time, I interviewed each of them separately to ask what effect the laboratory course had on the change in their attitude to the aims. The following procedure was adopted:
1. The students were confronted with their first aims Q-sort to remind them of their attitudes to the aims prior to taking the laboratory course.

2. They were then shown the recently completed Q-sort i.e. the one completed after the laboratory course had finished.

3. We compared the two aims sortings and talked generally about the students' aims before and after taking the course.

These three steps helped the student to think about the aims, and the changes, and generally prepared them for step 4.

4. I asked the students to focus their attention on the second Q-sort and ask themselves:

   a) why the aims had changed; THEN

   b) what possible role having taken part in the laboratory course might have had in effecting the change in attitude to the aims. This question was elaborated upon thus: could the laboratory course have played a role in making these aims more important than they were before taking the course?

Each student was asked to consider each of the ten most important aims in their Q-sort in turn, and consider what effect or impact the laboratory might have had on their attitude to them. Realising that some aims important in the students' first Q-sort were still important in their second one (and that change is not the only criterion
of "effect" or impact") * the students were asked, whenever this occurred, to consider in what way the laboratory could have played a role in keeping them important.

Each interview lasted between one hour and one and a half hours. They were tape-recorded with the student's permission, and transcribed afterwards for later analysis.

6.6.2 Results

Tables 6.9, 6.10 and 6.11 present the results. Although in the interview I asked each student to consider the effect of the laboratory course on each of their ten most important aims, only those of these aims defined as important in each post-laboratory cluster (as described above) are considered here.

Cluster One A

Table 6.9 shows the responses of the students in cluster 1A; there are five students in this cluster and eleven aims. All but two of the aims were thought in one way or another to have become important to the students partly as a consequence of the laboratory course. Aims P9 and P14 were not affected by the course.

* Feldman cautions: "To define 'impact' exclusively in terms of 'change' is too narrow an interpretation of the concept. Under certain conditions NON-CHANGE or STABILITY also may indicate impact----for example, as a senior, a student may be as favourable (or unfavourable) to some object or issue as he was as a freshman. But the object or issue may be more (or less) salient to the senior; it may be more (less) strongly related to other attitudes and more (less) firmly embedded in other processes of his personality system; he may have more (less) knowledge about it with increasingly (decreasingly) explicit reasons for his attitude. Thus there is both stability and change" (Feldman 1969 p.209).
<table>
<thead>
<tr>
<th>Cluster 1A</th>
<th>Characterisation: Personal/Social Intellectual</th>
<th>Students indicating that the laboratory course had an effect on the aim (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Important Aims</td>
<td></td>
<td>Students: 1 2 3 4 5 TOTAL</td>
</tr>
<tr>
<td>P 9 Have an all round development of your personality</td>
<td></td>
<td>✓ ✓ ✓ 0</td>
</tr>
<tr>
<td>P 11 Have developed self-reliance</td>
<td></td>
<td>✓ ✓ ✓ 3</td>
</tr>
<tr>
<td>P 14 Have broadened your view of life</td>
<td></td>
<td>✓ ✓ 0</td>
</tr>
<tr>
<td>P 20 Have developed a sensitivity for others</td>
<td></td>
<td>✓ ✓ ✓ 3</td>
</tr>
<tr>
<td>S 1 Be imaginative and sensitive to other people</td>
<td></td>
<td>✓ ✓ ✓ 3</td>
</tr>
<tr>
<td>S 2 Have a deepened understanding of yourself and other people, thus enabling you to develop more tolerant attitudes</td>
<td></td>
<td>✓ ✓ ✓ ✓ 4</td>
</tr>
<tr>
<td>S 5 Have social confidence</td>
<td></td>
<td>✓ ✓ 2</td>
</tr>
<tr>
<td>S 15 Ability to communicate with others</td>
<td></td>
<td>✓ ✓ ✓ ✓ 4</td>
</tr>
<tr>
<td>I 4 A wish to acquire knowledge for its own sake</td>
<td></td>
<td>✓ ✓ 1</td>
</tr>
<tr>
<td>I 8 Ability to teach yourself</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ 5</td>
</tr>
<tr>
<td>I 15 Development of a habit of disciplined, rational thinking</td>
<td></td>
<td>✓ ✓ ✓ ✓ 4</td>
</tr>
</tbody>
</table>
The number of students saying that any one aim was affected by the course varies from aim to aim. Aim 18 - Ability to teach yourself - was considered by all five students to have been influenced by the laboratory course experience. The experience of having to write laboratory reports was considered to be related to teaching oneself. This involved using appropriate text-books in the library and elsewhere; understanding the laboratory report questions and being able to use the text-books to find the answers; coming to terms with the need to spend time sifting through books, notes etc. and with spending time discussing the writing of the reports with other students.

Although the details of the experience of "teaching themselves" differ, the trend is the same for each student and can be illustrated by considering one particular student. This student said that "a year ago" (i.e. at the beginning of the laboratory course) she used one text-book and copied what was needed out of that. Now she will use "about six text-books and compare what they say and sort of amalgamate the best answer". In the interview I asked if that was a learning strategy picked-up in the laboratory course, or was it something more generally picked-up:

**Student**

"I think I picked that up (concerning laboratory reports) .... talking about what we'd written amongst ourselves, and obviously some people had gone into far more hard work about what they'd done, and I thought maybe I should be doing that. And, eh, I gradually started doing it"

**Interviewer**

"So that was something you picked up in the laboratory specifically?"
"Yes"

"How does that relate to the way you approach your work generally now - has it had any effect?"

"Well, I read more widely, definitely. Um, I'm a bit more thorough... in my work. I don't just leave something if I don't understand it. I'll go and chase it around until I do"

"Right. Has that been an experience of having to do that in the physiology laboratory?"

"I think so"

"In your reports?...."

"I think so, yes, because in lectures we just wrote down what they told us. In physiology laboratory reports you have to go and find out lots of things" (student 1).

Another student (student 4) also commented in relation to this aim and the role that the laboratory has played in making it more important to her:

"If I wanted to learn something now, if I wanted to teach myself something I think I'd have a better idea of how to go about it .... get books to teach myself with"

Six of the other eight aims were considered by 3 or 4 of the students to have been influenced, or made important, by the experience of the laboratory course. S15 - Ability to communicate with others - is a "hidden curriculum" aim of the laboratory course which seems to have
become important for four of the students. Again, one typical student's case illustrates this (Student 2):

Student "I think that's the thing that comes up again and again - that you've got to be able to express yourself and let others know that you know what you are talking about without being too simplistic"

Interviewer "And that's basically something that's happened in the laboratory?"

Student "Yes. That's the area where it's been highlighted most.... the laboratory is the biggest thing that we hand in"

Another student's reasoning for saying that the laboratory made this aim important for her goes as follows (Student 3):

Student "At the beginning (of the laboratory course) no one would say anything to anyone about the experiments. You just followed the sheet.... You just thought the lecturers knew best and there was no discussion needed about it. But after a bit we began to realise that.... if you talked to people, if you asked the lecturer to explain things, it made it all much easier."

Interviewer "So initially you didn't ask questions of staff or students?"

Student "Nobody. You just shook.... and made mistakes"

Interviewer "But as time went on that changed?"

Student "Yes. You began to realise that it helped if you talked to each other: to the technicians, lecturers and other students, and work out problems. Sort them out"
The development of self reliance (P11) has become important to three of these students because of the laboratory course. One student felt she had learned this in the laboratory and now was striving towards maintaining it as an important university aim (Student 3):

Student "... we were scared to touch anything.... because you tought you'd do it wrong. But you gradually began to realise that it didn't matter if you did things wrong, that you could always correct your own mistakes.... I just hated doing it (i.e. the laboratory work). By the end it was great fun - I like doing them. That change.... I'm more confident because I could do them"

This also had an effect on her university work generally:
"You begin to think you are quite capable altogether and therefore more able with everything. I think it (i.e. laboratory) has helped me in other areas too."

The laboratory course has also made some students more aware of their relationship to others and of the need to co-operate and be tolerant (aims P20 S1 and S2). Student four commented:

Student "I think it (i.e. laboratory) tends to make you realise that someone else's views are often as important as your own. You had to co-operate a bit.... I think I find it easier to tolerate it (i.e. other people's views) now than before"

and the student went on to explain that having to do that in the laboratory prepared her for doing it in other, more stressful learning
situations where co-operation and sensitivity to others is important (she cited several group projects where this was the case).

The development of a habit of disciplined, rational thinking (115) was also a "hidden" aim of the course and one which became important as a consequence of the course. One student commented that this was necessary in writing up laboratory reports (Student 4):

Student "You had to do them (i.e. reports) in a fairly small space, you had to be fairly precise. There was usually a lot to get in to get a fairly decent mark... and you couldn't waffle. So it taught you how to put things down precisely and not to give things that weren't relevant...."

and another student (Student 2) talked generally of developing "disciplined rational thinking" as a consequence of the laboratory course:

Student "... You begin to realise that there may be many factors that can cause one thing and you've got to.... take other factors into consideration. And I think this affects other courses... you sort of realise that the depth that's required - you've got to say why this happened, why that happened. And I think this sets you up for writing reports and things - far more complicated things like psychology.... this systematic way you're taught.... I think that's very profitable."
Cluster Two A

Table 6.10 shows the responses of students in cluster 2A. There are ten students in this cluster, and twelve aims. Two of the aims - PI4 and PI7 - are considered not to have been influenced by the experience of the laboratory course. Three others - P7, P18 and II1 - played a role in only one or two students' attitude changes and as such will not be considered in any detail.

The aim which seems to have been influenced most by the laboratory course experience for these students is P11 - Development of Self Reliance. During the interviews, every student was quite sure that the laboratory course had played a role in developing their self-reliance and had made this aim important to them. Their "self-reliance" is construed generally in terms of gaining more confidence in themselves:

Student "Basically I've got more confidence in what I know now. Probably it is working in the laboratory situation and... having to work on your own; you have to work things out" (Student 9)

and the sense of achievement associated with gaining this self-reliance is obviously exhilarating to some:

Student "You have to do most of the experiments yourself.... ... And very difficult things - I remember one prac., it was really, really difficult; I remember spending hours on it but the sense of achievement after I'd done it was fabulous. And you think, well you know, you can do it...... It boosts your self-reliance; you know you can do it" (Student 2).
Table 6.10 The Effect of the Laboratory Course on the Aims

Cluster 2A

Characterisation: Personal

<table>
<thead>
<tr>
<th>Important Aims</th>
<th>Students indicating that the laboratory course had an effect on the aim (✓)</th>
<th>Student:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 7 Be a well developed individual</td>
<td></td>
<td>✓</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>P 9 Have an all round development of your personality</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 11 Have developed self-reliance</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 14 Have broadened your view of life</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 15 Have developed maturity</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P 17 Have developed the framework for a purpose in life</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>P 18 Have fully realised your potential - recreational and working</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S 5 Have social confidence</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S 15 Ability to communicate with others</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I 6 Capability of intelligent decision making</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I 11 Ability to reason for yourself</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>V 20 Have a degree of competence in your subject</td>
<td></td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Associated with the development of self-reliance is an increase in "maturity" (P15). Eight of the students thought the laboratory course had "matured" them in some way, usually in their attitudes to other people because of the fact that they had to relate in a mature way to the other people, especially the other students, in the laboratory:

Student: "If it wasn't for those practicals, half the people in that course I wouldn't know very well.... I think I've matured in my attitude to other people.... whereas before I didn't accept other people's views; I used to think that, well mine are right, you know. I think you can see other peoples views and realise that they do have different attitudes to you and equally acceptable to your own" (Student 7).

Similar feelings are expressed about the increase in their ability to communicate (Student 15) with each other, especially as a consequence of laboratory project work: there were times when the students had to communicate effectively in order to get the work for the project completed. One student describes her feelings about this:

Student: ".... And the arguments we had were incredible. We would sit in the coffee bar.... In my group we wrote everything down; everybody's ideas. And then discussed their merits: whether we had time to do them, whether they were feasible to do in the laboratory...."

Interviewer: "How do you feel about that experience - was it a useful experience?"
Student: "I think it was; it was very useful.... I think it's proven to me that I can work in a group situation .... Whereas, I think I would have said before that 'No, I want to work on my own!' " (Student 2).

For this cluster of students, the characterisation, "Personal Development" is particularly apt; the aims discussed above reflect strongly what they think they achieved in the laboratory course in terms of their personal development. An increase in social confidence (student 5) was also something gained in part during the laboratory course, especially in relation to communicating effectively with the academic staff, as the following student points out:

Student: "I think I've developed more social confidence generally and I think also in the physiology laboratory; I would have been slightly scared earlier to have asked one of the doctors, and that - I would have been a bit intimidated. Em, you just go up, and if your fairly polite its allright" (Student 6).

For some students too, the experience of the course in the laboratory taught them to be more fully "rounded" people (P9), helping them to develop skills and attitudes not usually considered part of the focus of lab work. Talking of this particular aim and the role the laboratory course played in fostering it, one student commented:

Student: "....doing the laboratories.... it brings out your personality I should think. The way you go about doing the experiment; the attitude you take when things go wrong: if you start panicking; whether you can treat part of it as a joke and not get too flustered.... I think
in that respect it brings out your personality a bit. Whether you tend to get offensive if the person you're working with mucks-up the whole experiment. You put the blame on them, or whether you can turn round and say "Let's start again", sort of thing" (Student 8).

As well as the characteristics of personal development which the laboratory course seems to have developed in these students, two other slightly different aims were also fostered: I6 - Capability of intelligent decision making, ("in the laboratory you've got to make intelligent decision making" (Student 10)) and V20 - A degree of competence in your subject, an aim which would go part and parcel with the course. For these students, the laboratory course has not only been a means of achieving traditional academic aims of knowledge and perceptual-motor skills (i.e. the formal aims of the course), but also a personally enriching experience in the development of more affective aims which might never be considered, traditionally, as being aims of a physiology laboratory course but which obviously were important aspects of the learning context of the laboratory for them.

Cluster Three A

Table 6.11 shows the responses of students in cluster 3A. There are five students in this cluster (although one of them was not available for interview) and thirteen aims. Only two aims were considered by at least three of the students to have been strongly influenced by the laboratory course.
Table 6.11  The Effect of the Laboratory Course on the Aims

Cluster 3A

Characterisation: Intellectual/vocational/Social

Important Aims

| Students indicating that the laboratory course had an affect on the aim (✓) |
|---------------------------------|---|---|---|---|---|
| Student: | 1 | 2 | 3 | 4 | 5 | TOTAL |
| S 6 Ability to accept and practise the highest professional standards of integrity, compassion and service to ones fellow man | ✓ |   |   |   |   | 1 |
| S 9 Ability to speak with authority and give acceptable leadership in some area |   | ✓ |   |   |   | 1 |
| I 10 Ability to analyse problems critically and objectively |   |   | ✓ |   |   | 1 |
| I 14 Development of adaptability i.e. an ability to cope with changing patterns of knowledge | ✓ | ✓ | ✓ |   |   | 3 |
| I 15 Development of habit of disciplined rational thinking | ✓ | ✓ | ✓ |   |   | 3 |
| I 17 Ability to keep up with the advancement of knowledge in your field and know how to extend it |   |   | ✓ | ✓ |   | 2 |
| I 19 A real mastery of your subject and its application | ✓ | ✓ | ✓ |   |   | 2 |
| V 6 Ability to apply and extend academic standards to vocational work | ✓ |   |   |   |   | 1 |
| V 7 Ability to apply your knowledge directly to the aims and needs of society | ✓ | ✓ |   |   |   | 2 |
| V 9 Have the necessary professional skills | ✓ |   |   |   |   | 1 |
| V 13 Have acquired the standards, modes of thought and skills appropriate to a field of study | ✓ | ✓ |   |   |   | 2 |
| V 18 Ability to apply knowledge in new situations | ✓ | ✓ |   |   |   | 2 |
| V 20 Have a degree of competence in your subject |   |   | ✓ |   |   | 1 |
One student (student 1) in this cluster found it extremely difficult to articulate her attitudes to the laboratory course. She could only relate one of the aims to the laboratory course (aim 117), and indeed felt quite strongly that aims V9 and V20 were definitely not ones which, to her, had been part of the laboratory experience. Reading through the transcript of her interview I am struck by her resignation to failure in her degree course and to her own inabilities in the work she had to do in the laboratory course. She admitted that she "did not have the correct attitudes" to the laboratory work, and found the laboratory work tedious; she also admitted: "I didn't feel confident at all" throughout the course, and said she still did not feel confident in her work. Her attitudes to the course were clouded by certain criticisms she held about it, especially its non-vocational nature. I suggest that, at least partly, these attitudes made it extremely difficult for this student to relate in a positive way to the laboratory course or to talk retrospectively at that time about its affect on her aims of a university education. "I can't really say what I've learned from it" were her final words on the subject.

The two aims considered to have been influenced by the laboratory course by the three other students are 114 and 115 i.e. the development of adaptability and the development of a habit of disciplined rational thinking.

Because of the "unusual" nature of this cluster of students (one student not being available for interview; another being unable to say what she had learned from the laboratory course; the other three holding only the two aims mentioned above in common) I think it is sufficient to say that for them, the laboratory course strongly influenced
their attitudes to aims 114 and 115, and had an affect to a lesser extent on their collective attitude to the other aims.

Summary

What effect did the laboratory course have on the change in the students' attitudes to the aims?

In this section I have shown that the laboratory course did have an effect on the change in the students' attitudes to the university aims. By considering each cluster of students' important aims, it was possible to relate the emergence of their importance, at least in part, to the previous years experience of taking part in the laboratory course.

Looking generally at the aims, between them the three clusters of students held twenty nine aims in importance after the laboratory course. Of these twenty nine, twenty five had, in one way or another, been influenced by the laboratory course; of these, thirteen were most strongly influenced by the course. These thirteen "unexpected" aims are listed in Table 6.12.

6.7 Discussion

In chapter one I mentioned that one of the purposes of this evaluation study was to consider the "unexpected" outcomes of the physiology laboratory course. This chapter has considered one particular aspect of these "unexpected" outcomes, namely the effect of the laboratory course on the students' perceptions of the aims of a university education.
<table>
<thead>
<tr>
<th>Code</th>
<th>Aims of the Three Clusters of Students which were most Strongly Influenced by the Physiology Laboratory Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 9</td>
<td>Have an all round development of your personality</td>
</tr>
<tr>
<td>P 11</td>
<td>Have developed self-reliance</td>
</tr>
<tr>
<td>P 15</td>
<td>Have developed maturity</td>
</tr>
<tr>
<td>P 20</td>
<td>Have developed a sensitivity for others</td>
</tr>
<tr>
<td>S 1</td>
<td>Be imaginative and sensitive to other people</td>
</tr>
<tr>
<td>S 2</td>
<td>Have a deepened understanding of yourself and other people, thus enabling you to develop more tolerant attitudes</td>
</tr>
<tr>
<td>S 5</td>
<td>Have social confidence</td>
</tr>
<tr>
<td>S 15</td>
<td>Ability to communicate with others</td>
</tr>
<tr>
<td>I 6</td>
<td>Capability of intelligent decision making</td>
</tr>
<tr>
<td>I 8</td>
<td>Ability to teach yourself</td>
</tr>
<tr>
<td>I 14</td>
<td>Development of adaptability i.e. an ability to cope with changing patterns of knowledge</td>
</tr>
<tr>
<td>I 15</td>
<td>Development of a habit of disciplined, rational thinking</td>
</tr>
<tr>
<td>V 20</td>
<td>Have a degree of competence in your subject</td>
</tr>
</tbody>
</table>
The relationship between the laboratory course and the students' overall university education has been investigated, and it has been shown that the laboratory course had an impact on this - at times very prominently - affecting change in the students' attitudes to their education.

Although, as I discussed in chapter one, we cannot assume that all the aims traditionally associated with university laboratory courses are always achieved, we can be fairly sure that the majority of such courses are aimed at developing traditional aims of knowledge and perceptual-motor skills (although, as we shall see later, there are some laboratory courses with broader aims). Such aims as the development of manipulative, preparative and instrumental skills; the ability to illustrate and amplify lecture material; the ability to follow procedures, and other similar aims discussed in chapter one of this study are typically associated with laboratory courses. Similar aims are of course defined for the physiology laboratory course (for example, see the laboratory schedule accompanying the video-tape on Experiments With Blood which has been discussed in chapter four: the schedule forms part of Appendix 4).

Whether these pre-specified aims are achieved or not, it is clear that over and above them, the physiology laboratory course has offered the students an opportunity to develop their skills in other areas of intellectual and personal development less traditionally associated with physiology laboratory courses. For these students, the laboratory course was one in which they gained insights into personal relationships and personal development; for many, their self-reliance was increased as a consequence of the course, and they matured in their
sensitivity to and tolerance for others. The experiences of the course appear to have influenced the social confidence of still other students and their ability to communicate effectively; the course played a role in increasing their ability to teach themselves and make intelligent decisions. For many students, their competence in coping with the changing patterns of knowledge in physiology, and in thinking rationally and in a disciplined way was strongly affected by the various activities associated with the laboratory.

These are all learning outcomes of the laboratory course which are not traditionally considered to be the domain of the course. They are the "unexpected" outcomes of the laboratory course to which I made reference in chapter one. It is of course realised that in other laboratory courses such outcomes may in fact be the intended outcomes of learning: laboratory courses do exist which explicitly aim at a broader educational process and outcome. Table 6.13 is an attempt to classify the varied "non traditional" aims associated with some laboratory courses reported in the literature. It can be seen that the range of these "non-traditional" aims is very broad; some of them relate closely to the "unexpected" outcomes of the physiology laboratory reported by the students e.g. aim 12 - increase communication and co-operation, is similar to aim S15 - ability to communicate with others; aim 1 - improve thinking and learning, corresponds to aims I6 - capability of intelligent decision making, I8 - ability to teach yourself and I15 - development of a habit of disciplines, rational thinking, and so on.

However, all of these "non traditional" aims are formal aims of the laboratory courses to which they are associated i.e. they are intended
<table>
<thead>
<tr>
<th>AIM</th>
<th>Biological Sciences</th>
<th>Physics and Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Improve students' attitudes to laboratory work</td>
<td>Postlethwait 1970</td>
<td>Reif 1979; Cassen and Forster 1973; Prigo 1975</td>
</tr>
<tr>
<td>4. To promote creativity</td>
<td>Roberts 1967</td>
<td>Kahn and Strassenburg 1974; McGrew 1970; Rouda 1973</td>
</tr>
<tr>
<td>5. To simulate professional scientific work</td>
<td>Holtz 1974</td>
<td>Black et al. 1968; Eaborn 1970</td>
</tr>
<tr>
<td>6. Produce all round scientists</td>
<td>-</td>
<td>Foulds 1969</td>
</tr>
<tr>
<td>7. To increase excitement and interest</td>
<td>-</td>
<td>Kahn and Strassenburg 1974; Wilson 1969; Adelburger 1972; Kammer and Williams 1975</td>
</tr>
<tr>
<td>8. To build confidence, independence, involvement etc.</td>
<td>Woolcock 1974; Young 1967</td>
<td>Wilson 1969</td>
</tr>
<tr>
<td>9. Provide a chance to work in groups</td>
<td>-</td>
<td>Buono et al. 1973; Partlett and King 1971</td>
</tr>
<tr>
<td>10. Test initiative</td>
<td>-</td>
<td>Buono et al. 1973</td>
</tr>
<tr>
<td>11. Humanise laboratory work</td>
<td>-</td>
<td>Hicks 1973</td>
</tr>
</tbody>
</table>
or expected learning outcomes; whereas, the "unexpected" aims associated with the physiology laboratory course were never part of the formalised learning outcomes: they were "unexpected" learning outcomes.

So, it is certainly possible to extend the list of possible aims associated with a laboratory course to include "non traditional" ones. However, the present study has indicated that such aims can also be the product of a laboratory course which does not have them as part of its formalised list of aims. Students appear to have brought to the physiology laboratory course a host of personal needs and aims which they - consciously or unconsciously - worked through, along with the other formalised activities of the course.

The fact that thirteen "unexpected" aims were associated with the learning experiences of the physiology laboratory course should be taken into account in the organisation of the laboratory course. Account should also be taken of the possibility of other "unexpected" learning outcomes being achieved by students in the course e.g. learning outcomes closely associated with students' own personal aims. Such learning outcomes undoubtedly have a considerable effect on the students' attitudes to their university education. They can play an important role in the development of students' self-concepts and their ability to determine the purpose of their education.

In the final chapter I will discuss how this phenomenon of "unexpected" learning outcomes could be taken into account by the course organisers, to the general benefit of all the students.
It should perhaps be pointed out at this stage that the results and conclusions associated with this chapter are from a small-scale, case study involving, variably, twenty to twenty-five students. Although the study and the results do lead toward conclusions useful in the evaluation of the physiology laboratory course, they perhaps have to be treated cautiously when related to wider contexts of teaching and learning, and to educational research generally. At this level, any conclusions mentioned above should be treated as hypotheses to be confirmed by others. Indeed, what should be stressed is that the methodology employed here is a good one for generating hypotheses, since it clearly uncovered a lot that was unexpected.

6.8 Summary of Chapter Six

This chapter considers the role that the laboratory course played in the students overall university education. It has been shown that the students' attitudes to their university education (as determined by their attitudes to eighty university aims) changes from the period before the laboratory course to that after the laboratory course, and that the laboratory course had an important influence on this change.

The way in which the students' attitudes changed is summarised in Figure 6.4, and the aims most influenced by the experience of the laboratory course are listed in Table 6.12, both of which are reproduced here:
Figure 6.4 Pre-Laboratory and Post-Laboratory Clusters, Indicating:

a) that students changed Clusters, pre and post laboratory

b) that the aims of the students changed

PRE-LABORATORY (N = 25)
(indicating most important aims)

<table>
<thead>
<tr>
<th>CLUSTER 1 (N = 14)</th>
<th>2 students</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONAL</td>
<td>2 students</td>
</tr>
<tr>
<td>P7 9 14 15 17 20</td>
<td>4 students</td>
</tr>
<tr>
<td>S15</td>
<td>5 students</td>
</tr>
<tr>
<td>I6 11</td>
<td>1 student</td>
</tr>
<tr>
<td>V -</td>
<td>1 student</td>
</tr>
</tbody>
</table>

POST-LABORATORY (N = 20)
(indicating most important aims)

<table>
<thead>
<tr>
<th>CLUSTER 1A (N = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONAL/SOCIAL INTELLECTUAL</td>
</tr>
<tr>
<td>P9 11 14 20</td>
</tr>
<tr>
<td>S1 2 5 15</td>
</tr>
<tr>
<td>I4 8 15</td>
</tr>
<tr>
<td>V -</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLUSTER 2 (N = 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOCATIONAL</td>
</tr>
<tr>
<td>P7 9 15</td>
</tr>
<tr>
<td>S -</td>
</tr>
<tr>
<td>I10 11 19</td>
</tr>
<tr>
<td>V4 6 9 10 13 14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLUSTER 2A (N = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONAL</td>
</tr>
<tr>
<td>P7 9 11 14 15 17 18</td>
</tr>
<tr>
<td>S5 15</td>
</tr>
<tr>
<td>I6 11</td>
</tr>
<tr>
<td>V20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLUSTER 3 (N = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTELLECTUAL</td>
</tr>
<tr>
<td>P -</td>
</tr>
<tr>
<td>S -</td>
</tr>
<tr>
<td>I6 8 10 11 16 17 20</td>
</tr>
<tr>
<td>V8 13 14 18 20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLUSTER 3A (N = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTELLECTUAL/VOCATIONAL/SOCIAL</td>
</tr>
<tr>
<td>P -</td>
</tr>
<tr>
<td>S6 9</td>
</tr>
<tr>
<td>I10 14 15 17 19</td>
</tr>
<tr>
<td>V6 7 9 13 18 20</td>
</tr>
</tbody>
</table>
### Table 6.12 The Aims of the Three Clusters of Students which were most Strongly Influenced by the Physiology Laboratory Course

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Aim Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 9</td>
<td>Have an all round development of your personality</td>
</tr>
<tr>
<td>P 11</td>
<td>Have developed self-reliance</td>
</tr>
<tr>
<td>P 15</td>
<td>Have developed maturity</td>
</tr>
<tr>
<td>P 20</td>
<td>Have developed a sensitivity for others</td>
</tr>
<tr>
<td>S 1</td>
<td>Be imaginative and sensitive to other people</td>
</tr>
<tr>
<td>S 2</td>
<td>Have a deepened understanding of yourself and other people, thus enabling you to develop more tolerant attitudes</td>
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<tr>
<td>S 5</td>
<td>Have social confidence</td>
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<tr>
<td>S 15</td>
<td>Ability to communicate with others</td>
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<tr>
<td>I 6</td>
<td>Capability of intelligent decision making</td>
</tr>
<tr>
<td>I 8</td>
<td>Ability to teach yourself</td>
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<tr>
<td>I 14</td>
<td>Development of adaptability i.e. an ability to cope with changing patterns of knowledge</td>
</tr>
<tr>
<td>I 15</td>
<td>Development of a habit of disciplined, rational thinking</td>
</tr>
<tr>
<td>V 20</td>
<td>Have a degree of competence in your subject</td>
</tr>
</tbody>
</table>
CHAPTER 7

ISSUE FOUR

THE TAXONOMY
7.1 Introduction

This chapter considers Issue 4 from Stage I of the study i.e. the taxonomy of educational objectives in the psychomotor domain.

I shall consider in general terms the main trends in the development of taxonomies, and their evaluation; this will be followed by a discussion of existing taxonomies in the psychomotor domain, which will lead onto the proposal for a taxonomy, based largely on the existing ones, for possible use in a physiology laboratory.

7.2 The Main Trend in the Development of Taxonomies

7.2.1 Introduction

The late 1940 saw the beginning of an interest amongst psychologists in the classification of educational objectives with a view to furthering educational evaluation in achievement testing. The history of that exploratory interest has been described by Krathwohl (1964):

"In 1948 a group of psychologists interested in achievement testing met at an American Psychological Association convention in Boston. After considerable discussion on the difficulties of co-operating and communicating about work on educational evaluation, it became clear to us that a special limitation of this work was the absence of a common frame of reference. We grew quite enthusiastic about the possibilities of several schemes for securing, at the minimum, a common terminology for describing and referring to the human behavioural characteristics we were attempting to appraise
in our different school and college settings" (Krathwohl et al. 1964, p.3).

The members of the meeting did find a "common frame of reference", which developed into a taxonomy of educational objectives in the cognitive domain of learning (Bloom et al. 1956). Several years later, a similar taxonomy was published in the affective domain (Krathwohl et al. 1964) (see figure 7.1).

According to one of the participants at that original meeting, a taxonomy is "designed to be a classification of the student behaviours which represent the intended outcomes of the educational process" (Bloom et al. 1956). Within this framework, the students' behaviour would be defined in operational terms so that presence of the terminal behaviour (the objective) could easily be assessed.

Although a taxonomy should reflect the real order of elements, as indeed the cognitive and affective taxonomies were developed to do (whereas a classification may contain arbitrary elements), they are still abstractions of reality devised to suit the users own needs:

"Every classification scheme is an abstraction which arbitrarily makes divisions among phenomena solely for the convenience of the user, more particularly to emphasise some special characteristics of the phenomena of importance to the user".... "the arbitrariness of the Taxonomy structure is at once apparent, among other things, its division of the realm of educational goals into three domains: cognitive, affective and psychomotor" (Krathwohl et al. 1964, p.47).
Figure 7.1  The Taxonomy Structure of Bloom et al.

Part I  The Cognitive Domain

1.00  Knowledge
2.00  Comprehension
3.00  Application
4.00  Analysis
5.00  Synthesis
6.00  Evaluation

Part II  The Affective Domain

1.00  Receiving (attending)
2.00  Responding
3.00  Valuing
4.00  Organization
5.00  Characterisation by a value or value complex

Part III  The Psychomotor Domain

Still to be completed by these authors (but as we shall see, several have been proposed by other authors).
What principles guided the development of the taxonomy and what assumptions does the structure of the taxonomy make about learning?

7.2.2 Principles and Implicit Theories of the Taxonomy

Principles

Bloom (1956) points out that in the development of the taxonomy several organisational principles were adopted and followed in order to ensure some form of validity and reliability. Two main principles were held to be important:

1. The categorisation of the educational objectives by use of the taxonomy should facilitate communication between educators who might wish to use the Taxonomy:

"first importance should be given to educational considerations. In so far as is possible, the boundaries between categories should be closely related to the distinctions teachers make in planning curricula or in choosing learning situations. It is possible that teachers make distinctions which psychologists would not make in classifying or studying human behaviour. However, if one of the major values of the taxonomy is in the improvement of communication among educators, then educational distinctions should be given major consideration" (Bloom et al. 1956, p.6).

2. The ordering of the categories in the taxonomy

"should be consistent with relevant, accepted psychological principles and theories" (p.6).
These two principles were the guidelines in the development of the Taxonomy, and are the yardstick by which the Taxonomy can be evaluated.

Implicit Theories

The cognitive and affective taxonomies are based on the theory that learning is both cumulative and hierarchical (Bloom et al. 1956, p.18). Learning is seen to proceed from the lowest level and through a series of higher levels which accumulate until the highest level is reached. This supposes that before learners can perform complex forms of behaviour, they must firstly have proceeded from the less complex form of the behaviour up to the more complex form. The view taken is that complex behaviours are completely analyzable into simpler components (an alternative view is that a complex behaviour is more than the sum of its simpler components (a "Gestalt")). Bloom explains this further:

"Our attempt to arrange educational behaviours from simple to complex was based on the idea that a particular single behaviour may become integrated with other equally simple behaviours to form a more complex behaviour. Thus our classifications may be said to be in the form where behaviours of type A form one class, behaviours of type AB form another class, while behaviours of type ABC form still another class." (Bloom et al. 1956, p.18).

This cumulative, hierarchical view of learning is the main "relevant and accepted psychological principle" on which the Taxonomy is
How well does it, and the other "educational" principle, stand up to an evaluation of the usefulness of the taxonomy as an educational tool?

7.2.3 Evaluations of the Use of the Taxonomy

The usefulness of the Taxonomy as an educational tool can be evaluated by determining if it achieves the two main principles of "communicability" and a reflection of psychological principles of learning. Seddon (1978) has done just that in his review of research studies on the evaluation of these two principles in relation to the cognitive domain.

Seddon (1978) points out that an evaluation of the communicability of the taxonomy can be achieved by determining to what extent educators can agree independently on the classification of educational objectives or test-items according to the different categories of the taxonomy. Has this been shown to be possible?

In reviewing the research studies aimed at determining the "percentage of perfect agreement" amongst judges classifying items to the categories, Seddon concludes that there is a "general lack of agreement" among the judges. This suggests that in terms of promoting communication between educators, there is little evidence to suggest that the categories form a reliable method for communication about educational objectives or items being considered by educators. Since most of the research studies reviewed used judges experienced in the formulation of educational objectives and their categorisation, it is even less likely that the taxonomy would form a reliable basis.
for communication between teachers in "real life educational contexts" (Seddon, 1978, p.306).

The second issue - that the taxonomy should reflect sound psychological principles - can only be assessed after a consideration of the educational (communicability) issue, since "the claims concerning the psychological properties of the categories presuppose that objectives and test items can be classified correctly in the first place" (Seddon op cit). We have seen that in real life educational settings, this is unlikely to be achieved.

Nevertheless, it is important to assess the efficacy of the taxonomy in terms of its psychological premises. Seddon does so in some depth, summarising that from studies looking at the order of complexity of objectives ranked on the taxonomy, there is no evidence of a cumulative hierarchical relationship between the categories (p.315). Seddon goes on to emphasise the ambivalence of the results of studies aimed at confirming or disconfirming the psychological principles:

"No one has been able to demonstrate that these properties do not exist. Conversely, no one has been able to demonstrate that they do" (Seddon op cit p.321).

It would seem that on the basis of the results of studies evaluating the two major principles upon which the taxonomy is founded, it does not stand up to the original claims of the authors.

Nevertheless, despite there being strong factions for the Taxonomy and equally strong factions against it (e.g. see Rowntree 1977, it is
often referred to in the educational sector as an important educational tool, and to this extent it can be thought of as "useful".

It does, however, seem unlikely that any one theoretical framework upon which a taxonomy is based will lead to a taxonomy which will provide a complete and universal method of communication among educators. Taxonomies can be developed from a variety of theoretical frameworks, they need not all follow that of Bloom and his colleagues. Each different taxonomy will be useful to the extent that people want to use it, but each one will surely be an imperfect means of communication.

7.3 Taxonomies in the Psychomotor Domain

With this summary of the theoretical background to the development of the taxonomy in the cognitive domain, and the cautionary summary of its evaluation, we can now move onto a consideration of the taxonomies which exist for categorising objectives in the psychomotor domain.

The main trend in the development of taxonomies in the psychomotor domain has been to follow the line of thinking espoused by Bloom and his colleagues (Bloom et al. 1956), and to model psychomotor taxonomies on the cognitive and affective ones i.e. on the cumulative hierarchical model of learning. When considering these taxonomies, we should bear in mind the results of the evaluations of the cognitive domain taxonomy, and view them as taxonomies which have still to be validated by further research.
7.3.2 The Taxonomies

Several authors have produced taxonomies in the psychomotor domain; I will discuss the three main ones, those of Simpson (1967), Maclay (1969) and Harrow (1972). Those by Ragsdale (1950), Guilford (1958), Dave (1969) and Kibler, Barker & Miles (1970) are of historical interest only (a brief analysis of them is presented, however, in de Landsheere 1977).

Simpson's Taxonomy 1967

Simpson (1967) devised her taxonomy for use in home-economics and related fields. The methodology employed in the production of the taxonomy involved reviewing the related literature (q.v. Carlson and Griggs 1966), collecting and analysing existing objectives in the psychomotor domain; analysing appropriate tasks to decipher their psychomotor activity and finally discussing with "scholars who have specialised knowledge of the nature of psychomotor activities" problems related to this field of research.

The final product is set out in five distinct levels, viz:

1. Perception
2. Set
3. Guided Response
4. Mechanism
5. Complex Overt Response
but as Simpson points out herself, it is in need of further development.

Summary of Simpson's Taxonomy (1967)

Level 1

Perception - central portion of situation - interpretation - action chain.

1.1 Sensory Stimulation - impingement of a stimulus on one or more of the sense organs

1.1.1 Auditory
1.1.2 Visual
1.1.3 Tactile
1.1.4 Taste
1.1.5 Smell
1.1.6 Kinaesthetic

1.2 Cue Selection - deciding on which cues to select/respond to in order to satisfy the requirements of the task i.e. select and associate with the task

1.3 Translation - ability to relate perception to action in performing a motor act, i.e. determine the meaning of received cues for action (i.e. translate them).
Level 2

Set  preparatory adjustment or readiness for a particular kind of action or experience, i.e. to get SET for it.

2.1 Mental Set

2.2 Physical Set  - to get ready physically by making the necessary anatomical adjustments

2.3 Emotional Set  - to get set by having attitudes favourable to the motor act taking place

Level 3

Guided Response  - an early step in developing skill. Learning the abilities which are components of the larger, complex skill. Learner's overt acts are under the instructor's guidance

3.1 Imitation  - performing the act after having perceived the instructor do it

3.2 Trial and Error  - trying various responses (with a rationale) until the appropriate one is discovered

Level 4

Mechanism  - the learned response has become habitual - a degree of skill is acquired
Level 5

**Complex Overt Response** - the learner can perform complex, motor acts requiring a high degree of skill

5.1 **Resolution of Uncertainty** - the act is performed without building up a mental picture; sequences of risks are known and the learner is confident in performing the task

5.2 **Automatic Performance** - finely co-ordinated motor skill can be performed with ease

Level 1 considers the orienting parameter of Perception, which is central to the situation - interpretation - action chain. It is divided into three sub-levels: Sensory-stimulation, Cue-selection and Translation of Material. This forms the basis for defining objectives in Level 2, which Simpson terms "Set" - the preparatory adjustment or readiness for a particular kind of action experience. This begins with Mental Set, and progresses through physical and emotional set. Being "Set" for motor action allows the learner to begin to develop the skills being taught, and objectives for these activities start at Level 3, Guided Response. At this level the student is learning the abilities which are components of the larger, more complex skills; this can be achieved by Imitation (3.1) and Trial and Error (3.2).

The final two levels in the hierarchy build upon the component skills acquired by Guided Response: **Mechanism** (Level 4) describes the learner's responses as being habitual, with a fair degree of skills,
while Level 5 covers objectives which are concerned with complex overt responses which require a high degree of skill, beginning with the resolution of uncertainty in the skilled act leading to a performance which is basically automatic.

Maclay's Taxonomy (1969)

Maclay's taxonomy (1969; 1971; 1974) is grounded in Simpson's. There are six levels in this scheme and unlike Simpson, Maclay apparently did not analyse appropriate tasks to decipher the component skills before compiling the hierarchy; he did, however, analyse objectives of a psychomotor nature in the field of school science. His main focus initially was in devising a taxonomy which could be used as a basis for defining objectives in general school science curricula in New South Wales; objectives from a variety of school science courses were consulted (Maclay 1969, p.130). He later expanded these (Maclay 1971) and outlined steps to incorporate his taxonomy into the Australian Science Teaching Education Program (Maclay 1974). He is currently collaborating with Dr. Krathwohl of Syracuse University on the development of a broader based taxonomy (personal communication, September 1976).

The six levels of Maclay's scheme are:

1. Perception
2. Readiness
3. Guided Response
4. Mechanism
Summary of Maclay's Taxonomy (1969)

Level 1

1. **Sensory Stimulation**: a basis for cue discrimination

   1.1.1 Hearing

   1.1.2 Sight

   1.1.3 Touch

   1.1.4 Taste

   1.1.5 Smell

   1.1.6 Nerve-muscle

2. **Static-cue Discrimination**: cue selection by response

   1.2.1 Hearing - discrimination of pitch, quality, intensity, etc.

   1.2.2 Sight - discrimination of objects by shape, colour, etc.

   1.2.3 Touch - crystalline, smooth, etc.

   1.2.4 Taste - relative sweetness, sourness, saltiness

   1.2.5 Smell

   1.2.6 Nerve-muscle - relative weight in hand, etc.
1.3 Dynamic-cue Discrimination - application of 1.2 to semi-quantitative arrangements in sequence; trends and changes

1.3.1 to 1.3.6 as above

1.4 Translation - determining the meaning of cues 1.2 and 1.3 and communicating these for the benefit of others

1.4.1 Ability to follow experimental instructions of others

1.4.2 Ability to record experiences for their communication to others

1.4.3 Ability to respond from single concepts with appropriate motor activity

1.4.4 Ability to isolate simple concepts from above

Level 2

Readiness for further experience following perception

2.1 Mental Readiness to select and synthesise appropriate cues for interpretive action

2.2 Physical Readiness to adopt nerve-muscular abilities to assist interpretive action, posture and stance

2.3 Emotion Readiness to respond by attitudes favourable to action

Level 3

Guided Response - using the experience and attitudes of 1 and 2.
3.1 **Imitation** - performance after demonstration, with guidance if needed

3.2 **Trial and Error** - applied to simple problem solving

3.3 Following of written or other guidance

3.4 Obtaining a series of simple experimental results, then putting into portrayal form (graph etc.)

Level 4

**Mechanism** - using 1, 2, 3 experiences in the pursuit of a complex activity. Individual skills are being selected with discrimination

4.1 Choice of appropriate raw materials, apparatus, etc.

4.2 Planning order of activities logically and as time-motion study

4.3 Exercising skill in arrangement and assembly of apparatus or other materials of study

4.4 Execution of task with safety, competence, etc.

4.5 Interpolation and/or prediction from results

Level 5

**Complex Response** - using attitudes, etc. of 1, 2, 3, 4, involving precision acts to solve problems, test hypothesis or develop a model - WITH GUIDANCE if necessary

5.1 Adaptation, after choice, of appropriate resources
5.2 Competent planning and confident procedure

5.3 Skilled execution and professional poise

5.4 Clear and concise Reporting, classifying the background, aims and achievements

5.5 Prediction of possible extended investigations suggested by the results of the activities

Level 6

Complex Response - as under 5, but with NO GUIDANCE

Although based mainly on Simpson's work, Maclay's taxonomy is slightly more complex. Level 1 deals with Perception, and is sub-categorised into Sensory Stimulation (1.1) which is the basis for all discrimination; Static-cue Discrimination (1.2) which requires cue-selection by some response; Dynamic-cue Discrimination which is concerned with the application of static-cue discrimination to semi-quantitative arrangements in sequence (trends and changes) and finally Translation (1.4) of the cues to determine their meaning and for communication to others.

Level 2 defines objectives for Readiness for further experience following perception: Mental, Physical and Emotional Readiness. Level 3 - Guided Response - contains Simpson's Imitation (3.1) and Trial and Error (3.2), but is extended by the addition of two more sub-categories viz. 3.3 Following of Guidance and 3.4 Obtaining Simple Experimental Results and portraying them. Using the experiences of levels 1, 2 and 3, the learner begins to Mechanise her component skills (Level 4) by
Choosing Appropriate Raw Materials (4.1), Planning the order of her activities (4.2), Exercising Skill in arranging and assembling (4.3), Performing the Task with Safety and Competence (4.4) and Interpolating and Predicting from the results she obtains from completing the task (4.5). The final two levels are concerned with objectives and learning experiences involving complex responses using attitudes and experiences developed earlier; this involves precision acts needed to solve problems, testing hypotheses and developing models. Level 5 objectives include Complex Responses with Guidance and the sub-categories define behaviour of Adaptation (5.1), Competent Planning (5.2), Skilled Execution (5.3), Clear and Concise Reporting (5.4) and the prediction of possible extended investigations suggested by the results of the activities (5.5). Level 6 is basically the same but with no guidance.

Harrow's Taxonomy (1972)

Harrow (1972) developed her taxonomy to provide a basis for defining objectives involved in physical education, and as such has very limited applicability for physiology skill learning.

There are six levels in this taxonomy:

1. Reflex Movements
2. Basic Fundamental Movements
3. Perceptual Abilities
4. Physical Abilities
5. Skilled Movements
6. Non-discursive Communication

Summary of Categories in Harrow's Taxonomy which may be useful for laboratory skill training

Level 3

Perception

3.2.0 Visual Discrimination

3.2.1 Visual Acuity

3.2.1 Visual Tracking

3.2.3 Visual Memory

3.2.4 Figure Ground

3.2.5 Consistency

3.3.0 Auditory Discrimination

3.3.1 Auditory Acuity

3.3.2 Auditory Tracking

3.3.3 Auditory Memory

3.4.0 Tactile Discrimination

3.5.0 Co-ordinated Abilities

3.5.1 Eye-hand co-ordination

3.5.2 Eye-foot co-ordination
Level 4

Physical Abilities

4.4.0 Agility

4.4.1 Change Direction

4.4.2 Stops and Starts

4.4.3 Reaction-response time

4.4.4 Dexterity

Level 5

Skilled Movements

5.1.0 Simple Adaptive Skills

5.2.0 Compound Adaptive Skills

5.3.0 Complex Adaptive Skills

Skill levels 1 and 2 are developed early in the individual's ontogeny and are not normally the concern of teachers. The teacher may begin to formulate objectives at Level 3, Perception - which is sub-categorised into 3.1 Kinaesthetic Discrimination; 3.2 Visual Discrimination (acuity, tracking, memory, figure ground and consistency); 3.3 Auditory Discrimination; 3.4 Tactile Discrimination and 3.5 Co-ordinated Abilities (e.g. eye-hand-co-ordination). Level 4 considers Physical abilities such as endurance (4.1), Strength (4.3), Flexibility (4.3) and Agility (4.4),
which form the basis for describing activities involving Skilled Movements (Level 5) which may be Single (5.1), Compound (5.2) or Complex (5.3). Adaptive - Extremely complex skills involving the whole body and its parts are described by level b - Non-discursive Communication, Expressive and Interpretive Movements (e.g. ballet skills).

It seems clear that only certain sections of this taxonomy could be of use in formulating objectives in physiology skill learning.

7.3.3 A Critique of the Taxonomies

At this point I will a) briefly describe how the categories in these taxonomies could be related to the skills being taught in the physiology laboratory and then b) discuss some misgivings which I have about the taxonomies.

Relating the taxonomies to the physiology laboratory

The three taxonomies described above were developed with particular curricular fields and activities in mind viz. home economics, general school science and physical education, and as such cannot be as widely applied as Bloom's cognitive taxonomy (Bloom et al. 1956) or Krathwohl's affective taxonomy (Krathwohl et al. 1964). However, certain sections from each taxonomy may be useful in the definition of objectives for use in the physiology laboratory.

The role of perception in the physiology laboratory is of major importance due to the fact that most of the skill teaching is done by
video-tape. The incorporation of a "perception level" in the taxonomies is therefore very useful, but I feel not sufficiently emphasised for the purposes of the physiology laboratory. I shall come back to this point later.

Mental, physical and emotional readiness (set) to perform laboratory tasks is vital to the skill acquisition in the tasks; if a student does not have the proper set for performing her work, learning will be affected. In Chapter Three it was noted that the students do not have the appropriate mental set at the beginning of the laboratories for learning the laboratory skills; it seems necessary to teach towards this. Emotional set may by particularly important in those situations where the student is required to perform techniques on human subjects, such as taking blood pressures, blood samples, breathing rates and so on; certainly, for those entering the paramedical professions, training in this area will be necessary. Readiness to be trained by video-tape may also have to be a feature considered.

At level 3 - Guided Response - motor skills as such begin to be defined as educational objectives. Imitation is important in laboratory work (Kempa 1974) and especially so when the student is taught by video; the correct imitation of a demonstrated technique will be necessary in building a central motor program since it may form the basis for future higher level learning. Similarly with Maclay's level 3.3 - following Written Instructions; the student has to be trained in understanding the need for close adherence to laboratory instructions, especially in the early, cognitive phase of skill learning.
Level 4 of Simpson and Maclay's taxonomies (Mechanism) is concerned with objectives which define components of the higher-level skill, such as being able to plan the sequences of the technique being used, choose the correct apparatus, interpolate from the results of an experiment and so on. These are highly cognitive processes, but absolutely necessary in performing laboratory work. Physical abilities (Harrow's level 4), such as reaction response times and dexterity abilities are of course the bread and butter of skill acquisition: if the level of these abilities is low then performance of skilled techniques will be difficult for the student.

Complex responses (level 5) are those involving the full, automatic skilled performance discussed by Fitts (1969) (see page 321). However, the level of complexity required of the student's skill will never fully be that expert, say compared to a technician's skill. The level to be acquired may be simple, compound or complex (Harrow's level 5) depending on the aims of the laboratory course; some skills may be required at one level, others to a different level.

Some Misgivings

There are four criticisms which can be levelled at these taxonomies in relation to their usefulness in the physiology laboratory. They are:

1. They do not emphasise the perceptual levels sufficiently to be useful for covering the role of perception in the laboratory

2. They are founded on the belief that skill learning progresses in an hierarchical, cumulative fashion, which is not necessarily so.
3. They do not seem to take full recognition of some psychological studies on human abilities.

4. They do not provide accompanying strategies for teachers to easily devise objectives to be used in the taxonomies.

Each criticism will be discussed in turn.

1. Perception

We have seen in earlier chapters that the role of the video-tapes in the teaching of the laboratory skills is integral to the successful running of the laboratory; there has also been some indication of the importance of visual-memory in the overall learning processes of the students. So the role of perception in the laboratory is very important and as such requires more detailed consideration than is given in the above taxonomies.

Perception is a cognitive process (Hebb 1966) and the student in the laboratory can be trained to some extent to be discriminating in the way she perceives the various phenomena in the laboratory. It was pointed out in chapter 3 that some students may not learn efficiently by video-tape: they may require some training in how to learn from this medium. It also seems likely that some students may also require explicit training in comparing and contrasting new sensory phenomena encountered in the process of carrying out their laboratory work with those already 'stored' in their cortices. Such perceptual skills may be associated with performing intricate dissections; performing chemical tests involving colour changes; carrying out microscope work where an element of the "unknown" is always present and will require a training
in differential perception; performing techniques which require
tactile and/or olfactory discrimination, and so on.

The taxonomies discussed above do not provide for the definition of
objectives in these very specific areas of learning. To this end,
Moore's taxonomy of perception can be of use. Moore (1970) developed
a taxonomy of perception for use in general education. It considers
in detail the many facets of perceptual learning which can be
directly related to skill learning in the physiology
laboratory since it will be useful in developing objectives at this
level of the taxonomy. There are five levels to the taxonomy, viz.

1. Sensation

2. Figure Perception

3. Symbol Perception

4. Perception of Meaning

5. Perception Performance

Moore's Taxonomy of Perception (1970)

Level 1

**Sensation:** awareness of information in the stimulus i.e. awareness
and detection of change

Level 2

**Figure Perception:** awareness of an entity
2.1 Discrimination of unity e.g. brightness, distance and tactile discriminations
whole figure/background discrimination

2.3 Resolution of Detail

2.3.1 Response to detail in the sensory world, - judging size, shape and field-dependence

2.3.2 Response to detail within the sensory field - discrimination of symmetrical/asymmetrical figures etc.

Level 3

**Symbol Perception:** awareness of figures in the form of signs when no association meaning is considered

3.1 Identification of Form and Pattern relating information into auditory, visual, tactile forms e.g. ability to distinguish curves from rectangles, ability to respond appropriately to verbal directions

3.2 Naming and Classification of Forms and Patterns e.g. ability to name complex objects, pictures etc.

Level 4

**Perception of Meaning:** awareness of the significance contrarily associated with FORMS and PATTERNS and EVENTS i.e. their meaning.
4.1 Mental Manipulation of the Identified Form or Pattern e.g. ability to reproduce drawings etc.

4.2 Ability to Attach Significance to Symbols and to relate symbols to achieve a significant synthesis

4.3 Ability to Attach Significance to a Series of Events occurring over a period of time e.g. insight into cause and effect; make decisions

Level 5

Perception Performance: demonstration of sensitive and accurate demonstrations; ability to make complex decisions where many factors are involved; ability to change an ongoing behaviour in response to its effectiveness e.g. successful approaches to problem solving.

Little need be said about the taxonomy except that it will be of particular benefit for defining objectives especially needed for video-tape learning.

Hierarchical, Cumulative Learning

The format and proposed uses of the taxonomies suggest that motor-skill learning progresses in an hierarchical, cumulative manner - as is postulated for cognitive learning (Bloom et al. 1956). However, at the beginning of this chapter it was indicated that there is no clear evidence to substantiate the claim that learning does progress cumulatively and hierarchically (Sedgum 1979). Although skill learning may be different from knowledge learning, it cannot be assumed without further
study that it only occurs cumulatively and hierarchically. From reading some of the related literature, there appear to be other opinions concerning the process of skill learning. Before discussing these, it will be worth pausing to consider the nature of practical skills; and since a strong relationship between perception and motor-skill learning has now been established in (1) above, the term "perceptual-motor" will now be used in place of "psychomotor", which seems to be more limited in its coverage.

Practical Skills

In terms of performance, a skilled performance is one which is competent, rapid, expert and accurate; all the factors which go to make such a performance are concerns of those interested in the term "skill" (Welford 1968). It will be obvious that the term is not restricted to manual operations since we can be skilled in other activities, such as reading, mental problem solving and so on. However, our interest here is with perceptual-motor-skills. To become proficient in a perceptual-motor-skill, three factors are necessary:

1. spatial-temporal patterning
2. interaction of responses with input and feedback processes

Operationally then, in practising a perceptual-motor-skill (PMS) the individual must hold or handle some physical apparatus to perform some task, the results of which are readily available to her and which structure some cognitive process, so that eventually she learns
to perform the task in a proficient way (q.v. Bilodeau and Bilodeau 1961; Noble 1968). This operational definition is deceptively simple: it gives little indication of the very complex cognitive, perceptual and motor aspects of skilled performances as they occur in the physiology laboratory. Nevertheless, with this caution in mind, it will serve our purposes for thinking about motor-skills.

Perceptual-Motor-Skill Learning

What are the other opinions concerning the nature of perceptual-motor-skill learning? Most recent literature on perceptual-motor-skill (PMS) learning draws on the information processing model of learning (Klausmeier 1975; Fitts 1964; Miller et al., 1960; Posner and Keel 1972). During the learning of a PMS, the learner acquires an internal plan - or central motor program - of the skill being practised; this program contains the sequences of movements necessary to perform the skill and in the process of "building in" this program (i.e. learning it) five characteristics of the skill develop as is shown in Figure 7.6, leading towards a "professional" degree of competence where, in carrying out the task, there is a) little attention to specific movements; b) good differentiation of cues; c) rapid movement correction; d) good co-ordination of movement patterns and e) ability to perform under varying conditions (Klausmeier 1975).

Fitts (1964) proposes three interrelated phases in PMS learning which are closely related to Klausmeier's five developmental characteristics. They are:
Figure 7.6 Five Developmental Characteristics of Perceptual-Motor-Skill Learning (after Klausmeier 1975)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Performance of Beginner</th>
<th>Performance of Skilled Person</th>
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<tbody>
<tr>
<td>1. Attention to movements</td>
<td>S shows voluntary control over movements</td>
<td>S shows involuntary control</td>
</tr>
<tr>
<td>2. Differentiation of cues</td>
<td>POOR - S has to learn which cues need/do not need attention at beginning</td>
<td>GOOD - S is free from reliance on cues. Responds to finer cues</td>
</tr>
<tr>
<td>3. Feedback (KR) correction</td>
<td>S relies on both external (e.g. visual) and internal (kin-aesthetic) KR</td>
<td>S no longer needs to rely on external KR; reliance on internal KR increased</td>
</tr>
<tr>
<td>4. Co-ordinated movement patterns</td>
<td>S shows slow, inaccurate responses under control of external &amp; internal KR</td>
<td>S shows rapid, accurate responses, under control of central motor program (CMP)</td>
</tr>
<tr>
<td>5. Stability</td>
<td>UNSTABLE - S cannot adapt to different environmental conditions</td>
<td>STABLE - S has CMP which remains stable under varying environmental conditions</td>
</tr>
</tbody>
</table>
1. Cognitive Phase: the learner verbalises the skill and begins building the central-motor program. This may be a short period, or it may take days where highly complex skills are involved. Klausmeier's five developmental characteristics are low: control over movements are voluntary; cue-differentiation is poor; feedback is mainly external; co-ordination is slow and the learner's general ability in performing the skill is unstable.

2. Fixation (or Organising) Phase: lower level processes become more highly organised with practice; errors are gradually eliminated. This may last for weeks in complex skill learning. The five developmental characteristics are middling to high and the learner is beginning to internalise the sequence of the skilled event with greater ease and sophistication.

3. Autonomous (or Perfecting) Phase: there is
   a) a gradual increase in speed and accuracy
   b) a gradual resistance to stress and environmental factors.

In information processing terms, "hierarchical processes" or "executive routines" replace the earlier, lower-level processes and the skill is performed automatically i.e. attention to movements is involuntary; cues are easily differentiated; feedback (KR) is now internal in origin; co-ordination of movements is rapid and the skill is performed with increasing stability under varying environmental conditions.

As learning continues, the three phases merge together until the learner's performance becomes continuous. Fitts (1964) emphasises the CONTINUITY.
of the process

"Skill learning is primarily a continuous process, even though the fine grain structure of the performance itself may involve discrete operations. Thus it is misleading to assume distinct stages in skill learning. Instead, we should think of gradual shifts in the factor structure of skills, or in the nature of the processes..... employed, as learning progresses" (Fitts 1964, emphasis mine).

This differs from the cumulative hierarchical system suggested in the taxonomies where the various stages or levels of the taxonomy may mislead one into thinking that perceptual-motor skills are learned in discrete steps. The continuous process emphasised by Fitts seems more realistic in that it allows for the learner going back and forth from one level to another as the skill is being learned (according to Fitt's 3 stages outlined above); a loop system must exist within this system for this to occur.

The "gradual shifts in the factor structures of skills" refers to the changes which occur in the abilities and learning strategies required to learn a skill from the early learning stages to the later stages of competence. The descriptions above of Klausmeier's five developmental characteristics and Fitt's three phases are basically descriptions of changes in these "factor structures" as learning proceeds.

Is there any empirical evidence from psychological studies to suggest that Klausmeier's and Fitt's phases of learning perceptual-motor-skills are grounded in the reality of skill learning? (And which, incidentally
might go towards meeting Bloom's guiding principle that any taxonomy needs to be grounded in psychological theory).

Fleishman's work on basic abilities does provide some empirical evidence of the "gradual shifts in the factor structure of skills". Fleishman's work has extended to an analysis of the change in abilities required to carry out perceptual-motor-tasks from the easy learning stages to the later autonomous stages. He has shown that the combination of abilities leading to skilled, autonomous performances changes in time with practice, and more specifically that the contribution of non-motor abilities (e.g. cognitive and perceptual abilities) decreases with practice (Fleishman 1955).

An example of this is the role of spatial-visual and kinaesthetic abilities in the learning of some perceptual-motor-skills. Spatial-visual abilities are very important when beginning to learn a PMS, while the dominant abilities at later stages of practice are the kinaesthetic ones (Fleishman 1963) i.e. the ones relying on a sense of movement or of muscular effort. This empirical study confirms the theories of Klausmeier and Fitts.

We can relate all of the above points and present them as follows:

<table>
<thead>
<tr>
<th>Cognitive Control</th>
<th>Motor Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Perception and Learning)</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motor Control</th>
<th>Cognitive Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Beginning</th>
<th>Later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptual-Motor-Skill</td>
<td></td>
</tr>
</tbody>
</table>
In summary, we can say that the information processing model of learning proposes that perceptual-motor-skill learning occurs continuously, with the learner moving from one "level of learning" to another and back again as practice continues, and that the "factor structure" (abilities, learning processes) of the skilled movement changes as the skill is learned.

3 Studies of Human Abilities

There seems to me to be at least one area of psychological studies which is not given full recognition in the taxonomies, and that is Fleishman's work on human abilities.

Fleishman (1967; 1969) draws a distinction between abilities and skill: an ability e.g. manual dexterity, is "a, general trait of the individual which has been inferred from certain response consistencies on certain kinds of tasks" - the response consistencies are generally correlation scores on a variety of related tasks. A motor-skill e.g. dissecting a frog's heart, is "the level of proficiency on a specific task or limited group of tasks". In effect, skills can be described in terms of the more basic abilities - this is an important point because the rate of learning of a skill and the final level reached are limited by the basic abilities of the individual (Fleishman 1967), and these abilities change little after childhood (a period in the individuals life when they are overlearned, so that we find after periods of time without practice they are quickly brought back to function).

Twenty psychomotor abilities have been identified (Fleishman 1954; 1969), eleven of which may be of importance in considering the skills
being learned in the physiology laboratory. They are:

1. Control precision
2. Multi-limb co-ordination
3. Response orientation
4. Reaction time
5. Speed of arm movement
6. Rate control
7. Manual dexterity
8. Finger dexterity
9. Arm-hand steadiness
10. Wrist and finger speed
11. Aiming

These abilities are discussed below, and are followed by a laboratory skill technique, success at which may depend on the presence of each ability.

1. **Control Precision**: fine, highly controlled muscular adjustments e.g. use of equipment with displays-fine adjustments required

2. **Multi-Limb Co-ordination**: ability to co-ordinate the movements of a number of limbs simultaneously e.g. co-ordination of two hands e.g. any biology dissection; use of equipment
3. **Response Orientation:** ability to make the correct positional movement in relation to the correct stimulus e.g. frog-heart preparation-kymograph reading and drug injections

4. **Reaction time:** speed with which an individual is able to respond to a stimulus when it appears e.g. being able to react to changes in heart sounds, according to pre-specified criteria

5. **Speed of Arm Movement:** speed with which an individual can make a gross, discrete arm movement where accuracy is not the requirement e.g. manipulating equipment

6. **Rate Control:** ability to make anticipatory motor adjustments relative to changes in speed and direction of a continuously moving target or object e.g. using kymographs etc.

7. **Manual Dexterity:** ability to make skillful, well directed arm-hand movements in manipulating fairly large objects under speed conditions e.g. pipetting techniques

8. **Finger Dexterity:** ability to make skillful, controlled manipulations; e.g. dissections, setting up apparatus

9. **Arm-hand Steadiness:** ability to make precise arm-hand positioning movements where strength and speed are minimised e.g. dissections

10. **Wrist and Finger Speed:** ability to make the movements required in rapid tapping of a pencil in relatively large areas e.g. techniques involving use of miniature pipettes/droppers to drop liquid quickly into several places (e.g. taking a blood sample and transferring the blood to containers quickly before clotting occurs)
11. **Aiming**: ability to go from one circle to another placing one dot in each circle as rapidly as possible e.g. same as 10 (Fleishman 1969, p.892).

Some differentiation of the abilities can be achieved by "stringing" them along a continuum of Gross to Precise abilities:

<table>
<thead>
<tr>
<th>GROSS</th>
<th>PRECISE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of arm movement</td>
<td>Wrist-finger speed</td>
</tr>
<tr>
<td>Reaction time</td>
<td>Finger dexterity</td>
</tr>
<tr>
<td>Multi-limb co-ordination</td>
<td></td>
</tr>
<tr>
<td>Control precision</td>
<td></td>
</tr>
<tr>
<td>Rate control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Response</td>
</tr>
<tr>
<td></td>
<td>Orientation</td>
</tr>
<tr>
<td></td>
<td>Manual dexterity. Aiming</td>
</tr>
<tr>
<td></td>
<td>Arm-hand steadiness</td>
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<td></td>
<td></td>
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</tbody>
</table>

Many of the skilled techniques taught in the physiology laboratory would require students to possess these abilities to some extent. The majority of the laboratory techniques would probably be most closely related to those abilities at the PRECISE end of the continuum.
4 Strategies for Devising Objectives

It would seem useful to be able to provide some guidelines to teachers using the taxonomies on how to analyse the skilled behaviours which they are teaching, and develop behavioural objectives from them. None of the authors provide such guidelines. One tool which could be useful to this extent is that of Hierarchical Task Analysis (Annett 1971).

By using hierarchical task analysis (HTA) a complex perceptual motor task can be broken down into its component parts, thus "simplifying" the task and facilitating the production of precise behavioural objectives for teaching the skills involved in the task, and later for assessing students' levels of attainment. An example of the use of HTA should indicate the effectiveness of the method in producing behavioural objectives in skill training.

Figure 7.7 outlines the analysis of the technique of performing a red cell count. The initial, complex task is stated: Perform a Red Cell Count. This is broken down into its main sub-techniques, that is the actions which the student will have to perform in order to achieve the task of taking a red cell count. To be able to do a red cell count, four stages of actions are necessary viz.

A - obtaining a blood sample
B - dilution of the blood
C - the transfer of the blood to a haemocytometer
D - the examination of the blood under a microscope, and the cell count
DOA RED CELL COUNT

A obtain a blood sample
B Dilute blood
C Transfer to haemocytometer
D Examine under microscope and count

A1
- Put S at ease
- A2 Cleanse skin with alcohol
- A3 Pierce skin with lancet
- A4 Collect blood in pipette
- A5 Cleanse skin

A3.1
- Squeeze earlobe
- Pierce skin quickly

A4.1
- Squeeze earlobe
- Apply Pipette to blood
- Collect to 0.1 mark

B1
- Take up Hayem to 101 mark

C1
- Place c/s on haemocytometer
- C1.1 Salivate on to c/s
- c/s onto haemocytometer and press

C2
- Reject first few drops of blood

C3
- Run diluted blood under c/s
- Interference rings?

C3.1
- Run diluted

D1
- Examine under microscope L.P.
- Examine under H.P.
- Count cells in square

Fig. 7.7 Hierarchical Task Analysis: an example of the analysis of one of the techniques taught in the Physiology Laboratory
The next step is to take each of these four stages in turn, and define the tasks involved in each. Taking stage A - obtaining a blood sample - the tasks involved in this are:

\[ \text{A}_1 \] - putting the subject who is donating the blood at ease

\[ \text{A}_2 \] - cleansing the skin from where the sample is to be taken with alcohol

\[ \text{A}_3 \] - piercing the skin with a lancet

\[ \text{A}_4 \] - collecting the blood in a pipette

\[ \text{A}_5 \] - cleansing the punctured skin.

Having outlined the steps involved in stage A, a similar process can be applied to stages B, C and D (see Figure 7.7), thus building up a hierarchical picture or flow chart of the tasks involved in performing the complex technique of a red cell count. Each sub-level in this tasks hierarchy is less complex than the one preceding it: the sub-level at which one stops is determined by the level of sophistication towards which one is teaching. Once the final sub-level has been decided upon, each sub-task can be changed into a behavioural skill objective, the precise definition of which will again be determined by the level of sophistication required. (For an introduction to defining behavioural objectives, see Mager 1962; and also Harlen, 1972).

This is a fairly straightforward and hopefully useful evaluation tool to be used in the preparation of perceptual-motor skill objectives in the physiology laboratory.
7.4 The Composite Taxonomy - A Proposal

7.4.1 Introduction

Having a) discussed the role of perception in the physiology laboratory skill-learning and proposed the use of Moore's perceptual taxonomy as part of a composite taxonomy b) provided an alternative view of skill-learning based on the information processing model of learning and c) outlined the importance of Fleishman's work on abilities, it is now possible to propose a taxonomy which is chiefly based on those proposed by Simpson (1967), Maclay (1969) and Harrow (1972) but which also incorporates the above mentioned points:

It will be clear from looking at the proposed, composite taxonomy for defining objectives in the perceptual-motor domain in the physiology laboratory that the ordering of levels is not strictly hierarchical (see taxonomy below). As we pointed out above, the model of skill learning which we are following is that based on the information processing model of learning, where skill learning is constructed as being both continuous and relying on feedback loops, so allowing for movement back and forth among the various learning stages; to some extent, this overcomes the difficulties of construing skill learning as occurring in stages, as the other taxonomies suggest it does (similar difficulties in the use of Bloom's taxonomy have been commented on by Rowntree (1977)).

Indeed it is important when using the taxonomy not to think of it as a true hierarchy of learning: in fact it might be more advantageous to view it as a classification system, since it allows for the inclusion
of "arbitrary" elements such as perceptual and cognitive abilities alongside motor abilities.

When learning a complex perceptual-motor-skill in the laboratory, the student will be exhibiting many behaviours at different levels in the system as learning progresses. These clusters of behaviours (or "factor structures") might be defined by one set of objectives in the perceptual, cognitive and affective parts of the system, but by another perhaps different set later on in the learning process.

So, although at the beginning of learning, a student will have to be competent in perceptual behaviours associated with the "low" levels of the system, and will have to use these behaviours to become proficient at other behaviours defined at the "higher" levels of the system to become "skilled", the teacher should not be misled into thinking that learning the skill occurs in separate, distinct stages. If anything, it occurs in groups of related stages (i.e. simultaneously at different levels in the system).

All the levels of behaviour are exhibited by the student, but to varying degrees at the various "points" along the continuum of learning. It is up to the teacher to decide what objectives should be defined, at what point of learning and at what level of proficiency.

What follows, therefore, is a proposed composite taxonomy which will have to be tried out in real teaching situations in the laboratory, modified accordingly and always used with the above points in mind.
7.4.2 Composite Taxonomy for Defining Objectives in the Perceptual Motor Domain in Human Physiology Laboratories

Summary

1. Perception
   1.1 Sensory Stimulation
   1.2 Figure Perception
   1.3 Symbol Perception
   1.4 Perception of Meaning
   1.5 Translation

2. Readiness (Set)
   2.1 Mental Readiness
   2.2 Physical Readiness
   2.3 Emotional Readiness

3. Physical/Orientating Abilities
   3.1 Control Precision
   3.2 Multilimb Co-ordination
   3.3 Response Orientation
   3.4 Reaction Time
   3.5 Speed of Arm Movement
   3.6 Rate Control
   3.7 Manual Dexterity
   3.8 Finger Dexterity
   3.9 Arm-Hand steadiness
   3.10 Wrist and Finger Speed
   3.11 Aiming

4. Guided Response
   4.1 Imitation
   4.2 Trial and Error
   4.3 Following written/verbal guidance
   4.4 Obtaining Results/calculations

5. Mechanism
   5.1 Habituation of Learned Skill

6. Autonomy
   6.1 Autonomy with guidance
   6.2 Autonomy with no guidance
Detailed Description of the Taxonomy


1.1 Sensory Stimulation

1.1.1 Auditory

1.1.2 Visual

1.1.3 Tactile

1.1.4 Taste

1.1.5 Smell

1.1.6 Kinaesthetic

1.2 Figure Perception: an awareness of the entity

1.2.1 Discrimination of unity: e.g. brightness, distance and tactile discriminations

1.2.2 Sensory figure ground perception: parts to each other and to whole, figure/background discrimination

1.2.3 Resolution of detail

1.2.3.1 Response to detail in the sensory world: judging size, shape and field dependence

1.2.3.2 Response to detail in the sensory field: discrimination of symmetrical/asymmetrical figures
1.3 **Symbol Perception:** an awareness of figures in the form of signs when no associated meaning is considered

1.3.1 Identification of form and pattern: relating information into auditory, visual, tactile forms e.g. ability to distinguish curves from rectangles

1.3.2 Naming and classification of forms and patterns e.g. ability to name complex objects, pictures, places etc.

1.4 **Perception of Meaning:** an awareness of the significance commonly associated with FORMS, PATTERNS and EVENTS i.e. their meaning

1.4.1 Mental manipulation of the identified form or pattern e.g. ability to reproduce drawings

1.4.2 Ability to attach significance to symbols and to relate symbols to achieve a significant synthesis

1.5 **Translation:** Ability to relate perception to action in performing a motor task i.e. determine the meaning of perceived cues for action

1.5.1 From video-tape to laboratory situation

1.5.2 Follow laboratory instructions (verbal and written)

1.5.3 Record experimental results

1.5.4 Respond to concepts

1.5.5 Isolate concepts
2. Readiness (Set): preparatory adjustment of readiness for a particular kind of action or experience, with particular reference to readiness to learn from the video-tapes

2.1 Mental Readiness: to select and synthesise appropriate cues for interpretive action

2.2 Physical Readiness: to adapt neuro-muscular abilities to assist interpretive action, posture and stance

2.3 Emotional Readiness: to respond by having attitudes favourable to interpretive action (relaxed alertness; persistence when fatigued).

3. Physical/Orientating Abilities: to display, or be trained in, the necessary physical or orientating abilities required for skilled tasks.

3.1 Control Precision: ability to display fine, highly controlled muscular adjustments e.g. arm-hand movements

3.2 Multilimb Co-ordination: ability to co-ordinate the movements of a number of limbs simultaneously e.g. co-ordination of two hands

3.3 Response Orientation: ability to make the correct positional movement in relation to the correct stimulus

3.4 Reaction Time: speed with which the student is able to respond to a stimulus when it appears

3.5 Speed of Arm Movement: speed with which the student can make a gross, discrete arm movement where accuracy is not required
3.6 Rate Control: ability to make anticipatory motor adjustments relative to changes in speed and direction of a continuously moving target or object

3.7 Manual Dexterity: ability to make skillful, well directed arm-hand movements in manipulating fairly large objects (or movements of this nature) under speed conditions

3.8 Finger Dexterity: ability to make skillful, controlled manipulations of tiny objects involving primarily the fingers

3.9 Arm-Hand Steadiness: ability to make precise arm-hand positioning movements where strength and speed are minimised

3.10 Wrist and Finger Speed: ability to make the movements required in rapid "tapping of a pencil" in relatively large areas

3.11 Aiming: ability to go from one circle to another placing one e.g. substance, in each circle as rapidly as possible

4. Guided Response: an early step in autonomous skill learning. Learning the components of the "larger" more complex skill. Overt behavioural acts are under instructor's control

4.1 Imitation of VT demonstrations

4.2 Trial and error

4.3 Following written/verbal guidance

4.4 Obtaining results/calculations
5. **Mechanism**: using earlier experience in the pursuit of a complex activity.

5.1 Habituation of Learned Skill: individual component skills are linked together in a habituated manner

6. **Autonomy**: building on experiences of levels 1-5 to produce a skillful performance automatically

6.1 Autonomy - with guidance (resolving uncertainty)

   6.1.1 Of simple skills
   6.1.2 Of compound skills
   6.1.3 Of complex skills

6.2 Autonomy - with no guidance (automatic)

   6.2.1 Of simple skills
   6.2.2 Of compound skills
   6.2.3 Of complex skills

7.4.3 An Example of the Use of the Taxonomy

What follows is an example of the application of the taxonomy in defining the aims and objectives of carrying out a red cell count from the laboratory class titled an Introduction to Haematology.

**An Introduction to Haematology: Aims and Objectives**

**Aim**: To be able to carry out a red cell count using a haemocytometer.
1. Pre-Laboratory Preparation

Mental Readiness (2.1): to be ready and prepared for the laboratory class by knowing in advance what the laboratory is about.

Emotional Readiness (2.3): to be prepared to

   a) watch the video-tape
   b) carry out the various tasks associated with the laboratory and follow instructions carefully (see also 4.3)

2. Viewing the Video-tape

Readiness (2): a) to be emotionally prepared to view the VT (2.3) and concentrate on learning the skills being taught (2.1)

   b) to relate knowledge in the VT to previous knowledge (2.1)

   c) to relate instruction in VT to laboratory schedule instructions (2.1, 1.5)

Perception (1): a) to be able to follow the auditory and visual channels of the VT (1.1)

   b) to see and comprehend the special visual information of the VT e.g. Sensory Figure Ground

   Perception i) to see and comprehend the interference rings ii) to distinguish the RBC from other detail.
3. Preparing for the Laboratory Work

Mental and Emotional Readiness (2): to complete the laboratory work as directed in the VT and in the laboratory schedule.

4. Starting the Laboratory Work

1. Obtaining a Blood Sample

Guided Responses (4): a) ability to remember the VT instruction and imitate the skills taught therein (4.1)
b) ability to follow the written instructions in the schedule (4.3)

Emotional Readiness (2.3): a) ability to put the subject donating blood at ease prior to taking the blood sample and throughout.

Finger Dexterity and Arm-hand Steadiness (3.8 & 3.9):

a) ability to pierce the subject's ear-lobe with a lancet, causing minimum pain and discomfort
b) ability to quickly collect blood into a pipett before it clots, up to the specified 0.1 mm mark.
2. Diluting the Blood

Finger Dexterity and Arm-Hand Steadiness (3.8 & 3.9)
   a) ability to manipulate and hold the pipette without spilling blood

Sensory Figure-Ground Perception (1.2.2) and Manual Dexterity (3.7):
   a) ability to dilute the blood up to the 101 mark with Hayem Fluid

3. Transferring Blood to Haemocytometer

Imitation of VT instruction
   a) ability to recall the VT instruction in transferring the blood to the haemocytometer (4.1)
   b) ability to follow laboratory instructions closely at this point (4.3)

Finger Dexterity and Arm-Hand Steadiness (3.8 & 3.9):
   a) ability to place the cover-slip onto the haemocytometer effectively
   b) ability to efficiently transfer the blood from the pipette into the haemocytometer

Perception (1): a) ability to perceive the interference rings on the cover-slip when placed onto the haemocytometer
4. Examining the Blood Under the Microscope

Control Precision (3.1): a) ability to manipulate the various parts of the microscope

Multi-limb co-ordination (3.2): ability to
a) place the haemocytometer onto the microscope stand
b) focus onto the grid under LP and HP
c) scan the grid for RBC

Perception (1)

Sensory Figure-Ground Perception (1.22): a) ability to recognise the grid on the haemocytometer
b) ability to differentiate RBC's from anything else in field

Translation (1.5): a) ability to recall visuals from the VT showing RBC's and grid and relate to own

Guided Response (4)

Obtaining Results (4.4): a) ability to record the number of RBC's in the grid

7.4.4 Conclusion

As has been stated, the composite taxonomy is at this stage only a proposed one. The example of its use provides a guideline for its
application but it will be necessary to try it out in a variety of circumstances to establish its general applicability; this is outside the scope of the present study. However, I believe that in spite of its obvious shortcomings, it will provide a useful starting point for such work.
CHAPTER 8

SUMMARY AND THE POSSIBLE USES OF THE OUTCOMES OF THE EVALUATION
8.1 Introduction

This thesis focusses on the perceptions of the human physiology laboratory course held by students who have taken the course. In Chapter two I explained why I chose to evaluate the teaching and learning solely from the students' viewpoint: partly because I wished to avoid being involved in certain differences which existed between staff at that time; partly because I felt that there was much to be gained by focussing in depth on the students. The outcomes of the thesis are therefore based on the students' viewpoints, and are presented here for the information of the staff. In some instances the viewpoints of staff and students may agree, but it is quite likely that in other instances there will be disagreement. Such disagreements can be illuminating, even if the others viewpoint proves difficult to accept, and in all instances it is up to the staff to decide what use to make of the information provided here.

Throughout the study I have been heavily influenced by the ideas and theories embodied in the Illuminative approach to evaluation, and have tried to develop the thesis according to the strategies of this approach. Progressive focussing on the laboratory teaching and learning gave rise to several major issues of importance, each of which is dealt with in a separate chapter of the thesis as a "mini-reseaurch" study, the outcomes of which are considered in detail in each chapter.

In this final chapter I will try to bring the outcomes of the previous chapters together and indicate their possible value to those involved in the lab course and the ways in which they can be of use to those running the course.
8.2 The Video-tapes

How can the students' perceptions of the learning benefits of the video-tapes (VT) be put to use? There are several ways in which they can be of help:

8.2.1 Length of the video-tapes and theory versus demonstration content

It is clear (Sections 3.3.4, 3.3.5 & 4.2) that the students think the VT are too long, and that there is too much theory in them - factors which appear to reduce their educational effectiveness. Research into the optimal length of teaching video-tapes (Section 1.3.3) suggests that they should last for between 10 - 25 minutes, certainly no longer, in order to be most effective. Cutting the tape times will require some thought to be given to what to omit; the long theory sections could be reduced in length or omitted altogether, so as to present tapes which concentrate on demonstrating the experimental techniques. Students would therefore have to be constantly reminded (before the lab and on the tape) to read the theory sections of the lab schedules in advance of doing the lab work, if the present system of using labs to exemplify theory is continued.

8.2.2 Reproducibility of demonstrations

It may be thought worthwhile to give consideration to balancing the need to present "professional" demonstrations - where time and the medium are used fully to ensure that the most professional demonstrations are given in which nothing is seen to go wrong and in which results approximating closely to published results are "achieved" - and ensuring that the students are not left somewhat overawed by the apparent ease of the performance, which by experience they realise will not be so easy to reproduce in the lab
environment and which rarely gives rise to published results (Sections 3.3.1 & 3.3.6). It may not be sufficient just to point out to the students that it will be difficult to reproduce some of the experiments demonstrated in the video-tapes and that their results may differ widely from published ones; if the demonstration looks easy then the students tend to feel cheated if they cannot perform it in the lab. One possibility is to make the video-tapes as realistic as possible, presenting demonstrations in environmental conditions as close as those prevailing in any lab class; it may also be thought beneficial to discuss the relations between "expected" and "obtained" results (Section 3.3.8). It is reasonable to believe that the video-tapes will become more effective when discrepancies between what they teach and what can be achieved in the lab by the students are dealt with.

8.2.3 Concentrating while watching the video-tapes

The students' ability to concentrate while watching the video-tapes is, generally speaking, fairly poor (Section 3.3). The length of the tapes and the predominance of theory are probably the main factors at play here and can be dealt with as suggested above.

However, there are other factors which may continue to diminish concentration even when the tapes are reduced in length and when they concentrate on presenting only the experimental work:

a) Students' attitudes to learning from video-tapes - not all students enjoy this form of instruction, nor indeed can all learn equally well from it (Section 3.3.1). Perhaps no one teaching format will ever please all students; but by reducing the length of the tapes they will become more
accessible to the students. We can go some way towards facilitating more effective learning by ensuring that the ways in which the medium is being used are explained to the students, as is suggested in Section 3.3.3.

b) TV screen and headphones - the small size of the TV screens and the uncomfortableness of the headphones seem to sometimes make it difficult to concentrate (Section 3.3.1).

c) Environmental factors - environmental factors such as movement in the lab (eg by technicians; by students); outside noises; uncomfortable bench stools with no back supports, and so on, all appear to add to the difficulty of concentrating (Section 3.3.1).

d) Students' inability to stop the video-tape if necessary - eg to ask questions, or to think about what has been said (Section 3.3.1).

8.2.4 Flashbacks

It may be thought worthwhile to give full consideration to facilitating flashbacks since this is potentially a very fruitful way of using the information in the video-tapes when the students come to carry out the experimental work (Sections 3.3.7 & 4.5). This phenomenon deserves more research time to explore its potential fully. Suggestions which may help stimulate flashbacks include:

a) structuring the lab schedule to prompt recall of visual images from the video-tapes (Section 4.5) eg by step-by-step instructions which correspond closely with the way in which the demonstration is portrayed in the video-tape.

b) By ensuring that the students have easy access to visual aids/graphics/captions etcetera used in the tape while they are performing the experimental work.

c) By encouraging the students to try and recall visual parts of the tapes as they perform the work - such instructions could be incorporated into the
lab schedule at the point where the instructions for carrying out the technique occurs, thus encouraging the students to think back to the tape and so facilitating flashback.

d) Students' attention can be drawn specifically to certain skills/techniques being demonstrated in the tape - say by re-playing the important part of the demonstration after the initial exposure and drawing the student's attention to the specifics of the technique, so helping her to retain the image for recall later as a flashback.

8.3 Student Awareness and Level of Thinking

One matter on which the students' viewpoint may be of particular significance is their awareness and level of thinking while they are carrying out the experimental work. In their own perception these appear to be low, due to several related factors (Sections 3.3.6, 4.2 & 5.4): a) there is too much work to be done in three hours to be fully aware of everything (Section 3.3.6) b) the students feel that they have to carry out the work in a mechanical ("cook-book") fashion which does not require nor foster critical thinking (Section 3.3.6 & 5.4); c) the students feel that work in the lab often emphasises the achievement of "correct" results, which are then used in the completion of the lab report, the main aim of which is to gain a good assessment grade (Sections 3.3.6 & 5.4). As well as this, we have seen that the students feel that the lab course is a hard factual one in which little discussion seems possible (Section 5.4). I have discussed this at length in Chapter five where I pointed out that the students think the educational philosophy of the lab course seems not to encourage discussion and critical thinking.

These are fundamental aspects of the teaching and learning of the physiology lab. It may be thought worthwhile to give some consideration to the aims
of the lab work, and to the educational philosophy of the adopted teaching strategies. It is beyond the scope of this chapter to discuss such issues at length; all that can be offered are a few indications of possible alternatives.

The "cook-book" fashion of carrying out the lab work is based on the philosophy of using the labs as methods of exemplifying (and corroborating) physiology theory learned in lectures. At times the students indicated concern over the educational value of such a method (Section 3.3 & 5.4). It may therefore be felt that the students' attitudes should be taken into account at this point; alternative laboratory teaching and learning methods such as those discussed in Chapter six, may prove interesting and stimulating in this respect. Similarly with the writing of the lab reports - what educational aims are being followed here? If it is desired to raise the level of relativistic thinking - that is, thinking in which the student is confronted with ambiguities in professional findings, differences in researchers or lecturers' viewpoints, the fact that there may be several theories for explaining certain physiological phenomena and so on, and where the student is required to respond to such information - then it may be necessary to re-think the aims of the laboratory report so as to encourage the students to question more fully the knowledge which they are receiving. Such relativistic thinking could be achieved through group discussions, group work, after viewing a video-tape specially produced for the purpose, or something of the like. No matter what process is chosen, the emphasis would be on discussion, critical thinking and the discouragement of the acceptance of a belief in a single assumed reality of physiology and experimental physiological work.
8.4 Skill Learning

Throughout this evaluation study little (if anything) was mentioned by the students about skill learning. This is somewhat surprising considering that one of the functions of the lab is to help students achieve proficiency in certain manipulative skills and techniques. It can only be assumed that to the students, the actual process of learning the lab skills is fairly unimportant. Is this in fact the case? I gathered no direct evidence on the acquisition of skills, but the fact that the completion of the lab work would require some skill in using the equipment and apparatus indicates that the skills are acquired at least to some extent.

The proficient acquisition of lab skills is obviously of importance for the students' professional training; the level to which a skill is to be learned will of course depend on the aims of any lab class. Proficiency in some skills will be required at low levels - others to higher, sophisticated technical levels. Is skill training in the lab thought about in this way? Are the students aware of the different levels of expertise required of them? Which skills are of fundamental importance; which are really specialist skills?

Once such questions have been considered, the importance of the Taxonomy (Section 7.4.2) may become clearer; it can be used to help make judgements about the levels to which the lab skills should be taught and to help determine what the educational objectives of the lab work are and how to assess their achievement.

8.5 Lab Reports

The unexpected effects of requiring the students to complete the lab report
are discussed fully in Sections 3.3.8 & 4.4.2, and the effect of their structure and content on student learning is discussed in Section 4.4.

The completion of the lab reports is the final step in the lab work, and for many students is the main point of doing the lab work since it is from these that their work is assessed (Section 3.3.8). Much time is therefore devoted to their completion and the students often work together on particularly difficult parts of them, all of which is considered to be educationally worthwhile. However, in the pursuit of a high grade, the students said that they frequently "fake" their results (Section 3.3.8) so as to make them conform more closely with "expected" results; this the students say is necessary because the presentation of their own results, if not conforming to the expected, often leads to downgrading (Section 3.3.8). Here is another instance where knowledge of the students' perception of the situation is of value to staff, whether they agree with it or not.

This situation may be alleviated somewhat by ensuring that the students' own results are acceptable - guidance might be given in the interpretation of their own results, and more positive feedback aimed at helping the students understand where they have "gone wrong" would be helpful. Reducing the importance of grade acquisition, or eliminating the grading of the lab reports, would go some considerable way toward changing the students' methods of completing the reports, and would probably also go some way toward prompting student motivation based more on intrinsic factors than extrinsic ones. If it is thought necessary to change the present grading system, one possible alternative could be student profiles, which would emphasise personal development characteristics and the development of abilities in relation to the general lab aims without ever ascribing grades.

Little need be said at this point about the usefulness of paying attention
to the structure of the lab schedules. In section 4.4 it was shown clearly that the use of advance organisers and clearly laid out "steps-to-follow" help the students a) carry out the experimental work; b) recall the video demonstrations; c) clarify in their minds what the procedures and techniques involved in each lab session are. Such strategies are strongly recommended as being worthwhile when new/future lab schedules are written.

8.6 Unexpected Aims of the Lab Course

Chapter six is devoted to an analysis of the effect of the lab course on the students' perceptions of the aims of a university education. The outcomes of this chapter point to the fact that the physiology lab course has many aims which those running it would not normally associate with it. These unexpected aims (qv Table 6.12) are held to have been of importance to the students; the students have had the opportunity to develop their skills in areas of intellectual and personal development not traditionally associated with the lab (Section 6.6). To what use can this information be put?

I think, first of all, it could be beneficial to acknowledge that the physiology lab course can offer more to the students than is normally thought. By acknowledging this the next step might be to try and take this fact into account in the organisation of the lab course, perhaps by incorporating the unexpected aims into the formalised list of aims and activities of the course and by ensuring that their achievement by the students' is taken into account in the assessment procedures. (Of course, making these aims overt will change the system in itself).

Going a step further, one then has to acknowledge that there may be other aims which can effectively be achieved during the lab course, aims perhaps which individual students wish to work towards achieving. Allowing for these
would of course require some changes to the process of the lab work - perhaps by incorporating self-evaluations as an aim of the lab course. Students would be encouraged to review their feelings, skills and behaviours in the context of the teaching and learning of the lab course. For example, at the beginning, middle and end of a term the student and a member of staff could come together to discuss the student's self-evaluation. At the beginning of the term there might be discussion about the lab course: the aims of the labs, their formats and the various activities they can include. The student would be encouraged to relate each aim to herself and try to establish where she is NOW in relation to its accomplishment, and what activities she might wish to focus on in the coming half term. At the next meeting, she would look back at the work completed and assess what she had done and what had been achieved in relation to what she had set out to achieve, and then plan her lab activities for the next half term on the basis of this self-evaluation. The last meeting of the term would be given over to a consideration of the complete term's activities and accomplishments and the student would plan for the next half term's work. Such self-evaluations could go a long way in helping the students mature and evaluate their university work as well as personalising the assessment procedures of the lab course.

8.7 Continual Physiology Lab Course Evaluations

This evaluation study indicates the value of curriculum evaluation. Continual physiology lab course evaluations might be considered of benefit so that the effects of the curriculum changes and developments may be monitored. Of course any future course evaluations would benefit from the inclusion of evidence from the academic and technical staff, as well as the students - unlike the present evaluation which is purely from the students' perspective. There are at least three areas for evaluation:

a) Video-tapes: the video-tape evaluation tool (Section 4.3.3) could be used in 1) the production of future tapes, and 11) the evaluation of individual tapes.
b) Evaluation of each lab class: this would provide feedback on the teaching and learning of each particular lab class and would allow for specific changes and developments.

c) Overall course evaluations: these would allow opportunities to re-assess the overall structure of the course, methods of teaching and assessment, aims and objectives and so on. (including the attainment of perceptual-motor skills with the use of the Taxonomy (Section 7.4) if so desired).

8.8 Future Work

Although suggestions are made in each chapter concerning possible future work, it will be useful to draw them together at this point.

Video-tape Teaching and Learning

a) Productions: most of the present video-tapes have been produced in the TV studios and the content has been presented in a logical manner. It would be interesting to produce some future tapes in the physiology laboratory ie in the situation where the students will be carrying out the work, and determine if production location has any effect on the students' attitudes to the tape and their ability to learn from it.

Similarly with the accepted logical presentation of the subject matter; experimentation with presentation formats should be considered eg backward chaining (ie working from the end-point, backwards); programmed sequences etcetera. The aims of any particular tape might determine its presentation format.

b) Evaluation: the use of the video-tape evaluation tool (Section 4.3) should be considered both as an aid in production (where it could be used to help think through the process and take into account past-students' comments on tapes) and as a method of evaluating the effectiveness of each tape (the tool would probably be given to the students as an evaluation
form, to be completed by them). By doing this, some indication of the effectiveness of the tool will be obtained, and it can be changed and restructured accordingly.

c) Learning from video-tapes: it would be worthwhile to investigate the process of decoding the visual information in the tapes. How do the students react to the production techniques and the visual presentation; how is the visual information decoded and assimilated; what are the individual differences in the learning process? Research methods for investigating such questions could include stimulated recall (Section 4.3) and rep-grids (Section 5.2) - both of which have endless potential in educational research. Much more work needs to be devoted to the process of flashbacks (Sections 3.3.7 & 4.5) and its usefulness in video-tape teaching and learning. How do the students store visual images; what makes one image more likely to be stored than an other; in what ways can we encourage visual information storage through production techniques; can flashbacks be facilitated say through prompters in the tape or in the laboratory schedule? Such questions will require systematic investigation, but any work put into trying to answer them will surely be of great use in future tape productions and in understanding the process of learning from television.

Effects of Assessment

It would be interesting to look into the question of the effects of assessment on the students' attitudes to their laboratory work and to the ways in which they complete their lab reports. Does the acquisition of a good grade essentially control their learning processes (as seems to be suggested by some of the outcomes of this study); would a change in the assessment procedures - perhaps assessing fewer labs and allowing the students to choose the ones they want assessed, or eliminating assessment by grades and introducing student profiles as suggested above - have major effects on their study/work patterns?
Longitudinal Changes in Students' Attitudes to a University Education

Extending the work described in Chapter six to look at changes in students' attitudes to a university education throughout their whole university career would be an interesting and potentially useful research project. A modified from of the eighty university aims (say reduced to 40 or less) would be advisable since there is some indication that the students felt aims were repeated in the existing Q-sort. Larger samples of students are necessary, and perhaps a factor analysis would then prove more fruitful.

Comparisons between the changes in students' attitudes to the aims from subject area to subject area could be investigated. The possible causes of change are more difficult to investigate since we have to rely mainly on students' reflections; perhaps constant monitoring (by interview) throughout their university career would prove more reliable than a summative, post hoc interview. The use of diaries and log books in which the students could keep notes of their feelings, major events and so on would also be fruitful methods of monitoring effects.

Taxonomy

The Taxonomy presented in Section 7.4 requires further development; its usefulness will only become apparent when it is used to help think about the laboratory work and help define the aims and objectives of each class. It should be used freely and should not be allowed to define the learning process, but rather should help clarify what they might be.

It is obvious from Section 7.2 that such logically based taxonomies have serious drawbacks and often do not relate effectively to the learning process. Would a taxonomy based on the existing teaching and learning phenomena prove more useful? Such a taxonomy could be developed from an analysis of what goes on in the lab just now i.e. from analysing video-tapes,
students at work, lab schedules, demonstrators interventions and so on, and devising categories of "working" and "learning" behaviours which would both describe these processes and act as a tool for developing objectives. Such a phenomenologically based taxonomy would reflect the real teaching and learning activities of the lab rather than be reflections of a fairly abstract, but logically based, interpretation of what should be occurring.
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Appendix One

1 General lab evaluation questionnaire
2 Results and statistical analysis
UNIVERSITY OF SURREY
INSTITUTE FOR EDUCATIONAL TECHNOLOGY

Student Questionnaire on Aspects of the
Human Physiology Laboratories
February 1976

AIM OF THE QUESTIONNAIRE

The questionnaire is designed to assess your attitudes to certain aspects of the Human Physiology Labs. It is hoped that by getting your views we will be able to improve the labs for future students.

PLEASE: Since the questionnaire is confidential please feel free to be as frank as possible (no data on individuals will be made available to anyone other than the researcher).

NAME: ____________________________
COURSE: __________________________

Thank you.

David McConnell.

If you were to do another lab course in human physiology and had the option of instruction by video-tape and schedule or live demonstration and schedule, how willing would you be to take instruction by video-tape? (please tick the appropriate box)

Very Willing  Willing  Don't Know  Unwilling  Very Unwilling

WHY? Would you please give the reasons for your choice:

Do you think that a choice of instruction via video-tape or instruction by live demonstration should be offered to students? (please tick)

Yes  No

WHY? Would you please give the reasons for your answer:

From a student's viewpoint, do you think it is reasonable to expect every student to learn equally well from the video-tapes? (please tick)

Yes  No

WHY? Would you please give reasons for your answer:
When you are carrying out your lab experimental work, how *AWARE* are you of what you are doing?

<table>
<thead>
<tr>
<th>Very Aware</th>
<th>Vaguely Aware</th>
<th>Not Aware</th>
</tr>
</thead>
</table>

Generally speaking, how would you rate the video-tapes for clarity of explanation?

<table>
<thead>
<tr>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
</table>

Please rate your general interest level when watching the video-tapes:

<table>
<thead>
<tr>
<th>Very High</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Very Low</th>
</tr>
</thead>
</table>

Some students have reported having "FLASHBACKS" of images "in their minds" of part of the video-tape, which have helped them when doing the experiment.

a) Have you ever experienced this?

b) If YES please indicate roughly how often this has occurred.

<table>
<thead>
<tr>
<th>Many Times</th>
<th>Often</th>
<th>Not very often</th>
</tr>
</thead>
</table>

"A lot of the understanding behind the prac. isn't what is involved in the actual prac. itself .. but in interpreting your results and writing it up" (student quote)

Do you agree?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

"The videotapes are crammed full of information which is just too much to take in" (student)

Generally speaking, what would your reaction to this be? (please tick the appropriate box)

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Don't Know</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

"The tape to me is good in realising what you've got to do IN THE EXPERIMENTAL TECHNIQUE (a) But for anything else, I just tend to switch off, or look around the lab or do anything but listen to it - UNLESS IT'S THE ACTUAL TECHNIQUE WE'RE GOING TO DO" (b) (student)

a) Would you agree with statement (a)

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
</tr>
</thead>
</table>

b) Do you ever experience statement (b)

<table>
<thead>
<tr>
<th>Often</th>
<th>Sometimes</th>
<th>Never</th>
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Most video-tapes follow a set pattern consisting of 3 sections.

- Statement of Aims;
- General Theory Introduction;
- Demonstration of Experimental Work; Questions.

Would you please complete the following table, ticking each section on the three point scale with regard to Relevance to Lab Work, Length in the Video-tape and Interest.

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<th>VIDEO-TAPE SECTION</th>
<th>Relevance to Lab Work</th>
<th>Length in Videotape</th>
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Statement of Aims

General Theory Introduction

Demonstration of Experimental Work & Techniques

Questions

If you would like to mention anything further about the labs, please do so overleaf.
1.2 Results and Statistical Analysis

N = 61 (ie 65% of total)

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Chi-squared : 13.24  
Degrees of freedom (df) : 2  
Probability : < 0.02 (P)

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Chi-squared : 3.03  
(df) : 1  
P = < 0.10

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Chi-squared : 31.12  
(df) : 1  
P = < 0.01

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Chi-squared : 27.58  
(df) : 2  
P = < 0.01
**Question 5**

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Chi-squared = 28.08  
df = 4  
P = <0.01

**Question 6**

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Chi-squared = 19.65  
df = 4  
P = <0.01

**Question 7**

(a) Yes No  

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Chi-squared = 0.67  
df = 1  
P = NS

(b) Many Times Often Not Very Often  

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Chi-squared = 5.31  
df = 2  
P = 0.01

**Question 8**

Yes No  

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Chi-squared = 31.12  
df = 1  
P = <0.01

**Question 9**

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<th>Disagree</th>
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</table>

Chi-squared = 14.13  
df = 4  
P = <0.01
Question 10

(a) Strongly Agree  Agree  Disagree
18       39       4

Chi-squared = 10.97
df = 2
P = < 0.01

(b) Often  Sometimes  Never
23       31       7

Chi-squared = 8.88
df = 2
P = < 0.02

Question 11

1. Relevance to Lab Work

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2. Length in Video-Tape

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3. Interest

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Appendix Two

1 Video-tape evaluation form

2 Results of VT evaluations

3 Script for 'new research' video-tape

4 Original lab schedule

5 New lab schedule

6 New lab schedule evaluation form
This questionnaire is designed to assess your attitudes to the video-tapes. It is hoped that by getting your views every week we will be able to improve the tapes, and make the Labs more useful and enjoyable for you. It should take only a minute or so of your time to complete the questionnaire; no individual data will be made available to anyone other than yourself. I am very grateful for your co-operation. (David McConnell) I.E.T.

Each tape can be split into two main sections, via General Theory Introduction Section and Experimental Work Techniques Section. Please complete Parts 1 and 2 immediately after watching the tape and Part 3 at the end of the Lab.

PART 1 TO BE COMPLETED IMMEDIATELY AFTER WATCHING THE VIDEO-TAPE (Please ring the appropriate responses)

While watching the General Theory Introduction Section, I felt that:

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</table>

1. My level of interest was
2. My level of attention was
3. My level of comprehension was
4. My level of enjoyment was
5. The clarity of explanation was
6. The amount of information was
7. The length of this part of the tape was
8. The speed at which ideas and concepts were developed
9. (Anything you want to add)

PART 2 TO BE COMPLETED IMMEDIATELY AFTER WATCHING THE VIDEO-TAPE (Please ring the appropriate responses)

While watching the Demonstration of Experimental Work Section, I felt that:

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<th>Low</th>
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1. My level of interest was
2. My level of attention was
3. My level of comprehension was
4. My level of enjoyment was
5. The clarity of explanation was
6. The amount of information was
7. The length of this part of the tape was
8. The speed at which ideas and concepts were developed
9. (Anything you want to add)

PART 3 TO BE COMPLETED AFTER YOU HAVE FINISHED THE LAB. WORK

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1. The tape made the experimental work easier than it was
2. I felt I had to rush through the Lab. work
3. I had difficulty in performing this experiment
4. I could have done with more time to carry out the work
5. (Anything you want to add)
### RAW DATA FROM RETURNS OF QUESTIONNAIRES ON THE VIDEO-TAPES AND t TESTS RESULTS

#### TAPE 1

Fore-arm plethysmography

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Estimation of systemic blood flow

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## Skin and peripheral circulation

### TAPE 3

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Carriage of carbon dioxide

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### Effects of exercise

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- 4&4 t = 0.9 NS
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## Gastric functions

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**Oxygen–haemoglobin dissociation curve**
RESULTS OF STUDENTS ATTITUDE TO EACH QUESTIONPOSED IN THE EVALUATION FORM(VIDEO-TAPES)

Tape I
Forearm Plethysmography Video-tape

N= 23 Expected value for Chi square= 7.6

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*Categorised results: Score of 5/4 = High

**3 = Medium

**2/1 = Low
Tape 2
Estimation of Systemic Blood Flow Video-tape

N = 33 Expected value for Chi square = II

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Tape 3
Skin and Peripheral Circulation Video-tape

N = 52 Expected value for Chi square = 17.3

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Concentration: 3 7 2 1 2 8 0 5 5 1 7 3 2 4 3

**Key:**
- H = High
- M = Medium
- L = Low
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INTRODUCTION TO HAEmatology

In this video-tape I will be demonstrating some techniques used in the study of blood, but first let me draw your attention to the warnings about the use of blood in the lab, which are appended to the front of your schedule. You should read this sheet very carefully and abide by those precautions. I would like to emphasise one point - that is that if you have suffered at any time from hepatitis of any sort you must not act as a donor in any of these experiments.

With those warnings mentioned, let us consider what you will be aiming to do in this lab.

There are 3 main aims of the lab, as follows:

1. To enable you to carry out a red cell count using a haemocytometer and to appreciate the error inherent in this method.
2. To enable you to estimate haemoglobin and haematocrit and derive indices from these and
3. To enable you to perform a differential white cell count.

Red Cell Count

Haemocytometer

To do a red cell count you have to dilute some blood so as to separate the cells, and then count the number of cells in a known volume of the diluted blood.

You will use an instrument called a haemocytometer to count the cells - one of these is in front of you. It consists of a thickened glass slide divided into several troughs in an H shape; there are grids etched upon the glass at the crossbar from which you can work out the area you are looking at.

Turn to the page with the grid on it in your schedule and you will see that there are 9 large squares, 5 of which are labelled. Each large square has a side of 1mm, and therefore an area of 1sq.mm. The central 1mm square is sub-divided into shallow squares of 0.02mm, they therefore enclose an area of 0.04 sq.mm. Each of these squares is also subdivided into smaller squares of 0.05 mm with an area of 0.0025 sq.mm. When you come to do a red cell count, you will be using the central 1\(\times\)1 post of the grid.

When a cover slip is placed over the slide, the distance between the grid and the cover-slip is one tenth of a millimeter, 0.1 mm.

You can therefore work out the volume of blood in one of the smallest squares since you know its area and its depth.

1. Blood Diluting Pipette

To dilute the blood you will use a blood diluting pipette - pick up the one in front of you. It has three graduation marks - 5, 1 and 10\(\mu\)l. You draw blood up to the 5, mark, then draw Haem's fluid which prevents coagulation up to the 10\(\mu\)l mark. That gives you a 1 in 200 dilution of the blood. By rotating the pipette, the bead in the bulb here agitates the mixture and mixes the blood with the fluid so giving you a reasonably homogeneous dilution of blood. When taking blood from your subject, you will use the mouth piece to suck the blood into the pipette and at the same time you will be able to watch the graduation markings.
3. Taking Blood from an Ear-lobe

1. Sterilising skin with alcohol
   You will be taking blood from the ear lobe of your subject, which is a convenient place to take blood from because it isn't very painful and you will get a reasonable flow of blood.
   Firstly, you sterilise the ear-lobe with alcohol - just a little on the cloth, gently rub it onto the skin and let it dry.
   2. Piercing with Lancet
   You pierce the skin with a disposable lancet, which has a pointed neck so that it will only go in so far. Squeeze the ear lobe tightly, and firmly, jab the lancet into the ear lobe and express some blood by massaging gently.

   Now, take the blood up into the pipette to above the mark, then dab the end of the pipette on a tissue to take it down to the mark. Then take up the haemog fluid to the log mark and rotate the pipette to ensure a reasonable dilution.

   You now have to put the coverslip onto the haemocytometer. Put a little saliva down either side and press the cover-slip into place. It will impart quite a bit of resistance, but you want it stuck firmly on; you should be able to see interference patterns between the glass interfaces.

   Now, taking the pipette, you will have to blow out some of the contents of the stem since this will consist mainly of diluting fluid and not diluted blood, and then you can run the blood into the haemocytometer by touching the tip of the pipette against the haemocytometer and the glass. Blood will flow by capillary attraction under the cover-slip and fill the haemocytometer.

   | Slide: Low Power |
   | Grid again to show small squares |
   | Does this while talking |
   | Puts pipette down |

   Caption: 
   Red cell count:

   4. Viewing RBC
   Put the haemocytometer under low power on the microscope and allow the cells to stop moving - then you can count them. This is a low power view of the cells - the grid is not visible under low power. So turn to high power and the cells will look bigger and the grid markings will be seen.

   One block of 16 very small squares can be seen, each one of these being .0025 mm square. You should count the cells within each square according to the following convention: include in any square all cells that lie on this line and this line, in other words cells on the top and to the left of the picture. So that, if we were counting cells in this square we would count these ones in, whereas if we were counting the cells in this square we would ignore these two because they lie on the bottom - we don't count in any square any cells on the bottom line and to the right.

   To count the cells you will use a tally counter as you spot a cell you simply press the bottom on the top so that you can count the number of cells in each square, read it off and set it back to zero.

   To get a representative blood count you will count the cells in five groups of 16 squares - so take 5 of the large squares and count the number of cells within the 16 small squares, and record this on the grid given in the schedule. You can then calculate the number of cells per cubic m.m. of blood knowing the dilution factor and the volume you are counting in. I'd like you to consider the errors inherent in this method as asked in the schedule.

   5. Cell Counting Device
   Another method of counting red blood cells is to use a cell counting device. These allow large numbers of cell counts to be done quickly. You will use this machine to do a cell count on your blood sample and compare the result with that achieved using the haemocytometer.
You put a sample of diluted blood into this bucket - the blood is diluted by a factor of 80,000 and is sucked through a small hole in this central tube where it imparts an electrical resistance between two electrodes - one inside and one outside the tube. This is all recorded, and you get a readout in hundreds of thousands of red cells per cubic-millimeter on this rack counter on the front of the instrument.

So that concludes this section on the Red Cell Count, and problem questions relating to this are printed in your schedule.

2. Haemoglobin Concentration

To determine the haemoglobin content of blood, you have to convert the haemoglobin into a stable compound, and this is done by oxidising it. The central ferrous ion is oxidised into ferric ion by using Drabkins reagent - in fact the haemoglobin is converted into cyanmethaemoglobin which is chemically stable.

The technique involves taking 4 mls of Drabkins reagent and adding it to 0.02 mls of blood. Since Drabkins reagent is poisonous it is pipetted by using a pipetting bowl - you should not pipette it by mouth.

This is a pipetting bowl, which is fitted onto the top of a pipette. There are 3 valves labelled 1,2 and 3. By pressing valve 1 air is expelled to the outside, by pressing valve two the material can be drawn up into the pipette. By pressing valve 3, air can be let in here for filling the pipette to the correct level.

So, you will empty the bulb first, then take up slightly more than 4 mls of Drabkins reagent, then come down until you’ve got 4 mls in the pipette, and place that into a test-tube. Now, you must wash your hands to get rid of any excess reagent. This is very important since this is extremely poisonous and you don’t want to transfer it to another persons skin.

You now need another sample of blood and you will take this in the same way as before. The ear lobe is sterilised with alcohol, a fresh lancet is used to pierce the skin and you will collect 0.02 mls of blood into the pipette by capillary attraction. You then transfer this to the test-tube of Drabkins reagent by blowing it in and rinsing.
The tube contents are mixed and left to stand for 20 min for the colour to develop.

**Setting up the Colorimeter**

While that is happening, you can set-up the colorimeter from which you will read the transmission of the cyamethaemoglobin.

First, switch the machine on and ensure that the needle is reading zero and the selection knob is at position 2. You ensure that you are setting 100% transmission on water, so take a sample tube of water and place it in, ensure that the green filter is in place, close the hatch and press this rubber switch to get a reading. Adjust the needle to read 100% by using this lives by the side of the sample chamber.

Now to make your standard curve, two standards are provided; a high standard of 14.2 g of haemoglobin per 100 ml and a low standard of 7.1 g Hb per 100 ml. Take the high standard, press the button and take the reading - which is 4b transmission units. And do similarly with the low standard - which gives 68 transmission units. From your two readings you can draw a standard curve in the appropriate place in your schedule, from which you will be able to interpolate your own Hb concentration.

We make some up earlier to allow the colour to develop. You put some into the test-tube which is placed in the colorimeter and a reading is taken - which is 50 transmission units. You can interpolate this on your standard curve and get the haemoglobin concentration of your sample.

There are two ways of expressing haemoglobin: one is the Haldane standard where 100% is equivalent to 14.1 g Hb per 100 ml. Normal values for humans are:

<table>
<thead>
<tr>
<th></th>
<th>men</th>
<th>women</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>14.2</td>
<td>7.1</td>
</tr>
</tbody>
</table>

You should express your results on the Haldane scale in the space provided in the schedule.

You can also express haemoglobin by the oxygen carrying capacity (OCC) which is the amount of oxygen that blood can carry when haemoglobin is fully saturated with O₂. 1 g of Hb combines with a maximum of 1.34 ml O₂.

This is expressed in volumes % and the normal male and female values are

- men 20.9 vol %
- women 18.36

You should be able to calculate the OCC of your blood sample as indicated in your schedule.

---

**Haematocrit - packed cell volume**

Haematocrit, 4 packed cell volume, is the proportion of cells in the blood, and is usually presented as a.

To determine haematocrit, you will have to get a sample of blood into one of these heparinised capillary tubes, centrifuge it and then determine the % of the cells. You will take blood as normal - first cleansing the skin with alcohol then piercing it with a new lancet. You should allow the blood to flow into the capillary tube filling it to 2/3 full - and plug one end of the tube by putting the tube into critical seal-sort of putty-twist and withdrew.

Put the tube into the centrifuge with the putty-filled end to the outside like this, put on the top to retain the tube, close the centrifuge and switch it on, setting the switch here to 14 minutes (The speed is self controlled) and remove after 14 minutes.

We have already done this - and you can see the white of the putty, the red packed cells and the plasma. You determine the amount of red cells relative to the plasma by using one of these leads. The capillary tube is placed...
in the groove on the slide, and it is adjusted so that the bottom of the cells is on this black line labelled zero at the bottom and the miniscus of the plasma is on this top line here. You place the white line on this guide which you can nose here at the junction of the red and white - the junction of the cells and plasma. This gives a reading on this scale of 40%, which means that our subject has a haematocrit of packed cell volume of 40%.

So, you will have determined the red cell count, the haemoglobin content and the haematocrit and from these you can derive further indices of haematological value.

The average earpulular haemoglobin content

ACNC

The mean corpuscular haemoglobin content

MCAC

and the mean corpuscular volume

MCV

The arithmetic for deriving these is given in the schedule, as are some questions relating to them.

Differential White Cell Count

A differential white cell count is a determination of the relative proportion of the different types of white cells in a typical blood sample. This involves staining the cells so that they can be recognised.

First, you will take some blood directly onto a slide. You sterilize the ear, jab with a lancer and get a reasonable drop of blood on the ear lobe and collect it on the slide. Place it on the bench, and place the blood film spatula on the blood and allow the blood to run along the spatula to the edges, like so. Press firmly, and draw the spatula along the slide to spread the blood. You want a film of blood one cell thick; so if you can see the blood its probably too thick. You air dry the slide like so and put it on the staining rack, which will be over the sink in the lab. Then flush the whole slide with Pleshmans stain by pipetting it on, and leave for 3 minutes. We don't have time here, so we'll tip of the stain, wipe the excess off and then wash in buffered pH water until there is a slight pinkish tinge to the material on the slide - you should leave it until there is.

Remove the slide, wipe the back and drain off the water like so and air dry.

Since that takes a few minutes, we'll use a prepared slide. You will be using oil irroso so place a large blob of erosion oil onto the slide, with no cover - slip, place the slide beneath the oil immersion objective nose piece, then looking down the microscope adjust the Fine Focus until the cells are clearly focussed.

Since you are trying to determine the relative proportion of white cells, we have put a grid on the schedule for you to record your results, and there are colour photographs in the lab from which you can identify each cell.

You should scan the slide in this sort of way - going across the slide, down a bit and back across following a regular scan pattern, topping up with immersion oil when necessary. Count about 200 cells only.

When you have counted and recorded the different cells in your schedule, determine the age of each cell type in your white cell count.

This is what you may see in a typical smear. There's a mass of red cells there, and platelets there. In the centre of the picture are 3 large granules recognizable by their polymorphic nuclei - there, there and there. It's impossible to say what sort of granules these are because you cannot see the colour of the cytoplasmic inclusion. Finally, there's a lymphocyte there; evident by the large nucleus and small amount of cytoplasm.
There are several questions in your schedule which you should answer in relation to the differential white cell count.

Before you carry out these experiments, let me again remind you of the warnings of working with blood which are appended to the front of your schedule, and especially that if you have suffered at any time from hepatitis of any sort you must not act as a donor in any of these experiments.
N.B. There are certain precautions which must be taken when dealing with human blood as it is possible to contract viral infections e.g. hepatitis, through any small wounds on the hands from contact with any blood other than your own.

1. Use only your own blood for the following experiments.
2. Never use any instruments that could possibly be contaminated with other people's blood.
3. Put all used slides in hycolin immediately they are finished with.
4. Put all used lancets, cotton wool, tissues, etc., in the box provided immediately they are finished with.
5. Wipe up any spills of blood with hycolin immediately.
6. Wash your own pipettes immediately after use so that the blood does not clot in them.
   Put mouth pieces in hycolin, 1% HCl, tapwater, distilled water, acetone and other.
   Rapidex is available if the blood does clot in the pipette.

V.C.R. Schedule

UNIVERSITY OF SURRY

PHYSIOLOGY LABORATORY

Name
Course

1. Answer the questions in the spaces provided; additional sheets will not be marked.
2. This schedule accompanies a videotaped introduction to the experiment, and it should not be necessary to take notes.

INTRODUCTION TO HEMATOLOGY

The aims of this practical class are:

To enable you to

1. Carry out a red cell count using a haemocytometer, and to appreciate the error inherent in this method.
2. Estimate haemoglobin and haematocrit, and derive indices from these.
3. Perform a differential white cell count.

Before starting any experimental work, read the information sheet relating to experiments upon blood.

1. The red cell count. A diluted sample of blood is placed in a haemocytometer, and the cells present in a known volume of diluted blood determined. The volume is given by a grid etched upon the haemocytometer, details of which are reproduced overleaf. The volume is given as a product of the area bounded by the etched squares, and the height of the cover slip above the grid, i.e. 0.1 μm. The diluting pipette contains a red bead for mixing the blood with diluting fluid. Blood drawn up to the 0.5 mark is diluted 200 times by fluid drawn up to the 0.0 mark.

Take blood from the thumb or ear lobe of your subject, cleanse the skin with alcohol, which should then be allowed to dry. Pierce the skin with a disposable lancet, and immediately place the used lancet in the disposal box. Squeeze the ear or thumb gently to express a drop of blood and collect the blood into the diluting pipette in the manner demonstrated. Take up blood
Then take up the diluting fluid to the 10 ml mark. The diluting fluid is Hayeas fluid, the composition of which is as follows:

- \( \text{Na}_2\text{SO}_4 \) 176 mM
- \( \text{NaCl} \) 85.5 mM
- \( \text{HgCl}_2 \) 2.1 mM

The fluid provides an isotonic medium for blood cells, prevents coagulation and permits sufficient separation of cells to enable counting to be carried out.

Place the cover slip in position on the counting chamber. After rejecting the first few drops of fluid from the pipette, run some of the diluted blood under the cover slip. The liquid should not overflow into the grooves. Place the slide in the microscope platform which should be in the flat position and observe the erythrocytes. When movement of erythrocytes has ceased, examine the field to see if the distribution of red cells is fairly uniform. If not make a new slide.

Count the number of cells contained in five of the 0.2 mm squares (i.e. five groups of sixteen small squares).

Include in the count for each square all those cells which lie on or touch either the top or the left limits of the square but not those similarly on the bottom or right limits of the square.

Record the count on the grid below.

**RESULTS**

<table>
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<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
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<tr>
<th>Group 4</th>
<th>Group 5</th>
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</table>

**TOTAL COUNT**

\((\cdot)\)
The count (N) was contained in what volume of diluted blood?

Answer \( \text{mm}^3 \)

This count is, of course, a 1:200 dilution of the original blood. What then is the red cell count of whole blood?

Answer \( \text{cell mm}^{-3} \)

Normal values are as follows:

- For men: \( 5.5 \times 10^6/\text{mm}^3 \) (range 5.1 - 5.8)
- For women: \( 4.8 \times 10^6/\text{mm}^3 \) (range 4.3 - 5.2)

Counts below \( 4.5 \times 10^6 \) in the male and below \( 4.0 \times 10^6 \) in the female should be regarded as possibly abnormal.

Now repeat the count of the automatic counter (the technician will show you how to do this).

Cell count (automatic counter) \( \text{cells mm}^{-3} \)

Account for any difference that you note.

What factors do you think might affect the red cell count?

**Determination of haemoglobin concentration.** Because the spectral absorption of haemoglobin changes with oxygenation, to carry out a colorimetric determination of haemoglobin, the latter must be converted to a stable form. This is done by using Drabkin's reagent (O&H: poisons) which converts haemoglobin to the stable cyanmethaemoglobin.

Measure 4 ccs of Drabkin's reagent into a clean dry test tube using a bulb pipette as demonstrated.

Pipette 0.02 ml blood into the tube containing the reagent. Drabkin's reagent is poisonous use a rubber extension and mouth piece on the micropipette and gently suck up and blow out the reagent as to completely remove the blood from the micropipette. The blood must be blown out quickly after sampling or it will clot in the pipette.

Cover the top of the tube and invert several times to mix. Leave for 15 - 20 minutes while the Drabkin's reagent converts the haemoglobin which is a stable compound having an absorption peak at

Construct a standard curve for the color meter, using the high and low standards provided. Read transmission of your sample, and interpolate on the standard curve.

The Haldane standard is sometimes used to express haemoglobin concentration. On the Haldane scale, 100% is equivalent to 14.6 lb. 100 ml. Normal values on the Haldane scale are:

- Males: 40%
- Females: 95%

What will these figures represent in terms of g.Hb.100ml⁻¹?

Male

Female

Given that 1 g. haemoglobin combines with a maximum of 1.34 ml. oxygen, calculate the oxygen carrying capacity (OCC) of your blood.

The OCC is the amount of O₂ that blood can carry when haemoglobin is fully saturated with O₂, it is expressed in Vols.%

<table>
<thead>
<tr>
<th>Normal OCC</th>
<th>Men</th>
<th>Vols.%</th>
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<tbody>
<tr>
<td>Women</td>
<td>20.9 Vols.%</td>
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</tr>
<tr>
<td></td>
<td>13.36 Vols.%</td>
<td></td>
</tr>
</tbody>
</table>

Your blood OCC Vols. %

**Haematocrit (packed cell volume).** This is calculated, using the microhaematocrit technique, by spinning a column of blood in a capillary tube until the tube is nearly full. The capillary tubes have a coating of heparin which prevents the blood from clotting. Seal one end of the capillary tube with oxymat. Place the tube in the micro-haematocrit centrifuge so that the cells will pack against the sealed end, centrifuge for 14 minutes. Using the microhaematocrit reader, calculate the haematocrit of the blood.

**Haematological indices.** Using the results you have obtained, certain other haematological indices can be calculated.

1. The Average Corpuscular Haemoglobin Content (ACHC) (pg)

\[
\text{ACHC} = \frac{\text{Haemoglobin in gms/Litre}}{\text{Red cell count (millions/mm}^3)}
\]

<table>
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<tr>
<th>Normal value</th>
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<td>Men ( = 15.6 )</td>
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<tr>
<td>Women</td>
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</tbody>
</table>

Value for your blood pg.cell⁻²
(i) Mean Corpuscular Haemoglobin Concentration (MCHC)

\[
\text{MCHC} = \frac{\text{Haemoglobin in g/100 ml. of packed cells}}{\text{PCV}}
\]

Normal value

Men: 35.6 \times 100 = 34.5 g/100 ml. of packed cells

Value for your blood: g/100 ml. of packed cells

(iii) Mean Corpuscular Volume (MCV)

\[
\text{MCV} = \frac{\text{Volume of packed red cells}}{\text{litre of blood}}
\]

Red cell sp. gr. (1.052)

Approximation of normality: 850 = 90 \mu^3

The normal range is 78 - 94; such cells are termed normocytes. Cells outside this range are termed macrocytes if > 94, or microcytes if < 78.3.

Value for your blood: \( \mu^3 \)

Differential White Cell count:

This is a determination of the relative numbers of the various kinds of white cells in the blood.

Method

Prick the finger and obtain a small drop of blood, maximum diameter 4mm, and place it on a slide (which you have taken from alcohol and dried) about a third of the way along.

Place the edge of the plastic blood film spatula in contact with the blood and at 45° to the slide and wait until the drop has spread along the line of contact.

Push the spatula over the slide in a single fluid action.

Practise until an even film one cell thick is obtained.

Allow the film to dry in air. The film when dry should not appear red in colour. It is too thick if it does.

When dry, place the slide on a staining rack across a sink, drop on sufficient Jenner's stain to cover the film. Leave for three minutes. Wash off with distilled water until the film appears pink to the naked eye. Blot and allow to dry in air.

Place a drop of cedarwood oil on the film and examine with the 1/24th inch objective scan the slide in the manner illustrated.

Count at least 200 white cells, proceeding from one end of the film to the other and classify them as you count them. Express the numbers of each type as a percentage of the total number counted.

The different types of cells are as follows:

**Granulocytes**

The cytoplasm of these cells contains densely staining granules, and they are classified according to the staining of the granules.

1. **Polymorphic neutrophils**
   
   Cytoplasmic granules small, numerous and neutrophilic (i.e., they take up both the blue and red stain and so are purple). Nucleus very irregular and divided into lobes.
   
   Constitute 65% - 75% of the total leucocytes.

2. **Eosinophils**
   
   Similar to above but granules are very large and stain bright red.
   
   Constitute 0% - 3% of the total.

3. **Basophils**
   
   Similar to above, but granules are large and stained deep blue.

**Non-granular cells**

4. **Lymphocytes**
   
   Small round cells with very little cytoplasm. The nucleus is round, densely staining and nearly fills the cell.
   
   Constitutes 20% - 25% of the total.

5. **Monocytes**
   
   Large cells, with extensive pale blue cytoplasm and a large lobed nucleus.
   
   Constitutes 3% - 8% of the total.

Illustrations to help you identify the cells are available in the laboratory.

Your differential cell count:

<table>
<thead>
<tr>
<th>Cell type</th>
<th>No. seen</th>
<th>% total count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphocytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monocytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eosinophils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basophils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutrophils</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What conditions do you think might cause:

(i) An increase in the neutrophil/lymphocyte count?

(ii) An increase in the basophil count?

R.J.H./5.9.75.
NEW SCHEDULE

Experiments With Blood

X.8. There are certain precautions which must be taken when dealing with human blood as it is possible to contract viral infection, e.g. hepatitis, through any small wounds in the hands from contact with blood other than your own.

1. Never use any instruments that could possibly be contaminated with other peoples' blood.
2. Put all slides in Hycolin immediately they are finished with.
3. Put all used lancets in the disposal box, and cotton wool, tissues, etc., in the disposal bags provided immediately they are finished with.
4. Wipe up any spills of blood with Hycolin immediately.
5. Wash your pipettes immediately after use so that the blood does not clot in them. Use 1 MCl, tap water, distilled water, acetone and ether, using a water suction pump.

Put mouth pieces in Hycolin.

Rapidex is available if the blood does clot in the pipette.

Name: ............................................
Course: .......................................

1. Answer the questions in the spaces provided; additional sheets will not be marked.
2. This schedule accompanies a videotaped introduction to the experiment. It should be read in advance of the practical session and it should not be necessary to take notes while watching the tape.

INTRODUCTION TO HEMATOLOGY

The Aims of this practical class are:

to enable you to:
1. Carry out a red cell count using a haemocytometer, and to appreciate the error inherent in this method.
2. Estimate haemoglobin and haematocrit, and derive indices from there.
3. Perform a differential white cell count.

1. The Red Cell Count

Aim: To enable you to carry out a red cell count using a haemocytometer, and to appreciate the error inherent in this method.

During this practical you will have to:
1. Take a sample of blood from a subject.
2. Dilute the blood sample and transfer it to a haemocytometer.
3. Examine the blood under a microscope and count the number of red cells.

Materials


Diluting pipette and attached rubber tubing. The diluting pipette contains a red bead for mixing the blood with diluting fluid. Blood drawn up to the 0.5 mark is diluted 200 times when diluting fluid is drawn up to the 101 mark.

Hayens fluid (diluting fluid) which has the following composition:

\[
\begin{align*}
Na_2SO_4 & \quad 176.00\text{mM} \\
NaCl & \quad 85.50\text{mM} \\
HgCl_2 & \quad 2.10\text{mM}
\end{align*}
\]

Hayens fluid provides an isotonic medium for blood cells, prevents coagulation and permits sufficient separation of cells to enable counting.

Haemocytometer and coverslip. The haemocytometer contains a counting chamber (see diagram on separate page).

Microscope and tally counter (cell counter).

Background

A diluted sample of blood is placed in a haemocytometer, and the cells present in a known volume of diluted blood determined. The volume, which is given by the grid etched upon the haemocytometer, is given as a product of the area bounded by the etched squares and the height of the coverslip above the grid (see separate page).

Method

1. Taking blood from the subject's ear-lobe.

1. Put the subject at ease.
2. Cleanse the skin with alcohol and allow it to dry.
3. Pierce the skin quickly and confidently with a disposable lancet immediately place the used lancet in the disposal box.
4. Collect blood into the diluting pipette up to the 0.5 mark. You may have to squeeze the ear-lobe gently to express the blood.
2. Diluting the blood and transferring to a haemocytometer.

1. Take up the Hayem's fluid to the 101 mark and rotate the pipette to dilute the blood.
2. Place the coverslip in position on the haemocytometer (look for interference rings).
3. Reject the first few drops of fluid from the pipette (why?) and run the diluted blood under the coverslip, minimising any overflow.

3. Examining the blood under a microscope.

1. Place the haemocytometer on the microscope stage and examine under low-power. You will have to allow time for the cells to stop moving around.
2. Examine under high-power - the cells should be uniformly distributed; if not a new slide is necessary.
3. Count the cells contained in five of the 0.2mm squares (i.e. five groups of the sixteen small squares) using a tally counter. Include in the count for each square all those cells which lie on or touch the top or the left limits of the square, but not those similarly on the bottom or right limits of the square.

Record the count on the following grid:

**RESULTS**

<table>
<thead>
<tr>
<th>GROUP 1</th>
<th>GROUP 2</th>
<th>GROUP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP 4</th>
<th>GROUP 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Count

= _______ (N)

**Key to Diagram**

area of 1, 2, 3, 4 & 5 = 1mm² each
area of A = (0.2 × 0.2) mm² = 0.04 mm²
area of smallest square within A = (0.05 × 0.05) mm² = 0.0025 mm²

Section through a haemocytometer
Questions

1. In what volume of blood was the count (N) contained? Answer: _______ mm$^3$

2. This count is a 1:200 dilution of the original blood. What then is the red cell count of undiluted blood? Answer: _______ mm$^3$

Normal values are as follows:

- men $5.5 \times 10^6$ mm$^3$ (range: 5.1 - 5.8)
- women $4.8 \times 10^6$ mm$^3$ (range: 4.3 - 5.2)

Counts below $4.5 \times 10^6$ in the male and $4.0 \times 10^6$ in the female should be regarded as possibly abnormal.

3. Repeat the count on the automatic counter (the technician will show you how to do this). Answer: _______ cells mm$^{-3}$

Account for any difference that you note:

What factors do you think might affect your own red cell count?

---

2. Determination of Haemoglobin Concentration

Aim: To enable you to estimate the haemoglobin concentration of blood and derive some haematological indices from this.

During this practical you will have to:

1. Take a sample of blood from a subject.
2. Convert the haemoglobin in the blood to a stable form (cyanmethaemoglobin) using Drabkins reagent.
3. Construct a standard curve.
4. Use a colorimeter to read your own samples of blood and plot these on the standard curve.

Background

Because the spectral composition of haemoglobin changes with oxygenation, the haemoglobin must be converted to a stable form before a colorimetric determination of it can be determined. This is done by using Drabkins reagent (CARE - poisonous) which converts the haemoglobin to stable cyanmethaemoglobin.

Materials

- Bulb pipette and test-tubes.
- Drabkins reagent - oxidises the central ferrous ion to ferric ion, forming stable cyanmethaemoglobin.
- Micro-pipette and rubber-tube extension and mouth piece.
- Standards and colorimeter.

Method

1. Pipette 4mls. Drabkins reagent into a test-tube, using a bulb pipette as demonstrated in the video-tape.

   Remember: Pressing valve 1 expels air to the outside.
   Pressing valve 2 will draw the material up into the pipette.
   Pressing valve 3 draws in air, allowing the pipette to be filled to the correct level.

2. Take a sample of blood from your subject (as in experiment 1) collecting 0.02mls of blood into the pipette.

3. Pipette the 0.02mls of blood into the test-tube of Drabkins reagent, using the rubber extension and mouth piece since the reagent is poisonous. Gently suck up and blow out the reagent so as to completely remove the blood from the micro-pipette. The blood should be blown out quickly after sampling or it will clot in the pipette.
4. Cover the test-tube and invert several times to mix. Leave for 15 - 20 minutes to allow the Drabkins reagent to convert the haemoglobin to stable cyanmethaemoglobin, which has an absorption peak at 540nm.

5. Read the absorbance of the three standards and construct a standard curve. Read the absorbance of your own sample, and interpolate on this standard curve.

<table>
<thead>
<tr>
<th>Standard g 100ml⁻¹</th>
<th>Absorbance</th>
</tr>
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<tbody>
<tr>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td>own sample</td>
<td></td>
</tr>
</tbody>
</table>

Questions

1. The Haldane standard is sometimes used to express haemoglobin concentration.

Haldane Standard: 14.6gms.Hb.100mls⁻¹ = 100%

Normal values on the Haldane scale are:

men 105%

women 95%

Q? What will these figures represent in terms of g.Hb.100mls⁻¹?

2. One gram of haemoglobin combines with a maximum of 1.34mls. oxygen - this is used to derive the oxygen carrying capacity (OCC) of your blood.

Thus, oxygen carrying capacity = \[ \frac{[Hb] \times 1.34}{(g.100mls⁻¹)} \]

The OCC is the amount of oxygen that blood can carry when haemoglobin is full saturated with \(O_2\). It is expressed in vols.%, the approximate normal values being:

men 20.90 vols%

women 18.36 vols%

Q? What is the OCC of your blood sample?

OCC = __________ vols%

3. Haematocrit - Packed Cell Volume

Aim: To enable you to determine haematocrit and derive indices from there.

During this practical you will have to:

1. Collect a sample of blood directly into a capillary tube.

2. Centrifuge the blood and read the haematocrit on a microhaematocrit reader.

Background

Packed cell volume is calculated, using the microhaematocrit technique, by spinning a column of blood in a centrifuge so that the cells pack down tightly. The height of the cells relative to the total height is the haematocrit.

Materials

Red-tipped capillary tube and 'Critoseal'. The capillary tubes have a coating of heparin which prevents that blood from clotting.

Microhaematocrit centrifuge and reader.

Method

1. Obtain a sample of blood as before, directly into the capillary tube and seal one end with 'Critoseal'.

2. Place the tube in the microhaematocrit centrifuge so that the cells will pack against the sealed end. Centrifuge for 14 minutes.

3. Using the microhaematocrit reader, calculate the haematocrit of the blood.

\text{Haematocrit of your blood sample} = \text{_____ %}

Haematological Indices

Using all the results you have obtained, certain other haematological indices can be calculated:

1. The Average Corpuscular Haemoglobin Content (ACHC)

\[
\text{ACHC} = \frac{\text{Haemoglobin in gms litre}^{-1}}{\text{Red Cell Count (millions.mm}^{-3})}
\]

Normal Value

men \[ \frac{15.6}{5.5} = 28.3pg.cell^{-1} \]

Value for your blood \[ \text{_____ pgms.cell}^{-1} \]
2. **Mean Corpuscular Haemoglobin Concentration (MCHC)**

\[ \text{MCHC} = \frac{\text{Haemoglobin in gms}}{\text{PCV}} \times 100 \]

Value for your blood ______ g.100nl\(^{-1}\) of packed cells

3. **Mean Corpuscular Volume (MCV)**

\[ \text{MCV} = \frac{\text{Volume of packed red cells/litre of blood}}{\text{Red Cell Count (x} \times 10^6 \text{mm}^{-3})} \]

Approximation of normality \( \frac{4.50}{5} = 90\mu^3 \)

The normal range is 78 - 94\(\mu^3\) - such cells are termed normocytes. Cells outside this range are termed macrocytes if > 94\(\mu^3\), or microcytes if < 78\(\mu^3\).

Value for your blood ______ \(\mu^3\)

4. **Differential White Cell Count**

Aim: To enable you to determine the relative numbers of the various kinds of white cells in the blood.

During this practical you will have to:

1. Obtain blood by pricking your finger/ear lobe.
2. Obtain a one-cell-thick smear of blood on a slide.
3. Stain the blood.
4. Count the white cells under a microscope.

**Materials**


**Method**

1. Obtain a little blood (4mm diameter) on a slide (taken from alcohol and dried).
2. Place the edge of the plastic film spatula in contact with the blood at 45\(^\circ\) to the slide. Wait until the drop has spread along the line of contact, then, pressing firmly, push the spatula over the slide in a single action.
3. Practise this until an even film one cell thick is obtained.
4. Allow the film to dry in air - when dry, it should NOT appear red in colour; if it does it is too thick.
5. When dry, place the slide on a staining rack across a sink and drop on sufficient Leishman's stain to cover the film. Leave for 3 minutes. Wash off with distilled water until the film appears pink to the naked eye. Blot, and allow to dry in air.
6. Place a drop of cedar-wood oil on the film and examine with the 1/12th inch objective.

Scan the slide in the manner illustrated in the video-tape. Count at least 200 cells, proceeding from one end of the film to the other, classifying them as you count them. Express the numbers of each type as a % of the total number counted in the grid below.

**The different types of cells are as follows:**

**Granulocytes**

The cytoplasm of these cells contains densely staining granules, and they are classified according to the staining of the granules.
1. **Polymorphic neutrophils**
   Cytoplasmic granules small, numerous and neutrophilic (i.e. they take up both the blue and red stain and so are purple). Nucleus very irregular and divided into lobes.
   Constitute 65% - 75% of the total leucocytes.

2. **Eosinophils**
   Similar to above but granules are very large and stain bright red.
   Constitute 0% - 3% of the total.

3. **Basophils**
   Similar to above, but granules are large and stained deep blue.

Non-granular cells

4. **Lymphocytes**
   Small round cells with very little cytoplasm. The nucleus is round, densely staining and nearly fills the cell.
   Constitutes 20% - 25% of the total.

5. **Monocytes**
   Large cells, with extensive pale blue cytoplasm and a large lobed nucleus.
   Constitutes 3% - 8% of the total.
   Illustrations to help you identify the cells are available in the laboratory.

**Your differential cell count:**

<table>
<thead>
<tr>
<th>Cell type</th>
<th>Number seen</th>
<th>% total count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphocytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monocytes</td>
<td></td>
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</tr>
<tr>
<td>Basophils</td>
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<td></td>
</tr>
<tr>
<td>Eosinophils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutrophils</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total number of cells counted =

What conditions do you think might cause:

i. An increase in the neutrophil/lymphocyte count?

---

ii. An increase in the basophil count?
Questionnaire on the schedule accompanying the video-tape on "An Introduction to Haematology" |

NAME:

The schedule accompanying this video-tape has a new layout and has several other features designed to help you carry out your practical work. Could you please indicate your attitude to these changes on the rating scale below.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

1. The inclusion of the AIM at the top of each section of the schedule helped me to remember what each part of the lab was about.

2. The explanation of what was to be done during each part of the practical via 'During This Practical You Will Have To' helped me clarify what I was required to do:
   - 1. Helped me remember the demonstration
   - 2. Helped me remember the demonstration in the video-tape

3. The Materials Section:
   - 1. It was useful to have the 'Materials required' listed
   - 2. The listing of the Materials helped me in organising my experimental work

4. The Method Section:
   - Setting the Method out into steps:
     - 1. Helped me carry out the experimental work
     - 2. Helped me recall the demonstration in the video-tape
     - 3. Helped me to clarify the procedures / techniques involved

In comparison to the other Physiology Lab Schedules how would you rate this one?

Please put a cross on the scale below to indicate your rating:

- easier to use: ----:----:----:----:----:----:----:---- more difficult to use
- vaguer: ----:----:----:----:----:----:----:---- more precise
- more frustrating: ----:----:----:----:----:----:----:---- more satisfying
- makes the lab work easier: ----:----:----:----:----:----:----:---- more difficult
- has a more pleasant layout: ----:----:----:----:----:----:----:---- more disorganised
- is more pleasant
- makes the lab work
- is more disorganised

If you would like to make any personal comments please do so on the reverse side of this Questionnaire.

Thank you for your co-operation

David O'Connell
Inst. for Educational Tech. 1977
Appendix Three

1 Student instructions for completing the rep-grid
2 Two examples of completed rep-grids
3 Authors interpretation of students' constructs
4 Output from PREFAN analysis of rep-grids
5 Composite diagram of component one with three
**Student instructions for completing the rep-grid**

"You have worked in each of these situations. You know what each one entails - the work involved, how much you like/dislike it, and so on. Each of them is a component of your Human Biology degree course - together they 'make up' Human Biology.

I would like to know something about the way you perceive these various components of your Human Biology course, and the effect they have had on your attitude to the overall degree course. What is your attitude to each? How important is each one to you? What role do you think each one plays in the overall degree course?

THINK OF THE EFFECT EACH OF THESE COMPONENTS HAS HAD, OR DOES HAVE, ON YOUR ATTITUDE TO THE HUMAN BIOLOGY DEGREE COURSE.

Think about the components that are circled in row I, i.e. components 1, 2 & 3 and DECIDE:

IN WHAT IMPORTANT WAY WITH RESPECT TO THE EFFECT THEY HAVE HAD ON YOUR ATTITUDE TO THE OVERALL HUMAN BIOLOGY COURSE ARE ANY TWO OF THEM ALIKE, AND DIFFERENT TO THE THIRD

Please think carefully and consider any effect which you think is important and relevant.

a) What makes two of the components alike? BRIEFLY write this in column A

b) What makes the third different? BRIEFLY write this in column B

Repeat the above instruction for rows II-X, considering the three components circled in each row.

PLEASE TRY NOT TO WRITE THE SAME THING IN COLUMN A OR B MORE THAN ONCE."
<table>
<thead>
<tr>
<th>SEMESTER</th>
<th>GEUS</th>
<th>PHYS.</th>
<th>L.C.</th>
<th>ANAT.</th>
<th>BIOCH.</th>
<th>PSYCH.</th>
<th>NAME</th>
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</thead>
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</table>

<table>
<thead>
<tr>
<th>Comments</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Interestting: Often difficult to grasp - many factors involved.</td>
<td>Not so interesting: Involves more learning than actual understanding.</td>
</tr>
<tr>
<td>Well-organised experiments and lectures relevant to each other.</td>
<td>Badly prepared: Lectures detached from lectures.</td>
</tr>
<tr>
<td>Although more 'biological' than psychology, little detail of anatomy in teaching.</td>
<td>Less obvious: Interesting with direct application to human biology.</td>
</tr>
<tr>
<td>Practical work: Subject which involves a lot of detail in study.</td>
<td>Prepared to spend more time reading</td>
</tr>
<tr>
<td>Lectures seem interested in their subjects.</td>
<td>Uninteresting: Lectures (too many from one subject).</td>
</tr>
<tr>
<td>Problems difficult to solve, require much thought and reading.</td>
<td>No actual problems - just involves completing form.</td>
</tr>
<tr>
<td>Practical work enjoyable.</td>
<td>Direction: Rather unpleasant.</td>
</tr>
<tr>
<td>Lecture notes: Not always straight.</td>
<td>Lectures always take the same course.</td>
</tr>
<tr>
<td>Lectures and lab course have always been relevant to life.</td>
<td>The last course of lectures had only a passing link to human anatomy in 'real life'.</td>
</tr>
</tbody>
</table>

Notes: 1. Well-organised experiments and lectures relevant to each other. 2. Badly prepared: Lectures detached from lectures. 3. Less obvious: Interesting with direct application to human biology. 4. Prepared to spend more time reading. 5. Uninteresting: Lectures (too many from one subject).
<table>
<thead>
<tr>
<th>GEN  PHYS</th>
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<th>ANAT.</th>
<th>BLOCH.</th>
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<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Anatomy and physiology are alike as they both involve direct attachment to "bodies" and concrete objects.

Genetics involves concepts and factors which cannot be seen or only seen by a microscope - more difficult

Again 2+3 are concrete. See direct results.

It is abstract. Results in chemical means. "Dig to understand.

8+4, Both involving the body. Factor 5, involving the mind. Opinions play large part.

4+1+4 not pleasant in sense that you have to really learn the formulas etc and can't discuss the subject.

2+3 difficult - less enjoyable. 2+4 difficult - less enjoyable.

3, can talk about where organs are! can discuss the subject / work together in a group.

Factor 5, easier; more enjoyable.

1, 4, don't really have to evaluate. Results are given in a test. Much easier. 2+3, atmosphere is very "smick," it must be properly arranged to give an easy feeling - tense atmosphere.

2+4, results obtained but have to be thought about - although "how" gives a feeling of satisfaction.

8+5, more enjoyable as adventurous. 1, 5, by allowing the body finding a new way. 1+4, made me aware of the importance of chemistry in the body.

3, a much easier atmosphere more relaxed as concepts involved more common room - familiar.

1, boring, as not always an obvious change or consequence of experiments. Factor 5, without much supportive evidence.

3, involves emotion - chemistry, made aware of this.

1+5, isolated subjects not supporting each other. If they are unlike...

4+3, brings together a whole field of study. More enjoyable as incorporated...
Table 1  Author's 'Interpretations' of the Constructs

The subjects (elements) in the triads used for the initial construing are listed after the constructs. This provides a reference for the positioning of the construct poles in the composite diagrams (i.e. Figures 5.2 and 5.3 and the one in this Appendix).

Key:  G = Genetics   PL = Physiology Lab   A = Anatomy
      B = Biochemistry   Ps = Psychology

<table>
<thead>
<tr>
<th>constructs along one array</th>
<th>STUDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONSTRUCTS</strong></td>
<td></td>
</tr>
<tr>
<td>1 (1) Involve dissections - whole body; very enjoyable (PL&amp;A)</td>
<td>Involve chromosomes (G)</td>
</tr>
<tr>
<td>2 (2) Laborious learning of facts (A&amp;B)</td>
<td>Requires grasping of concepts and applying to other situations very stimulating (PL)</td>
</tr>
<tr>
<td>3 (3) Deal with facts: you know where you stand in exam</td>
<td>Opposite (Ps)</td>
</tr>
<tr>
<td>4 (4) Involve mathematics (pet hate) (B&amp;G)</td>
<td>Involves descriptive terms - very boring from revision viewpoint (A)</td>
</tr>
<tr>
<td>5 (5) Interesting interconnections demonstrated in labs - set rules can be seen (PL&amp;B)</td>
<td>No set rules - but generalisation</td>
</tr>
<tr>
<td>6 (6) Interesting links between subjects can be seen ... easy to concentrate on (G&amp;B)</td>
<td>Prefer hard facts subjects (Ps)</td>
</tr>
<tr>
<td>7 (7) Can be closely associated with HB (most important) (A&amp;PL)</td>
<td>Physiology looks at interactions on larger scale even more interesting (PL)</td>
</tr>
<tr>
<td>8 (8) Highly contentious subject - provoke discussion (G&amp;Ps)</td>
<td>Subject in its own right - but not interested in (Ps)</td>
</tr>
<tr>
<td></td>
<td>Has 'hard stand point' - discussion difficult since opinions don't exist - only facts (A)</td>
</tr>
</tbody>
</table>
9 (9) Featured all term - split work up too much (PL&B)

10 (10) Have to produce lab report - this is the hard work part (PL&Ps)

'Student 2'

11 (1) Link-up with other parts course (PL&A)

12 (2) Teach lab techniques atmosphere clinical (PL&B)

13 (3) Involve objects and materials. Finish expt then go (A&B)

14 (4) Course linked - one helps explain the other (G&B)

15 (5) Lab work in confining atmosphere. Finish and go early

16 (6) Results discussed (G&B)

17 (7) One helps explain the other (PL&A)

18 (8) Involve experimentation - help understanding of lectures (G&A)

19 (9) Hot labs - overbearing atmosphere (G&B)

20 (10) Good working conditions No VT intros (G&Ps)

'Blocks' ∴ can look at all terms/concepts and fully understand without having to worry about other parts course (G)

No report writing - material ... easily revisable for exams (G)

Abstract - does not link systems together (G)

Looks at 'structure' ∴ atmosphere not clinical (A)

Involves interaction with people, not objects (Ps)

Looks at structure and gross function; not chemical basis (A)

Easy-going atmosphere (Ps)

Time limited - emphasis on finishing experiment (PL)

More abstract - not related to other parts course (Ps)

Less scientific and precise - unpredictable (Ps)

Less so (Ps)

Learn many techniques in short space of time. VT take up lot of time (PL)
<table>
<thead>
<tr>
<th>Student 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 (1) Supervisors not helpful work boring/disillusioning (G&amp;PL)</td>
</tr>
<tr>
<td>22 (2) Interesting - involving all students (PL&amp;B)</td>
</tr>
<tr>
<td>23 (3) Have purpose - scientific and logical (A&amp;B)</td>
</tr>
<tr>
<td>24 (4) Long sessions involve thought and work; students get involved and obtain some knowledge (G&amp;B)</td>
</tr>
<tr>
<td>25 (5) Practical write-up often too high level for students - infuriating (PL&amp;B)</td>
</tr>
<tr>
<td>26 (6) Regard with awe (involve chemistry) difficult (B&amp;PL)</td>
</tr>
<tr>
<td>27 (7) Involve writing reports can always refer to them for exams etc useful (PL&amp;Ps)</td>
</tr>
<tr>
<td>28 (8) Make me disillusioned with course: poorly organised; lax attitude of staff (G&amp;Ps)</td>
</tr>
<tr>
<td>29 (9) Involve little thinking - enjoyable at time, but really boring (G&amp;Ps)</td>
</tr>
<tr>
<td>30 (10) Told what to do and left to get on with it little effort - done as quickly as possible since no-one encourages you or pushes you along (G&amp;Ps)</td>
</tr>
<tr>
<td>Student 4</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>31  (1) Look at body, how it works etc. Interesting (PL)</td>
</tr>
<tr>
<td>32  (2) Most interesting parts of course (PL&amp;A)</td>
</tr>
<tr>
<td>33  (3) Essential parts of course - relate together (B)</td>
</tr>
<tr>
<td>34  (4) Employ lab work to illustrate lectures - adds interest (G&amp;A)</td>
</tr>
<tr>
<td>35  (5) Look at how body works - applicable to rest of course (PL&amp;B)</td>
</tr>
<tr>
<td>36  (6) Involve high work load - practicals require write-ups (G&amp;PL)</td>
</tr>
<tr>
<td>37  (7) More useful - total knowledge in them limited (PL&amp;Ps)</td>
</tr>
<tr>
<td>38  (8) Involve understanding of brain (G&amp;PL)</td>
</tr>
<tr>
<td>39  (9) Lectures boring (G&amp;B)</td>
</tr>
<tr>
<td>40  (10) Unrelated - do not apply to each other (G&amp;PL)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>41  (1) Enjoyable - lecturers helpful interesting (PL&amp;A)</td>
</tr>
<tr>
<td>42  (2) Enjoyable - work interesting, less complicated, less of it (PL&amp;A)</td>
</tr>
</tbody>
</table>
43 (3) L boring; process badly planned.; uninteresting/ boring. Waste of 3 hours (B&Ps)

44 (4) Interesting (A&B)

45 (5) Involves human as whole man (PL&Ps)

46 (6) Interesting - :: preferred (PL&B)

47 (7) Concerned with structure and working of body - preferred (PL&A)

48 (8) Lecturers more interesting (A&Ps)

49 (9) Disliked - very difficult (G&B)

50 (10) Well organised - helps in understanding lectures. Lecturer helpful and interesting (PL&Ps)

51 (1) Make understanding of body more complete (PL&A)

52 (2) Parallel course - well presented, each stage leads to another (PL&A)

53 (3) Keeps students interested - variety - leads to knowledge (A&Ps)

54 (4) Not well presented or built into context of course (G&B)

Student 6

Abstract - not put into context of course by lecturer (G)

Not relative to course - not presented for HB understanding (B)

Totally irrelevant to HB course (B)

New ideas introduced - increases interest (A)
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<tr>
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<tbody>
<tr>
<td>55</td>
<td>(5) Presented badly - take no account of previous knowledge- treated like children (B&amp;Ps)</td>
</tr>
<tr>
<td></td>
<td>Makes students feel gain knowledge by own experience - enjoyable (PL)</td>
</tr>
<tr>
<td>56</td>
<td>(6) Boring - notes taken from course books - extra reading impossible (G&amp;B)</td>
</tr>
<tr>
<td></td>
<td>Practicals need reading to fix subject in mind - leads to encouragement to read (PL)</td>
</tr>
<tr>
<td>57</td>
<td>(7) Treated as adults (PL&amp;A)</td>
</tr>
<tr>
<td></td>
<td>Treated like children - some students thrive on it (Ps)</td>
</tr>
<tr>
<td>58</td>
<td>(8) Not related to rest of course too abstract (G&amp;Ps)</td>
</tr>
<tr>
<td></td>
<td>Related to course (A)</td>
</tr>
<tr>
<td>59</td>
<td>(9) Tedious - due to block system (G&amp;Ps)</td>
</tr>
<tr>
<td></td>
<td>Struggles throughout term - usually good (B)</td>
</tr>
<tr>
<td>60</td>
<td>(10) Extra work spread out - difficult to complete in time (don't know what to give in and when) (G&amp;Ps)</td>
</tr>
<tr>
<td></td>
<td>Extra work given and handed in within module time - no overlap of work with other modules (PL)</td>
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</table>

**Student 7**

<table>
<thead>
<tr>
<th>No.</th>
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<tbody>
<tr>
<td>61</td>
<td>(1) Interesting (due to presentation) - labs - involve investigating phenomena. Phys. workload is hard but OK (PL&amp;A)</td>
</tr>
<tr>
<td></td>
<td>Put across in boring way. Demonstrators labs - little involvement (G)</td>
</tr>
<tr>
<td>62</td>
<td>(2) Relate to human body. Interesting due to self-participation (PL&amp;A)</td>
</tr>
<tr>
<td></td>
<td>Boring - problems not discussed clearly (B)</td>
</tr>
<tr>
<td>63</td>
<td>(3) Involve the body (A&amp;B)</td>
</tr>
<tr>
<td></td>
<td>Done it already (Ps)</td>
</tr>
<tr>
<td>64</td>
<td>(4) Relate to body and disorders (G&amp;A)</td>
</tr>
<tr>
<td></td>
<td>Too fast to take notes - lecturer will not repeat points when asked to (B)</td>
</tr>
<tr>
<td>65</td>
<td>(5) Practicals interesting - tie in with class. Easy to understand (PL&amp;B)</td>
</tr>
<tr>
<td></td>
<td>Treated like children - not credited with one's intelligence (Ps)</td>
</tr>
<tr>
<td>No.</td>
<td>Comment</td>
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<tr>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td>66</td>
<td>Concerned with human body functions and effects of different disorders (PL&amp;B) Don't like 'blocks', i.e. A week's solid Genetics. Course 'slap happy' - not relevant to other work (G)</td>
</tr>
<tr>
<td>67</td>
<td>Should get more time - very important to HB (A&amp;PL) Not well organised. Some parts not taught clearly (Ps)</td>
</tr>
<tr>
<td>68</td>
<td>Badly presented. Lecturers are sarcastic; treat students like kids (G&amp;Ps) Sensibly presented and taught (A)</td>
</tr>
<tr>
<td>69</td>
<td>Not interesting, but appear to have most relevance to rest of course (G&amp;B) Could be tied in with rest course - less strain on students having too much (Ps)</td>
</tr>
<tr>
<td>70</td>
<td>Could be related if 'blocks' did not exist and more variety of classes available (G&amp;Ps) Staff aware of 'block' time table problem and try to overcome (PL)</td>
</tr>
<tr>
<td></td>
<td><strong>Student 8</strong></td>
</tr>
<tr>
<td>71</td>
<td>Made me more aware of similarities between them (PL&amp;A) A subject by itself (G)</td>
</tr>
<tr>
<td>72</td>
<td>I enjoy both (PL&amp;A) Not keen on (subject) (B)</td>
</tr>
<tr>
<td>73</td>
<td>Subjects I can understand (A&amp;B) Don't like... difficult to understand (Ps)</td>
</tr>
<tr>
<td>74</td>
<td>Interesting courses (G&amp;A) Lectures interesting, but no fluency in course (B)</td>
</tr>
<tr>
<td>75</td>
<td>Factual - don't get bored easily (PL&amp;B) Easily bored - difficult to understand (Ps)</td>
</tr>
<tr>
<td>76</td>
<td>Prefer to study - like the lectures and practicals (G&amp;PL) Will not get out of my way to study - boring practicals (B)</td>
</tr>
<tr>
<td>77</td>
<td>Make me more aware of functioning of human body (PL&amp;Ps) Poorly structured (A)</td>
</tr>
</tbody>
</table>
78 (8) Both relate to physical aspect of course and I enjoy (G&A) Difficult to understand theory as in texts: sub. by itself (Ps)

79 (9) Not disinterested - but would not do job in either (B&Ps) Interesting - sometimes mathematical - I enjoy (G)

80 (10) Would not do job in either - neither my favourite subject (G&Ps) Like to do job in - most favourite subject (PL)

Student 9

81 (1) Keen on these - become more involved in them (G&PL) Have gone off S due to labs - view of subject has changed (A)

82 (2) Not confusing (PL&A) Very confusing - too much to learn and take in (B)

83 (3) Explain how the body works (A&B) Not EP and makes the course more interesting (Ps)

84 (4) Lecture material can be applied in labs - we learn more (G&A) Cannot apply lecture material in labs (B)

85 (5) Involve just concentrating on lectures or lab work (PL&B) Involves going out and meeting public for course work (Ps)

86 (6) Go together - need knowledge of one to study other (PL&B) Can be studied on its own (G)

87 (7) Take more of our time (PL&A) Not major part of course (Ps)

88 (8) Involve labs - important to have labs in every subject (G&A) No labs - cannot apply what we learn in lectures (Ps)

89 (9) Involve no work outside labs or lectures (G&B) Involves essays, project etc - prefer this since have to think of study outside classes (Ps)
90 (10) Have learned more about these this term (PL&Ps)
Have not learned great deal about this (G)

Student 10

91 (1) Involves direct attachment to bodies, i.e. concrete objects (PL&A)
Involves concepts/factors not able to see (except through microscope) \*: more difficult to grasp (G)

92 (2) Concrete - see direct results (PL&A)
Abstract - chemical results \*: Difficult to understand (B)

93 (3) Involve body \*: Factuals (A&B)
Involve the mind \*: opinions play large part (Ps)

94 (4) Not pleasant - have to learn formulae etc. Can't discuss the subject (G&B)
Can discuss and work together in a group (A)

95 (5) Difficult \*: less enjoyable (PL&B)
Easier \*: more enjoyable (Ps)

96 (6) Don't have to evaluate results or use of imagination - BORING (G&B)
Results have to be thought about - harder but satisfying (PL)

97 (7) Atmosphere very strict - must be properly dressed-uneasy feeling - tense atmosphere (PL&A)
Easier atmosphere - relaxed because concepts involved are more familiar (Ps)

98 (8) More enjoyable because adventurous, i.e. exploring body/mind (A&Ps)
Boring, lots of facts without supportive evidence

99 (9) Make me more aware of the importance of chemistry in body (G&B)
Involves emotion - more aware of this (Ps)

100 (10) Isolated subjects, not supporting; if unlinked then uninteresting (G&Ps)
Brings together a whole field of study \*: more enjoyable (PL)
<table>
<thead>
<tr>
<th>Student 11</th>
<th>101 (1) Different parts of body and how they work (PL&amp;A)</th>
<th>Less distinct (G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>102 (2) Increase knowledge (and also as (1)) (PL&amp;A)</td>
<td>Lab work :: less interesting, but necessary (B)</td>
<td></td>
</tr>
<tr>
<td>103 (3) Concerned with everyday associations. Encourage you to think of your body (A&amp;Ps)</td>
<td>Abstract - but interesting results (B)</td>
<td></td>
</tr>
<tr>
<td>104 (4) Less background info. - concerned with details that cannot be readily seen (G&amp;B)</td>
<td>Interesting (A)</td>
<td></td>
</tr>
<tr>
<td>105 (5) Great importance attached, i.e. lengthy write-ups (PL&amp;B)</td>
<td>Little practical work (Ps)</td>
<td></td>
</tr>
<tr>
<td>106 (6) In HB department and with familiar lecturers (G&amp;PL)</td>
<td>Different departments - not familiar with (B)</td>
<td></td>
</tr>
<tr>
<td>107 (7) As (6) and have hard subjects throughout course (PL&amp;A)</td>
<td>Done in 'blocks' (Ps)</td>
<td></td>
</tr>
<tr>
<td>108 (8) Throughout course - concern body functions (G&amp;A)</td>
<td>In 'blocks' :: period of not being concerned with it :: less important to course (Ps)</td>
<td></td>
</tr>
<tr>
<td>109 (9) Interesting (G&amp;B)</td>
<td>Less 'hard' facts given (Ps)</td>
<td></td>
</tr>
<tr>
<td>110 (10) Lectures place more emphasis on these (by exam &amp; no lectures). Concerned with body :: interesting (G&amp;PL)</td>
<td>Less emphasis on these :: only one lecturer involved (Ps)</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Student 12 | 111 (1) More enjoyable - relate directly with HB (G&amp;A) | Not so enjoyable (PL) |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>(2) Consider the human body (A&amp;B)</td>
<td>PL course often difficult to fit in with lectures (PL)</td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>(3) Tangible/definite subjects; opinions don't exist - right and wrong do exist (A&amp;B)</td>
<td>Opinions - not clear cut, well defined reasons &amp; explanations (Ps)</td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>(4) Both enjoyable (G&amp;A)</td>
<td>Not enjoyable (B)</td>
<td></td>
</tr>
<tr>
<td>115</td>
<td>(5) Subjects interrelate - knowledge of one helps the other (PL&amp;B)</td>
<td>Does not interrelate (Ps)</td>
<td></td>
</tr>
<tr>
<td>116</td>
<td>(6) Preferred (G&amp;B)</td>
<td>Not preferred (PL)</td>
<td></td>
</tr>
<tr>
<td>117</td>
<td>(7) Link together well and in some block (PL&amp;A)</td>
<td>Not so enjoyable - does not link-up (Ps)</td>
<td></td>
</tr>
<tr>
<td>118</td>
<td>(8) Concerned directly with HB and man (G&amp;A)</td>
<td>Involves aspects not related to man :: not so applicable (Ps)</td>
<td></td>
</tr>
<tr>
<td>119</td>
<td>(9) Concerned directly with HB and man; more enjoyable (G&amp;B)</td>
<td>Involves aspects not related to man (Ps)</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>(10) More important for understanding HB (G&amp;PL)</td>
<td>Least preferred - not so applicable (Ps)</td>
<td></td>
</tr>
</tbody>
</table>

**Student 13**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>(1) Interesting - concepts difficult to grasp - many factors involved (G&amp;PL)</td>
<td>Not so interesting - involves more learning than understanding (A)</td>
<td></td>
</tr>
<tr>
<td>122</td>
<td>(2) Well organised - practicals and lectures relevant to each other (PL&amp;A)</td>
<td>Badly prepared - practicals detached from lectures (B)</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>(3) More 'biological' (than ¥) but involve drudgery in learning (A&amp;B)</td>
<td>Interesting with direct application to HB (Ps)</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>(4) Spend as little time as possible on these (A&amp;B)</td>
<td>Spend more time reading up on these (G)</td>
<td></td>
</tr>
</tbody>
</table>
125  (5) Practical work dull - ill prepared (B&Ps)  Lab exciting, well prepared and easily linked to practical problems (PL)

126  (6) Lecturers seem interested in their subject (G&PL)  Too many lectures; put little 'life' into subject (B)

127  (7) Problems difficult to solve. Require much thought and reading (PL&Ps)  No actual problems (A)

128  (8) Practical work enjoyable (G&Ps)  Dissection unpleasant, feel rushed to finish and clean up (A)

129  (9) Variety in lectures. Not always straight lectures - discussions, questions etc. (G&Ps)  Lectures always same - just writing down what lecturer says (B) (G&Ps)

130  (10) Lectures and labs always related to HB (G&PL)  Tenuous link to 'human behaviour in 'real life'. Little relevance (Ps)
COMPUTER OUTPUT FROM THE PREFAN ANALYSIS

Key to the computer output:

Item = Element

.: Item 1 = Genetics
Item 2 = Physiology lab course
Item 3 = Anatomy
Item 4 = Biochemistry
Item 5 = Psychology

Case = Student

e.g. Case 1, 7 refers to student one, construct seven

Because the constructs are in one long array, the numbering of them from one student to the next is cumulative, e.g. Case 3, 5 refers to student three, construct five, which is of course construct twenty-five in the array of 130 constructs.
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<td>5.251</td>
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<td>27.12</td>
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<td>TOTAL, ALL ITEMS</td>
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### FIRST THREE COMPONENTS

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### POLAR CO-ORDINATES

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### COMPONENTS AS PER PCT

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Component 1 with 3

Component 2 Loading

Component 3 Loading

1. Genetics
2. Physiology Lab
3. Anatomy
4. Biochemistry
5. Psychology
Appendix Four

Students' Q-sort scores of the 80 aims arranged by cluster
STUDENTS Q-SORT SCORES ON EACH OF THE 80 AIMS
ACCORDING TO CLUSTER

CLUSTER 1

Students: 1 5 12 14 19 17 * 4 8 10 15 20 22 * 11 21

a) Scores on the PERSONAL AIMS

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c) Scores on the INTELLECTUEL AIMS

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d) Scores on the VOCATIONAL AIMS

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#### b) Scores on the Social Aims

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#### c) Scores on the Intellectual Aims

| Student | AIM       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---------|-----------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|
| 8       |           | 4 | 5 | 3 | 5 | 2 | 6 | 7 | 4 | 7 | 7 | 8 | 8 | 7 | 6 | 6 | 6 | 4 | 7 | 5 | 8 | 6  |
| 15      |           | 7 | 5 | 3 | 5 | 4 | 7 | 4 | 3 | 7 | 6 | 6 | 5 | 1 | 4 | 6 | 2 | 4 | 1 | 6 | 3  |
| 10      |           | 6 | 3 | 4 | 1 | 6 | 5 | 5 | 6 | 4 | 5 | 2 | 7 | 3 | 6 | 4 | 3 | 4 | 2 | 4 | 7  |
| 17      |           | 3 | 2 | 7 | 0 | 6 | 6 | 3 | 3 | 4 | 3 | 4 | 5 | 5 | 6 | 3 | 8 | 4 | 8 | 4  |
| 20      |           | 4 | 6 | 4 | 6 | 5 | 2 | 1 | 2 | 3 | 7 | 3 | 4 | 4 | 7 | 6 | 6 | 8 | 8 | 6 | 5  |

#### d) Scores on the Vocational Aims

| Student | AIM       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---------|-----------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|
| 8       |           | 5 | 2 | 4 | 4 | 4 | 4 | 3 | 5 | 6 | 4 | 4 | 2 | 6 | 6 | 6 | 3 | 4 | 8 | 5 | 7  |
| 15      |           | 5 | 4 | 2 | 8 | 0 | 5 | 4 | 0 | 7 | 8 | 4 | 5 | 7 | 6 | 0 | 5 | 5 | 6 | 5 | 8  |
| 10      |           | 1 | 5 | 3 | 8 | 2 | 6 | 7 | 0 | 5 | 5 | 4 | 4 | 4 | 7 | 1 | 5 | 5 | 6 | 0 | 4  |
| 17      |           | 7 | 7 | 2 | 5 | 0 | 6 | 7 | 2 | 6 | 4 | 3 | 4 | 8 | 7 | 6 | 3 | 5 | 4 | 0 | 6  |
| 20      |           | 3 | 5 | 5 | 2 | 5 | 7 | 8 | 6 | 0 | 3 | 4 | 8 | 6 | 5 | 2 | 7 | 5 | 4 | 5  |