SELF-INSTRUCTION IN MEDICAL EDUCATION

by

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" I counsel you not to cumber yourself with words unless you are speaking to the blind. If however notwithstanding you wish to demonstrate to the ears rather than to the eyes of men, let your speech be of things of substance and natural things, and do not busy yourself in making enter by the ears things which have to do with eyes, for in this you will be far surpassed by the work of the painter."

Leonardo de Vinci
(as quoted by Drake 1963)

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2. PURPOSE AND SCOPE OF THESIS

2. PURPOSE AND SCOPE OF THESIS

This thesis reports a series of studies undertaken between 1968 and 1973 in collaboration with members of the departments of medicine and education in the University of Glasgow. The object of the work was to develop and test tape-slide presentations as an alternative to the traditional lecture in part of the fourth year of the medical curriculum.

The plan of the thesis is to present an historical review of techniques used in medical education, relating this to a need for new methods and to the fact that more students are now being pressed to cover an expanding syllabus on a relatively fixed university budget.

The section on methods includes a detailed description of the preparation and use of tape/slide presentations. The results section is concerned with their testing. It is with these aspects of the work that I have been most involved.

The discussion is concerned with issues raised during the work - the production of programmes, equipment, the theoretical aspects of educational technology and the significance and implications of the results. Finally, future developments are considered.

3. INTRODUCTORY REVIEW: LITERATURE ON TECHNIQUES IN MEDICAL EDUCATION

3.1 A NEED FOR CHANGE IN MEDICAL EDUCATION?

There are many problems in medical education today. First, there is an "information explosion" (Illingworth 1968); more and more facts are considered relevant to the undergraduate course. The process is not confined to medicine (see Hartley 1972). The effect on the medical curriculum is obvious. Among other things a first year medical student may learn 13,000 new terms (Bridge 1962).

Secondly, because there is a need for more doctors, both in this country (Miller 1966) and elsewhere (Gerber 1967) the number of students must increase. The Royal Commission on medical education (1968) recommended that the annual intake should be raised to about 5,000 by 1990 from the present figure of about 2,500 (1960/1961 2,020: 1966/1967 2,502). They suggested that, although a number of new schools would be needed, part of the increase could be met by expanding intake at established ones. In the city of Glasgow, for example, they felt that if the University of Strathclyde could provide a preclinical course in addition to the existing one run by the University of Glasgow the total annual intake could be raised from 200 to 275. Similar increases could be achieved at other centres. They conceded that a substantial rise in costs would result but they felt that if the medical schools were expanded as they recommended, "neither the cost of additional buildings nor the increase in medical school staff required need be proportionate to the increased number in undergraduate intake capacity".

Whatever the economic arguments it is likely that more students will converge on the same departments to cover an ever-expanding syllabus. Some of the congestion created could be relieved by pruning obsolete material from the syllabus (Illingworth 1964). Also, specialised training could be left until after graduation (Pickering 1956) but this might prolong the education of post-graduates into early middle age. Specialised training has already been described by Illingworth in 1968 as a race between the consultantship and the coronary.

3.2. EXISTING TEACHING METHODS

3.2.1 A THEORETICAL OR PRACTICAL BASIS FOR MEDICAL EDUCATION?

At present the clinical subjects are taught both formally (in lectures) and by clinical clerkship. The relative emphasis placed on each varies. In Glasgow, in the fourth year, it is on so-called integrated topic teaching by lectures and other forms of large group instruction such as demonstrations and seminars. Clinical work is confined to two hours each day (9-11 a.m.). (Although in his final year, a Glasgow student works as a junior houseman). In London, on the other hand, greater emphasis is placed on the clinical clerkship throughout the course and less on the formal lecture. In both situations however, although more so in London, the student has to accept a measure of responsibility for his own education and supplement the course by private study.

Although clinical teaching at the bedside is useful the most valuable experience is gained when students interview and examine patients themselves and most would accept that there is no substitute for this. In addition, a large amount of information has to be learnt by students and it is in this area that self-instruction may be useful.

In 1966, almost 2,000 final year medical students were asked by the Association of the Study of Medical Education (A.S.M.E.) and the National Foundation for Educational Research (N.F.E.R.) to complete a questionnaire on their own education. The results were published as a supplement to the report by the Royal Commission (1968). Students were asked to rank twelve methods of teaching in order of value. Their replies are shown in Table 1. Three points of interest emerge - the three clinical techniques involving contact with patients were in the upper five places. The only method of self-instruction considered, reading textbooks, was in second place. The formal lecture was ninth in the list of twelve.

3.2.2 THE LECTURE

Lectures are frequently criticised as being an inefficient means of transmitting information. McLeish (1968) found that students' attention declined after about fifteen minutes and one week later they remembered only 17% of what they had been taught and other studies have also cast doubt on the value of lectures. It was ranked only eighth in a survey of American college students (non-medical) who were asked to rank ten situations in order of their ability to stimulate mentally (Brinkley 1953). Seguin (1965) reported that the lectures in their course on psychology and psychiatry were considered "worse than useless" as the students

Table 1

"TEACHING METHODS"

(arranged in ranking order)

Bedside teaching	1
Reading textbooks	2
Working in wards	3
Group discussion	4
Working in out-patient department	5
Integrated topic teaching	6
Clinico-pathological conference	7
Practical class	8
Lecture	9
Research work	10
Medical film	11
Writing essays for tutor	12

Results of a survey of final year medical students carried out in 1966 by A.S.M.E. and N.F.E.R. for the Royal Commission on Medical Education.

misunderstood and misinterpretated according to their own preconceptions. Bligh (1972) has reviewed the literature on lectures fully and concludes that they can only effectively teach bare facts and that they are relatively ineffective in stimulating students to think or to change attitudes. A student (Lipkin 1969) has suggested that lectures are an inefficient substitute for reading, although they are possibly appropriate for new or controversial material. However, lectures may have a place at the beginning or end of a course to bring ideas together (Collins 1962).

Student criticisms often focus on poor lecturing technique: 80% of third year students at Illinois considered their lectures had been a waste of time and should either be abolished or improved (Samter et al. 1957); similarly in the Hale report (University Grant Committee 1964) on university teaching methods the students criticised the poor quality of lectures and felt too much emphasis was placed on them.

Clearly, lectures can be improved by good preparation and various other techniques (Hall and Wenzel 1964; Bligh 1972; Beard 1972; Brittin 1972). Students can actively participate during the lecture by being asked questions (Manning 1967; McCarthy 1970 and 1971; Barnhard 1971). The lecturer cannot know how students are progressing unless some feedback device is used. These vary from the direct question through an audience response card (Harden 1968) to more sophisticated devices (Bridgman 1964; Leytham 1970; Womersley et al 1972).

However, even perfect lectures tend to foster a rigid timetable and as will be discussed later (6.10) this may be more serious than the intrinsic faults of the lectures. It is pertinent therefore to consider alternative techniques.

3.3 SELF-INSTRUCTION: TECHNIQUES AND POTENTIAL

Although the potential of self-instruction is considerable, approaches have been fragmentary and this may have delayed its greater use (Lysaught 1969a). There are two broad aspects to consider: the design of the material and the method by which it is presented (books, booklets and a variety of audiovisual aids). The two are clearly related.

3.3.1 PROGRAMMED LEARNING

One form of self-instruction that has been widely used is programmed learning. A useful review of its approaches, characteristics and achievments has been provided by Macdonald-Ross (1969). Its application to medical education has been discussed by Jason (1965) and Lysaught (1968).

The principles of programmed learning are not new and it is interesting to look at the early teaching machines from which they developed. In the 1920's, Pressey (1926) developed a machine which was able to administer and score multiple-choice tests. Initially it was used to test students but with modifications, the student was made aware whether or not his answer was correct. It was then usable for teaching. Pressey foresaw the potential of such equipment and suggested that labour-saving devices in education should be practicable and should, instead of mechanising education, leave the teacher free for more important work (Pressey 1927).

Following this, there were no major developments until Skinner (1954) again focussed interest on teaching machines but for quite a different reason. From his experiments with pigeons he recognised the importance of positive reinforcement of a correct response. By feeding a hungry bird as soon as it made a movement in a particular (correct) direction it was possible to condition behaviour. In this way he was able, for instance, to make the bird turn through 360°, to pace the floor in a figure of eight and so on. More complex activities could also be produced: two pigeons could be taught to play competitive ping-pong by pecking a ball across a table. When the ball passed one pigeon, the victorious bird was fed.

Skinner then turned his attention to learning in schools. Fortunately feeding was not needed for reinforcement; praise and encouragement alone seemed sufficient. However, Skinner found that the value of these was often impaired by a long delay between the child's answer and the teacher's reaction. The size of classes was at fault since each response a child made could not be individually and speedily reinforced by the teacher as it was impossible to deal with a large number simultaneously. In practice therefore, positive reinforcements were relatively infrequent and often delayed.

To overcome these problems Skinner developed his teaching machines. If the child answered correctly he was reinforced (and encouraged) by a bell ringing and a new question was revealed. If he was wrong, another attempt had to be made at the same question. Skinner modified the design of the machine for use with older children and adults so they could write down the answer. They then operated a lever which turned on the paper roll to reveal the correct response and make it impossible for the student to alter his original answer (see Skinner 1958).

Skinner claimed the following advantages for his technique: reinforcement of the correct response was immediate, carefully designed material could be presented so that the solving of one problem led logically to the next; reinforcement was frequent and finally the individual could work at his own pace. In practice, manipulation of the machine seemed enjoyable for the user. The teacher was freed for more rewarding work.

For this study Skinner used a linear programme (illustrated diagrammatically in Fig. 1a) that is, one with only a single path which all students must follow. Most linear programmes are now presented in book form. McRae (1966) designed a machine with a larger frame size which could accommodate photographs (pasted on to the paper roll). It also incorporated a pointing device so that students could be asked to identify anatomical features on diagrams. Linear programmes have the disadvantage that the design may not suit every individual, faster students may require fewer frames and slower students may need additional teaching material. This objection applies to most forms of teaching.

Branching programmes offer a possible solution (a schematic form is shown in Fig. 1b, for more detailed examples see Crowder 1960; Owen et al 1964). The most direct path through the programme is still a linear one, but if errors are made, the student is diverted through a remedial sequence before rejoining the main stream (Crowder 1960). The branching format can be presented as a book ('scrambled book') (Berlyne 1966; Owen 1966) and at the end of each page the student is asked multiple choice questions.

A) LINEAR PROGRAMME

B) BRANCHING PROGRAMME

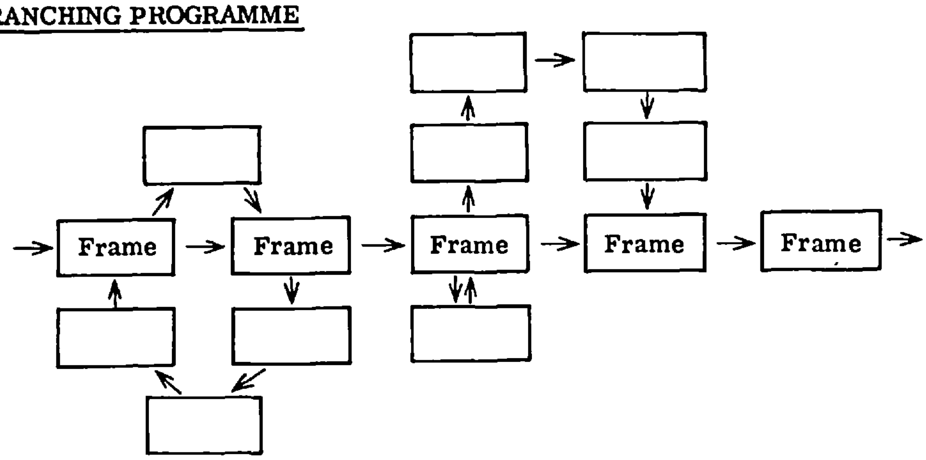


Fig. 1. A Frame is a section of the programme which contains teaching material and usually ends with a question. The answer is given on the next frame.

(Each possible answer refers the student to a different page.) If he is correct, he is told so and new information is given. If, he has made a mistake further explanations are given. He may then be returned to the main stream or he may have to pass through a remedial sequence.

Most teaching machines of the branching type (e.g. Grundy tutor see Owen et al 1964) are simply page-turning devices and the information is shown visually. The student selects his answer, pushes the appropriate button and the machine automatically finds and presents the next frame. A machine was developed in Sheffield (Annett 1963) which could present either a linear or a modified branching programme. Students were also able to "word" their own answers and thus the programme was not restricted to multiple-choice questions. The machine enabled some revision if the wrong answer was given but was not as flexible as a full branching programme.

In general, branching programmes are more versatile than linear programmes as they adapt themselves to the learner. They are also much more difficult to design. In Owen's (1966) programme on electrocardiography, for example, there were 604 frames, of which only 254 were the main (linear) teaching sequence, the remainder being remedial material. Although this programme was effective whether presented by machine or by a scrambled text (Owen et al 1965a and b; Stretton et al 1967) doubt has been cast on the efficacy of branching or scrambled textbooks for teaching adults. Thus a study of a "herring bone" branching programme by Biran and Pickering (1968) revealed that it was no more effective than a modified version in which all the remedial frames were placed together nor was the branching system superior to a straight linear version. The authors further suggested that 'scrambled' programmes may actually interfere with learning in adults.

Concepts of programmed learning have broadened considerably since 1960 (see Table 2). More emphasis has been placed on defining objectives following the work of Tyler (1949) and Mager (1962) (See 6.3.1). In addition many of Skinner's principles, for example the small step size, - have been questioned and modified (see Leith 1969). The design of programmes is now only part of a broader process which has come to be known as "educational technology".

The place of educational technology in medicine has been discussed by Jason (1968a) and Millard (1971). The former pointed out that medical education was generally thought of in the terms of the activities of the teacher (their lectures, ward rounds and so on) and less attention was paid both to the earlier planning stage, when the goals of the course were defined and specific objectives formulated and to the later stages of assessment when the course was evaluated.

3.3.2 PROGRAMMED LEARNING IN MEDICAL EDUCATION

The use of programmed learning in medical education has been fully reviewed (Weiss and Green 1962; Green and Weiss 1963; Allender 1964; Lysaught et al 1964a and b; Lancet 1965; Balson 1967; Blizard 1971).

It seems generally accepted that programmed material needs careful preparation (see Hector 1968) and there are useful texts

Table 2

CHANGING EMPHASIS OF PROGRAMMED LEARNING

1960	1963	1967	1971
Small steps	Task analysis	Task analysis	Systems analysis
Overt responses	Behavioural objectives	Behavioural objectives	Task analysis
Immediate feedback of results	Small steps	Subject analysis	Contrast analysis
Validation	Logical sequence	Flow charts	Behavioural objectives
	Active responding	Small steps	Structuring material (via analysis and synthesis)
	Self-pacing	Active responding	Appropriate teaching strategy
	Validation	Presentation as a communication problem	Controlled interaction via: digestible steps; appropriate stimulus content; relevant response modes; reinforcement
		Validation	Presentation as a communication problem
			Appropriate instrumentation
			Validation and evaluation
			Installation and implementation

Courtesy: Davies 1972

available commercially to help the beginner such as that by Markle (1969). However, because preparation of programmed material is time-consuming (6.1) most of the work in the field has been on an experimental basis where only a limited amount of a conventional course has been programmed (e.g. Peck and Benton 1970).

Programmes differ from textbooks in that they can be tested before publication; first on a small number of students to correct any deficiencies in the design of the material and then on larger groups to prove their efficiency. Thus some idea of their likely success can be given when the programme is mass-produced. Weller et al (1967) have described in detail the preparation and testing of their programme on the examination of the urinary deposit and similar studies have also been reported by Owen et al (1964 and 1965a and b) and Azneer et al (1968). A high level of success may be demonstrated using some programmes; Lagerkvist (1970) found that half their test class made less than one mistake in the written examination based on a programme in paediatrics.

Linear programmes are commonly used to teach factual information such as the basic definitions in psychiatry (Mathis et al 1966). Wilds and Zachert (1967a) used their linear programme on gynaecological oncology in a similar way. Programmes need not be limited to this and application of knowledge and ability to solve problems can also be taught. (see Wilds and Zachert 1965; Wilds and Zachert 1967b). The linear programmes prepared by us in Glasgow involve problem solving as well as learning factual information (see Harden et al 1969e) and 4.2.2.4)

Branched programmes can also be designed to teach factual medical knowledge (R.N. Smith 1971) and problem solving (see Owen 1966; Berlyne 1966).

In addition to retention of knowledge, students may also perform better in a related practical skill as was suggested by Reinecke (1967) in his studies on a linear programme in ophthalmology.

Programmed texts can be particularly useful in courses where students start with varying degrees of background knowledge (Gildenberg 1967; Hawkridge and Mitchell 1967; Buckley-Sharp et al 1969; Castle and Davidson 1969). This could be important at the beginning of a course.

In haematology, Harris and his colleagues (Harris et al 1962; Harris and Horrigan 1963) integrated their programmes (involving problem solving in detailed case presentations) into a carefully designed course which included assigned readings, clinico-pathological conferences, small-group discussions and laboratory experiments. In addition, practical laboratory work can be handled in this way and the student can be guided through a course of self-instruction which involves not only reading, listening to audiotapes and watching film loops, but also performing experiments (Postlethwait 1965) or examining histological slides (Zollinger 1972a; Carter et al 1973). In a similar way, the pathology museum can be designed to actively involve students by arranging the material carefully and asking questions on the specimens (Sobin 1968).

It is more difficult to programme clinical bedside medicine. The art of interviewing a patient has been outlined in a programmed text which has objectives far beyond factual recall (Froelich 1966). The value of this approach must be limited and students gain much more insight when they interview patients themselves.

Programmed texts may also be valuable if teaching staff are not available. Hawkridge and Nelms (1968) reported the successful use of a published programme to teach biostatistics to their students in Rhodesia.

The volume of literature referred to indicates a widespread use of programmed material in medical education. The sparser evidence on its effectiveness is considered later (see discussion 6.6).

Programmes produced in one institution are often not used elsewhere. This is unfortunate, exchange between centres must increase because the costs of producing a programme (see 5.7) greatly exceed those of duplication and distribution. That transfer is possible has been demonstrated: Kent et al (1972) reported that comparable results in examination marks, time and students' attitudes were achieved in a second institution and Wilds and Zachert (1967a) also found similar encouraging results. In addition some programme texts are available commercially (Owen 1966; Berlyne 1966) and journals may also contain programmes as part of a continuing education course (Lemberg et al 1971).

Programmes are most commonly presented in the form of a written text. However, a variety of audiovisual techniques have been used as an alternative. Eaton et al (1964) used slides during the developmental stage and slides may be of particular value in subjects where there is a strong visual element such as histopathology (Carter et al 1973). In Glasgow, we used the combination of audiotape, 35 mm slides (and an answer sheet) (Harden et al 1969b). The advantages of this approach are discussed in the next section (3.3.3). Other techniques include programmed films (Huber 1966 and 1967; West and Stickley 1965) and models associated with a programmed text (Scott and Lang 1967).

3.3.3. SELF-INSTRUCTION BY AUDIOVISUAL TECHNIQUES

There is a wide choice of techniques available (Table 3). The book is one of the most obvious methods and was ranked second by students in the A.S.M.E. and N.F.E.R. survey (Table 1). However the usefulness and place of the textbook has been questioned by some although it was conceded that the role of the book, at present, was assured (Dudley 1966). I do not propose to consider books further in this thesis as, in my view, they are complementary to all other forms of teaching. There is no question of their being replaced by some other technique.

The question at issue is whether the audiovisual approach has any advantages compared with the traditional lecture. The Brynmor-Jones Committee on Audio-visual Aids in Higher Scientific Education (see University Grants Committee et al 1965) seemed convinced that audiovisual aids could "help to improve the quality of learning and to ease and enrich learning processes". Similarly a survey carried out by the British Medical Students' Association (1965) recommended that greater use should be made of audiovisual aids in medical teaching.

Table 3

SELF-INSTRUCTION: TECHNIQUES AVAILABLE

Print -	text books programmed texts
Non-projected aids, e.g.	display boards models
Sill pictures -	slides photographs microfiche
Audiotape -	alone with slides
Film -	16 mm 8 mm
Television -	closed circuit videotape broadcast cassette

Radio and telephone conferences

Computers

Simulation techniques

The theoretical aspect can be considered by examining the advantages in medicine of vision alone, sound alone and both in combination. The practical side, particularly the assessment of one technique, the tape-slide presentation is considered in the discussion.

Clinical medicine is essentially auditory and visual; the best way of understanding myxoedema is to watch and listen to a patient with the disease. Though ideal, this is not always possible: scrutiny by large numbers of students may be difficult or embarrassing as, in other disorders, with sigmoidoscopy, gastroscopy and ophthalmoloscopy. Though visible, a lesion may not be readily identifiable; the microaneurysms in the fundus of a diabetic are an example. Also, there are conditions so rare that students may not see them during their clinical course.

Visual aids could help with all of these difficulties. A diabetic fundus could be seen, first on a colour slide or photograph with the lesion clearly identified, and then in a patient through an ophthalmoscope. Features of some diseases change with time: acromegaly and thyrotoxicosis are instances and the sequence of changes can be well demonstrated by photographs. Clinical bedside teaching can also be reinforced by supplementary colour slides and 8 mm films (Russell 1958).

Many laboratory investigations can only be shown visually and slides provide a convenient way of demonstrating X-rays, histological specimens, haematological slides and E.C.G.'s. If necessary, the lesion can be labelled or a question and answer technique can be used where the lesion is not identified in the first (question) slide but is clearly marked in the second (answer) one. Side-room tests such as the examination of the urinary deposit, can also be demonstrated by slides (Weller et al 1967). In some instances it may be better to use originals, radiologists for example may prefer X-rays to photographs or slides of them.

For people who learn better using their eyes illustrations can aid memory (Robson and Treadgold 1960; Kapandji 1964), convey the tone of an argument (Clark-Kennedy 1955; Treadgold 1962) and summarise data (Drake 1954).

Pictures have a great potential in our experience (see results 5.2.4). Thus a photograph comparing a normal kidney with a small contracted one conveys the message far more vividly than a lengthy description. It is easier to understand the feedback mechanism of the adrenal cortex with the hypothalamus if shown visually. The same diagram can be modified to show the effects of various abnormalities such as bilateral adrenal hyperplasia, adrenal tumours and so on.

Sound also has potential when used on its own (Graves 1962) or in combination. Recordings of heart sounds are an effective means of teaching a difficult subject when combined with orthodox auscultation (see Grace 1970). An excellent series of tapes containing heart sounds made on a simulator (released by Merck, Sharp and Dohme U.S.A. Ltd.) is distributed in this country by the Medical Recording Service Foundation. Breath sounds can be recorded in a similar way (Cugell 1971). Although Ward and Orr (1972) consider that to avoid distortion of both cardiac and respiratory sounds they should be heard through a stethoscope and they describe a unit which allows students to hear recorded tapes in this way.

Sound recordings can also illustrate abnormal speech such as the voice in hypothyroidism or the dysarthrias. Case histories of a personal nature (gynaecology or venereal disease) can also be heard in this way (Russell 1966). Finally sound has the ability to convey the personality and enthusiasm of an expert better than the printed word.

It is often suggested that learning can be improved by appealing to the ears and eyes together. The idea is not new, in the seventeenth century Stratenus proposed that teaching was more effective when both 'auditive' and 'visual' methods were used (see Sanazaro 1960). Sound and vision can be used together so that the breath sounds are heard while the pattern of air flow or tidal volume is displayed on a monitor (Cugell 1971). Similarly, the phonocardiogram can be linked with the heart sounds (McGuire et al 1964). Adolph and Campbell (1971) have refined this technique so that only a portion of the cardiac cycle is heard while the rest is muted so that students can concentrate selectively on different parts of the cycle.

The combined approach also enables a student to study a visual, e.g. an E.C.G. tracing, without having to take his eyes off the tracing; similarly he can examine a microscope slide of a histological section (Fletcher and Watson 1968).

Application of audiovisual techniques to medical education is dealt with in a number of publications (Warner and Bowers 1956; Orr 1962; Graves 1966; Broadbent 1967; Engel 1967; Jason 1968b; Romano 1968; Alberti 1969; Lysaught 1969b; Blizard 1972).

Recently, a steering committee from the Association of Medical Colleges has examined, in some depth, the place and implementation of educational technology in American Medical School (J. Med. Educ. 1973).

The ideal audiovisual technique for a course is partly determined by its objectives and its nature. For the fourth year course in Glasgow we chose tape-slide presentations. Other audiovisual techniques are available; some like 16mm film and television are generally used within a conventional course, they are therefore largely excluded from the main review on self-instruction and the appropriate literature is contained in an appendix (A), subdivided by subject for ease of reference. Others, such as 8mm film, computers and the multimedia approach are appropriate for self-instruction, although not strictly relevant to the theme in this thesis. These are considered briefly and their references are contained within the main bibliography. I propose to consider these first and then the literature on tape-slide presentations in greater detail. The final part of the introductory review is concerned with earlier work on tape-slide presentations at the Western Infirmary, Glasgow.

3.3.3.1 <u>Models and other simple techniques</u>

These include blackboards, overhead projectors and diazo overlays. Most of these aids are used to illustrate a conventional course and some references to the literature are listed in Table 4 (the details of these publications are in appendix A).

Models have been used in conjunction with a programmed text (Scott and Lang 1967) and they can be designed to enable students

Table 4

MODELS AND OTHER SIMPLE TECHNIQUES

Subject	First Author and Date
a) within the conventional course*	
Blackboard	Barabas 1965
Overhead projector	Golden 1973
Diazo overlays	Gardner 1960
Models	Barnett 1956, Hytten 1956, Moore 1956, Kindred 1958, Erskine 1960, Andrew 1961, Huber 1963, Kapandji 1967, West 1967, McRae 1968, Garston 1970, Griffiths 1970, Griffiths 1972, Hubbard 1973
b) for self-instruction**	
Models	Plunkett 1966, Graves 1967, Scott 1967, Penta 1973

* details of publications - in Appendix A

** details of publications - in main bibliography to teach themselves a practical procedure such as external cardiac massage (Plunkett 1966); the National Institute of Health in the U.S.A. uses imitation plastic eyes, which can be looked at through an ophthalmoscope, to simulate the appearances of retinal disease (see Graves 1967). At Illinois, similar models (and other simulation techniques) were found to significantly improve the performance of a randomly selected experimental group (Penta and Kofman 1973).

3.3.3.2 <u>Slides and photographs</u>

Slides are most commonly used to illustrate the conventional lecture, less often in clinical teaching and in practical classes such as histology. The subject is a large one and some references to it are contained in Table 5 (see also appendix A).

Colour microfiche has been used for self-instruction in pathology (Smith 1971a and b; Smith 1972). In this study, 84 lesions (clinical photographs and text were included in addition to the gross and histological sections) were covered in 20 cards. A single 4" x 6" card contained 60 photographs and these could be bought by the students. Microfiche is not used extensively in this country for medical education and it is difficult to see any major advantage over 35mm slides. Another technique, also used for self-instruction in pathology, is the stereo-reel (David 1967). The pictures are seen in 3 dimensions which may be helpful in a subject such as pathology. However, specialised equipment is required for their preparation and again the standard 35mm slide would seem preferable.

Table 5

SLIDES AND PHOTOGRAPHS

Subject	First Author and Date
Within the conventional course*	
Slides in: Clinical teaching	Russell 1966
Pathology	Koprowska 1964
Histology	Stinson 1968, Fitzgerald 1972
Radiology	Schwarz 1970
Haematology	Keitges 1971
Examinations	Levan 1966, Ackerman 1967
For self-instruction**	
Colour microfiche	Smith 1971a and b, and 1972
Stereo reel	David 1967
Display boards	Russell 1956, 1958, 1959 Joseph 1958, Backett 1960 Lunnon 1965, Plunkett 1966, Alberti 1969, Duncan 1969, Levinson 1970

* details of publications in Appendix A

** details of publications in main bibliography

Display boards, containing photographic prints, can also provide self-instructional material (Russell et al 1956; Russell 1958; Joseph and Mackeith 1958; Russell et al 1959; Backett 1960; Lunnon 1965; Plunkett 1966; Alberti 1969; Duncan 1969; Levinson 1970). The amount of material that can be presented is restricted only by the number of panels used and these can be changed regularly. Static displays of this kind can provide a valuable adjunt for self-instruction. However, used alone, they are not as flexible as other forms (tape-slide presentations, 8mm film) as the students can only study the topics currently on display which may prevent them from using material more appropriate to their own particular needs.

3.3.3.3 <u>Film</u>

The main advantage of film is its capacity to show motion and it is therefore of particular value in subjects where this is an important feature (such as chorea, Mackeith 1954 Table 6). In common with television, film has other attractive features (see Foy and Leach 1969) such as the capacity to slow down or accelerate movement, to condense sequences (and thus save teaching time) to make complicated relationships more evident and diagrams and animation can both be included. Finally both film and television can show events which are normally outside the scope of the conventional course. Film is cheaper than television because the capital outlay is less and in addition its definition of picture is superior. Finally, colour films can be produced at a moderate cost.

16mm film was only appropriate for group instruction and is not considered further here (see Table 6 and appendix A).

Table 6

FILM

Subject	First Author and Date
16mm Film	
General overview	Wakerlin 1971
Use and availability	Collard 1954, Markee 1959, Whyte 1962, Mulvihill 1968, Engel 1969, Fonkalsrud 1971, A.V. Communication Bulletin (B.M.A.) 1973.
Advantages and importance of production techniques	Longland 1944, Stanford 1944, Anderson 1950, Ollerenshaw 1951, Leveridge 1963, Audouze 1965, Gueguen 1968, Germouty 1969, Wadsworth 1969
Use in clinical teaching	Mackeith 1954, Creer 1968, Goodenday 1968, Germouty 1970, Chez 1971
Evaluation of film	Steinberg 1951, Cardew 1953, Humphreys 1965, Hayden 1967, Merrill 1969
Film used for testing clinical skill	Cline 1961, Langsley 1970
8mm Film	
Advantages	McRae 1964, Foy 1969
Production	McRae 1965, Barrows 1968, Duncan 1969 Cardew 1970, Welser 1970
Use: Demonstrations	Foy 1969, Jepson 1969
Pre-clinical	Huber 1966,1967, West 1968,
Clinical medicine	North 1967, Barrows 1968
Evaluation	Barrows 1968, Welser 1970
Potential use	Silvertson 1969.
Programmed	Huber 1966,1967, West 1968

16mm film is excluded from the main review as it is not used for self-instruction: the details of the publications are in Appendix A.

8mm is appropriate for self-instruction: details of its publications are in the main bibliography.

However, 8mm film which is cassette loaded provides material in a form suitable for self-instruction (McRae 1964). It is appropriate for both the pre-clinical (Huber 1966 and 1967; West and Stickley 1965; Foy and Leach 1969) and clinical subjects (North 1967; Barrows 1968); demonstrations can be clearly seen (Jepson and Pearson 1969). Its value can be increased by programming the material (Huber 1966 and 1967; West and Stickley 1965). A disadvantage of 8mm film is that it offers only limited possibilities for editing and making satisfactory copies (Cardew 1970), unless an internegative or print master is used (Welser 1970) or the copies are transcribed from an edited 16mm master (Duncan 1969).

8mm films therefore can provide a useful source of theoretical and practical information for self-instruction. They are of particular value where motion is an important feature; for this reason they often form part of a 'multimedia' course (see 3.3.3.8) in combination with other techniques.

3.3.3.4 <u>Television</u>

Television has been widely used (though infrequently assessed) in medical education; closed-circuit television (C.C.T.V.) and videotape recordings for undergraduates and broadcast television for doctors. It has a vast literature and some of the references are classified in Table 7. It has a number of advantages: it can reach a wide audience. The image can be magnified (useful in subjects such as anatomy and histology) and also multiplied to a number of monitors so that a large group can see a demonstration clearly. Pictures can be relayed over a distance; this may be an aid to privacy, e.g. in a psychiatric interview, or

Table 7

TELEVISION IN MEDICAL EDUCATION

Subject	First Author and Date
Facilities in different centres:	Agnello 1965, Romano 1967, Heinivaara 1968, Marshall 1969
Planning of network:	Rising 1963, Lewis 1969a and b, Olson 1971
General review and potential:	Lancet 1961, Engel 1963, Rising 1963, Merrill 1963, Ramey 1964, Harris 1966, Scot. Med. J. 1966, Green 1967, Romano 1967, Meyrick 1968, Judge 1968, Robertson 1968 Huber 1968, Lewis 1968, Gregg 1969, Maclean 1969, Marshall 1969, Benoit 1970, Olson 1970
Production of programmes:	Roy 1964, Lennox 1965, Groom 1966, Brit. Med. J. 1965, Wilmer 1967, Canad. Med. Ass. J. 1968a and b, Anderson 1969
Use: In pre-clinical course:	
Anatomy	Potts 1969, Metcalf 1970
In demonstrations	Geddes 1959, Keasling 1959, McGuire 1961, Samson 1964, Scott 1964, Gasking 1967, Harris 1969, Millington 1969, Rogers 1969, Scott 1970, Okagaki 1971, Gasser 1972
In clinical course:	
Medicine	Torkelson 1967, Wagner 1967, Jason 1971, Stoeckle 1971, Mai 1972, Enelow 1970, Adler 1970
Surgery: teaching	Torkelson 1967, Goldman 1969, Keggi 1970, Goldman 1972
demonstration of operations	Trimble 1947, Ruhe 1957, Soulas 1957, Heiss 1964, Gregg 1969, Hansell 1971
Dental surgery	Kramer 1965, Nairn 1965, Messing 1970, Robinson 1973
Emergency care	Peltier 1969, Keggi 1970, Geertsma 1970
Psychiatry	Ruhe 1960, Moore 1961, Kornfeld 1964, Benschoter 1965, Yonge 1965, Suess 1966, Wilmer 1967, Sclare 1968, Barnes 1969, Gibbard 1969, Rosenberg 1970, Ryan 1970, Suess 1970, Miller 1972, Tupin 1972, Moore 1965, Geertsma 1965
Radiology	Davidson 1970

Subject	First Author and Date
To standardise variation In Examinations:	Hess 1969 Waugh 1969 Wilson 1969
In Psychotherapy:	Michaux 1953
Televised examinations:	Markee 1962 Markee 1965
Evaluation of effectiveness:	McGuire 1961 Staub 1963 Samson 1964 Smith 1965, 1966 Sclare 1968 Cantrell 1969 Kenmure 1969 Bach 1971
Exchange of Videotapes:	Leslie 1972
C.C.T.V. for post-graduate courses:	Clarke 1971
Cassette television:	Benoit 1970 Fonkalsrud 1971 Yarborough 1971
Broadcast television:	Castle 1963 Groom 1963 Michael 1963 Abbey 1964 McGuinness 1964 Moses 1965 McGuinness 1965 Cameron 1966 Bell 1966 Menzel 1966a,b Lancet 1966 Smart 1966 Meighan 1967 Brayton 1968a,b McGuinness 1968 Robertson 1968 Lancet 1968 Vaillancourt 1968 Brayton 1969 Fahs 1970 Mock 1970 Trinca 1970 Smith 1971 Walker 1971 Driver 1972 Hufhines 1972 Hunter 1972
Colour television: (alternative solution)	Elsom 1951 Holleb 1954 Lancet 1957 Schafer 1963 Knothe 1969 Platzer 1966 Harris 1969

These references are contained in Appendix A as the papers are not strictly relevant to self-instruction.

be of benefit in reducing infection in surgery by removing the audience from the operating theatre. The scope of presentation can be increased by 'filming' in different locations. Videotapes can be prepared in advance, thus recordings can be made of special techniques or of events (e.g. emergencies) which occur only rarely or at inconvenient times. In addition, unlike film, it is easy to check if the recording is satisfactory because of its capacity for 'instant' replay.

However, television is expensive. Also, in its present form, it is unsuitable for self-instruction, although the recent development of cassette television could make it as easily and widely used as 8mm film. Programmed material could also be presented as the frames can be advanced one at a time. Assessment is needed on whether it would confer greater benefit, at a competitive price, than the simpler techniques such as tape-slide presentations. An important consideration will be the availability of programmes; this will have to be resolved either by the production of new ones or by making existing material (videotapes, 8mm film, tape-slide presentation) available in a suitable form. The place and use of cassette television has yet to be evaluated.

3.3.3.5 Radio and telephone

Both radio and the telephone have been used in postgraduate and continuing education (see Table 8). However, like broadcast television they are not really appropriate for self-instruction as the listener can choose neither the topic nor the time he studies. However, many of the talks are pre-recorded on audiotape which could provide additional material for independent learning (Graves 1967).

Table 8

RADIO AND TELEPHONE *

Subject	First Author and Date
Broadcast Radio	Med. J. Aust. 1970
Two-way Radio	
Advantages and use	Woolsey 1958, Pratt 1959, Woolsey 1960, Ebbert 1963, Bergen 1966
Disadvantages	Denne 1972
Telephone	Balint 1964, Meyer 1968a and b, Ingall 1972, Evans 1972

* details of the publications are contained in appendix A

3.3.3.6 Audiotape alone

As indicated, sound recordings have a number of applications in medical education. Within the conventional course, they have also been used as an aid in teaching the medical interview (see appendix A and Table 9). Used alone, they can also provide a source of material for self-instruction (Pickney 1961: Aitken 1964). An alleged advantage of this approach is that they can be listened to at any time - even when driving a car. Although, in my view, their value if used in this way remains debatable. In Winconsin (Meyer et al 1970) doctors could telephone to a centre at any time and listen to a short (4-6 minutes) audiotape of their choice. About 50% of requests came from doctors with a specific management problem and the remainder simply for self-instruction.

Audiotape can be useful in pathology museums (Scott 1970) where a cassette recorder can be used to provide a commentary on the exhibits in much the same way as in an art gallery. In Denmark, where it was used in a postgraduate course, it was found to be an effective way of teaching (Birn and Christophersen 1973). However, unless the eyes are occupied, as in the above examples, visual distractions are more likely to occur (see Macbeth 1960) and therefore for self-instruction a combined audiovisual approach is probably superior.

3.3.3.7 Computer

As Peterson (1964) points out doctors probably use different logic systems to make diagnoses and to decide on treatment and, at present, there is little attempt to teach this during the undergraduate course. It is in this field that the computer may have great potential. However, it is unlikely, because of the

Table 9

AUDIOTAPE

Subject	First Author and Date
Within the conventional course*	
As an aid:	
to bedside teaching	Grace 1970
to teaching techniques of medical interview	Brissenden 1959, Morgan 1972 Mai 1972, Tapia 1972
in supervision of psychotherapy	Beiser 1966
For self-instruction**	
As a source of information	Pickney 1961, Aitken 1964, Meyer 1970
In pathology museums	Scott 1970, Birn 1973

* for details of literature see Appendix A

** for details of literature see main bibliography high costs involved, that the computer could be used as a prime source of information; this would have to be obtained from simpler techniques; reading, tape-slide presentations and so on. Once the student had acquired the necessary background knowledge he could then test his diagnostic ability on a computer. As Table 10 indicates the major application of the computer has been in this type of problem solving. Unless the capacity of the computer, to react, adapt and provide additional assistance for individual students as necessary, is exploited it becomes an expensive and unnecessary cumbersome means of communication. Thus, it could be a valuable adjunt to other self-instructional techniques and could teach students skills, e.g. problem solving, which are difficult to handle satisfactorily in the present system, for example simulated patients can be allowed to die if the student takes the wrong decision. Further assessment of the role of the computer in medical education is needed.

3.3.3.8 Combination of techniques: Multimedia

Just as in conventional medical education (lectures, texts and clinical work), the new techniques need not be used in isolation and good results may be achieved with the so-called "multimedia" approach. This avoids the common tendency to regard each new technique as a solution to all problems in medical education. In practice no single technique, new or old, seems a universal panacea and an important problem for the future will be to identify areas in which the particular methods excel.

Postlethwait (1965) pioneered the approach of self-instruction to a complete course in biology at Purdue. He adopted a multi-media approach and in the teaching laboratory the student's work was guided by an audiotape which directed him to textbooks,

Table 10

COMPUTER *

Subject	First Author and Date
General review	Atkinson 1968, Alpert 1970
Potential in medical education	Ovenstone 1966, Starkweather 1967 Taylor 1972
Use:	
Diagnosis and management of clinical problems	Entwisle 1963, Swets 1965, Fonkalsrud 1967, Schorow 1967, Budkin 1968, de Dombal 1969a, b, Harless 1971, Hoffer 1972, Schneidermann 1972, Friedman 1973
Pathology: diagnosis of clinico-pathological cases	Bowden 1967
Bacteriology: identification of bacteria	Grimes 1972
Haematology	Gilchrest 1972
Practical skills: (intubation in anaesthetics)	Abrahamson 1969, Denson 1969
As a testing device	Bowden 1967, Nishimoto 1972
Evaluation of its effectiveness	Thies 1969, de Dombal 1971, 1972
'Tutorial' function	Weber 1972
Costs	Kopstein 1968, Alpert 1970
Preparation of material	Harless 1967
Simplified systems	Starkweather 1967, Brown 1968, Harless 1971, Gilchrest 1972, Weber 1972

* details of the publications are in the main bibliography

journals, short films for further study. His activities ranged from listening to short lectures on audiotape, looking at demonstrations, microscope work, dissection, discussion with fellow students or the instructor - who was available for consultation - (2 or 3 instructors could handle a large class). After each assignment the student was quizzed by an instructor. Theoretical and practical work were thus integrated. Postlethwait et al (1972) have described the system and its potential in greater depth in a stimulating book.

A similar approach has been used for the six week course in obstetrics and gynaecology in Pittsburgh (Chez and Hutchinson 1969; Chez and Kubiak 1970). The student was again guided by audiotape through a course which took about 30-36 hours to complete. The self-instructional material included slides, 8mm film, models, X-rays, textbooks and reprints. The instructors, relieved of lecturing, acted as tutors to small groups of students.

Ralston and Kochhar (1971) have developed an audiotutorial course in microscopic anatomy which correlated both the theoretical and practical aspects. The information was provided by textbooks, work sheets, photographic and microscopic slides. After each assignment the student completed a written test and then was quizzed orally and practically by an instructor; thus all students met staff members individually and the longest time was spent with the weakest student. One lecture was given weekly mainly as a stimulus.

Other subjects have also adopted a multimedia system including infectious diseases (Martin 1964) and practical laboratory skills in haematology (Fieland Ways 1972).

The major advantage of these courses is the flexibility they allow within the curriculum. Students can study in their own time and can integrate their theoretical with their practical work; they become more responsible for their own learning as they are actively involved. Staff time is also spent more profitably.

3.3.3.9 Other forms of self-instruction

"Self-instruction" is usually taken to include any form of education without an instructor. Most of the commoner forms (excluding the textbook) are considered in previous sections. There remain a few rarely used techniques which are considered briefly below. (Appendix A contains some of the relevant literature).

3.3.3.9,1 Role-playing and simulation techniques. Any medical student taking a history from a patient is playing the "role" of the qualified doctor. Role-playing of this type, even in the absence of 'real' patients has been used to teach students the skill of interviewing in both medicine and psychiatry. In addition, "patients" have been trained to simulate a disease for teaching or examination purposes. Both these techniques usually form part of a conventional course and their literature is summarised in Table 11.

3.3.3.9,2 Instruction by self-assessment. In the undergraduate course examinations provide a strong stimulus for students to learn. However, it has recently been appreciated that this means of evaluation should not end with the final diploma and tests have been introduced in the U.S.A. which enable doctors to assess themselves privately. Some of the key references to this form

Table 11

OTHER FORMS OF SELF-INSTRUCTION*

Subject	First Author and Date
Role-playing and other simulation techniques	Gordon 1960, Barrows 1964, Bowker 1964, Barrows 1967, 1968 Ramey 1968, Froelich 1969, Levine 1970, Bamford 1971, Hersh 1971, Lamont 1972, Meadow 1972
Games	Smith 1972
Self-assessment:	
in continuing education	Rosenow 1969, Carmichael 1970, Eisenberg 1970, Rosenow 1970, Rosato 1972, Tovell 1972
in post graduate education	Ferrer 1969
in the undergraduate course	Olsen 1968, Fleisher 1972
Simulated patient management problems	Rimoldi 1963a and b, Williamson 1965, McCarthy 1967, Williamson 1967, de Dombal 1971, Andrew 1972 Sedlacek 1972

* Details of publications in Appendix A

of self-assessment are listed in Table 11.

'Games' are also becoming more widely used in education (see Beard 1972) but, so far, have had little application in medicine with the exception of the simulated patient management problems. These pose clinical problems for diagnosis and management in much the same manner as for a computer. The form of presentation varies with the different systems. Some of the references are contained in appendix A. (Table 11).

3.3.3.10 Self-instruction for patients

Although this thesis is primarily concerned with undergraduate education, a further important potential of some of the self-instructional techniques is in teaching patients more about their own disease. This can be done with illustrated booklets (MacKeith 1951) or in the form of comics for children (Treadgold 1960). Audiotape has also been used (Midgley and Macrae 1971).

A programmed text has been found valuable in the self-education of diabetic patients (Spiegel 1967). Another study (Etzwiler and Robb 1972) which presented the programmed material to diabetics by teaching machine also found their factual knowledge was increased although there was no objective evidence (from blood or urine tests) of any improvement in the control of their diabetic state.

3.3.3.11 The combination of audiotape with visual aids

Audiotape can be combined with a variety of visual material, including print, 35mm slides or microscope slides.

Asher (1962) used audiotape with a folder of printed notes and diagrams, although the latter had to be returned after the presentation. Engel (1971) advocates the use of a notebook containing illustrative material which the student can keep. He also claims that slides add to the complexity of a system as students require a viewer. However, a cassette recorder is already necessary so that the addition of a simple hand viewer does not increase greatly either the cost or the inconvenience of the system. A disadvantage of many tape-slide programmes as Engel (1971) points out is that the slides have to be returned and therefore the student has no record of the presentation; while this may be true of the majority it is not necessarily so. In the programmed presentations we developed in Glasgow the student keeps the specially designed answer sheet for future reference (see 4.2.2.5).

Fletcher and Watson (1968) prefer the combination of audiotape with the original microscope slides of histological sections for training pathologists. They consider that skill in using a microscope is essential and that there is no substitute for the examination of stained tissue sections. This may be true for specialist postgraduate training but it is less certain in the undergraduate course where photographic slides, appropriately labelled to aid identification, could well be superior and Carter et al (1973) have successfully used this technique.

In practice, the commonest combination is probably audiotape and 35mm slides. Spence (1968); Harden et al (1969b); Phillips (1969) and Brooke (1970) review the technique.

In Great Britain the use of audiotape in medical education was pioneered by the Drs. John and Valerie Graves. Initially the material was aimed at general practitioners in an attempt to help them learn at home. The Graves produced their first two tapes (slides were added to their presentations later) in 1958 and circulated them to twenty-seven doctors (Graves and Graves 1958). They confirmed that this had affected learning habits by a questionnaire the following year (Graves and Graves 1959). In 1960, 680 copies of the programmes were sent out on loan. By 1965 this had risen to approximately 7,000 (Graves 1965) and more recently to almost 16,000 (Medical Recording Service Foundation News letter 1973). Their current catalogue (obtainable from the Medical Recording Service Foundation, Kitts Croft, Writtle, Nr. Chelmsford, Essex) contains over 1,000 titles and more than 100 new programmes are added annually (M.R.S.F. Newsletter 1973). In addition to preparing material, they also provide a distribution centre for programmes made elsewhere. Their audience is no longer restricted to general practitioners but includes medical students and other health science workers.

Tape-slide presentations can be used in a number of ways: they can supplement a conventional course (Alberti 1969; Amos et al 1969; Harden et al 1969a) or replace lectures by providing the prime source of information (Harden et al 1969a; Sweet and Doyle 1971). They are suitable both for individuals (within the hospital or at home) or for groups where they may be useful in stimulating discussion (Graves and Graves 1961; Graves 1965; McKee 1965; Alberti 1969). Squire et al (1972) used this technique in teaching radiology as they considered that students learn more in small peer groups.

A major advantage of tape-slide presentations is that they can be used repeatedly (Phillips 1968; Gauvain et al 1969). In 1970, Phillips reported that six thirty-minute talks (i.e. 3 hours of instruction) had been used over 730 times in eighteen months. Such repetition would be impossible within a conventional course. They are also an attractive proposition in laboratory subjects such as histology which have a strong visual element and have been used in pathology (Koprowska et al 1971; Zollinger 1972b). In a physiology course in Denmark the practical laboratory sessions are handled in a 'cook-book' style by tape-slide presentations which are later supported by group discussion (Naeraa 1970).

Another potential user of tape-slide material are the developing countries (see Taxay et al 1963). Here low cost is an important consideration and a system has been developed primarily for overseas use by Morley and Lunnon (1973).

An important danger of tape-slide presentations is that they may be too passive and uninteresting unless active participation by the student forms an integral part of the programme. This can be achieved by asking questions, for example on the identification of abnormalities in X-rays (Hood 1968; Squire et al 1972) and electrocardiographs (Udall 1970). In Glasgow, we chose to prepare our material in the form of a linear programme. As will be seen from the examples given later, tape-slide programmes can be designed to teach both application of knowledge and problem solving. They are not purely restricted to factual recall as suggested by McFie (1969).

A different approach to the problem of involving students more actively in their learning was adopted in Edinburgh; where students in a course on social medicine prepared their own tape-slide presentations (Maclean and Pilkington 1972). We have also used the technique in Glasgow; although it encourages detailed study of a topic by students it is time-consuming which limits its usefulness.

Tape-slide presentations can be used on a wide range of equipment from a simple cassette tape recorder and hand viewer (Harden et al 1970b; Gardiner et al 1973; Morley and Lunnon 1973) or automatic slide projectors (Amos et al 1969) to the more sophisticated teaching devices such as the Frank-Kindermann Audiovisual tutor machine (Harden and Wayne 1968) and the Devans tutor (Devlin 1973). Other techniques include the Plessey supervisor (Craddock 1971) and the 3M sound and slide machine (Koprowska et al 1971; Med. biol. Ill. 1973). Some other machines incorporate a response device, the student having to choose and indicate the correct answer from a number of possibilities (see Doust and Fischer 1971; Reich 1972). The relative advantages of the different equipment is considered in the discussion (6.2).

Audiotape and slides are cheap to produce and use - much less expensive than 16mm film and certainly far less than television and computers. Initial production costs of the master copy are lower and it is cheaper to produce duplicates (see Graves 1969).

One possibility to consider is to use slides but to replace the audiotape with a printed script. This allows the student more freedom to work at his own speed as he is not restricted to the rate of the speaker although he loses the emphasis of the spoken word. Koprowska et al (1971) offered their students a choice of tape or script for use with the slides. Engel et al (1972) also investigated this problem; although in this study the script (in written or spoken form) was used in conjunction with a booklet. They found that about half the students chose the tape and half the text.

The use of self-instruction can completely alter the design of a course as illustrated by the ten week pathology course in Rotterdam (de Vries et al 1970) which relies heavily on tape slide (35mm and histological sections) presentations. Each student has to complete seven tapes a week each lasting 15-20 minutes. The course is centred round small group discussions (3 hours/week) where questions arising from the programmes can be answered and in-depth discussion encouraged. It has not been found necessary to provide extra demonstrations, practical classes or lectures; although time is allocated for a single one hour lecture each week by an invited speaker or for a clinico-pathological conference.

The Rotterdam experiment emphasises the potential of self-instruction. Staff, freed from lecturing,are able to be in closer contact with students by taking part in the group discussions.

In summary, 'tape-slide' presentations seem appropriate for a wide range of medical studies and the choice of which presentation system to use should be governed by the topic. For some the illustrations may be adequately handled by a notebook; for others, particularly where there is a strong visual element, slides may be an advantage. The possibility of offering a written form of the script should be considered. Results so far suggest that tape-slide presentations are popular with students and staff. They have not been adequately assessed and compared with other teaching techniques. Those are themes of work reported in this thesis.

3.4 NEED FOR BETTER MEANS OF ASSESSING EDUCATIONAL TECHNIQUES

During the last twenty years a wide variety of new techniques has been developed in education. Some of these have been applied to medical education. As will be apparent from the foregoing analysis of self-instruction the claims made for individual techniques vary from extreme enthusiasm to indifference. Usually neither view can be accepted because standards of assessment are poor. A situation analogous to that in medical therapeutics before the advent of the double blind trial seems to prevail in medical education: enthusiastic but uncritical advocacy at first leading to later disappointments. In some ways, a form of assessment analogous to the clinical trial has its attractions in medical education: random allocation of students to self-instruction and conventional lecture course with assessment by examination (probably multiple choice in form) provides some information on the new techniques as we discovered (Harden et al 1969c). However, there are possible dangers in this method since it is quite likely if multiple choice examination is the only form of assessment, that the self-instruction course will be designed with the primary object of teaching students to answer multiple choice questions. Whether or not this is desirable, there would be no reason to conclude, if self-instruction fared better, that it was a superior method of teaching medicine.

Also, unlike the double blind trial, students are perfectly aware of the experimental group to which they belong. Comparison of groups could then be compromised if, for example, students worked harder (initially) at the new techniques because of its novelty or simply by the knowledge that they were taking part in an experiment - the so-called Hawthorne effect. Thus an intrinsically inferior new technique may seem superior. In addition objectives of the two systems may not be identical. As Richmond (1969) has suggested different methods of presentation may alter the orientation and thus the objectives of the teaching material.

Such comparisons may also be compromised by the fact that the techniques on test are not the only ones used by students in the trial. It is possible that self-instructional students may be encouraged to read more or less of their medical texts than their control colleagues or that they attend a larger or smaller number of ward rounds and that these secondary effects are responsible for any differences observed between groups.

In fact as Cheris (1964) points out the validity of many comparative studies is questionable. For proper comparisons to be possible the material taught should be identical, both presentation systems should be optional with appropriate study conditions for each and the learning time should be accurately measured for both systems. Finally, the criterion test should be unbiased. In practice, it is almost impossible to control all these variables adequately. For example, in our experience, one or two of the subject specialists commented that the presentation of their lectures had improved after being involved with programming the material.

Another, and in our view very important, aspect involves the students' attitude to their new course. Some workers now consider that studies of an 'on-going' system is as or even more important than results of examination performance (see Parlett and Hamilton 1972). Certainly in our own experience, the students' comments on the self-instructional tape-slide programmes, both in conversations and in the questionnaires, provided valuable information.

Thus, although there is a clear need to assess new techniques of medical education an adequate form of assessment has yet to be developed if comparative studies are to be undertaken. It was for these reasons that many studies reported in this thesis were concerned with the different methods of presenting programmes to students (examination results and attitude questionnaires being used to assess results) rather than restricting the project to a simple comparison of tape-slide presentations with the conventional lecture.

3.5 PREVIOUS EXPERIENCE WITH AUDIOVISUAL AIDS AT THE WESTERN INFIRMARY

During 1966, an audiovisual system was introduced in the department of medicine at the Western Infirmary primarily for postgraduate students. Initially tape-slide programmes were presented to groups of students. The audiotape was played on a Ferrograph tape recorder and the slides were projected on to a wall screen by a Leitz Pradovit projector. The slides were changed automatically at the appropriate places by means of a Phillips external synchronising unit (Harden et al 1968). However, group learning for postgraduate students has particular problems: it is difficult to find a time and place suiting everyone - and standards vary much more than with undergraduates. It was therefore decided to investigate the possibilities of individual instruction. At that time, the Frank-Kindermann Audio visual tutor machine (see Harden and Wayne 1968) was available and it seemed to combine the necessary requirements. The initial experience was encouraging and it was decided to extend its use and to investigate the place of self-instruction using audiovisual presentations for undergraduates. My own interest in the work began at this stage.

At that time the formal teaching in medicine and surgery was done in the fourth year (Illingworth 1964). The course is taught by topics in an integrated fashion. The topic selected for a study of self-instruction was endocrinology, largely taught by the department of medicine. It was decided to encourage active participation by the student during the tape-slide presentation and the format chosen was a linear programme (Skinner 1954).

As indicated subsequently my work lay in the designing of tape-slide programmes and their integration into courses of endocrinology and, later, renal disease.. Assessment of the student's performance in examinations before and after the tape-slide course and of their attitudes to this method of teaching became an important part of the project.

Some of the work described in this thesis has been published (Harden et al 1969a,b,c,d,e; Dunn et al 1969; Harden et al 1970a and b; Holroyd et al 1970; Lever et al 1970; Lever 1971), or will be published. I was also involved in a related topic of machine marking of examination papers (Lennox and Lever 1970). It has not been described further here.

The method I describe for the preparation of a programme is my own and the other medical editors involved in the project may not use exactly the same procedure. The results section reports the outcome of the collaborative work of the team and it would be difficult to delineate my own contribution. However, the views expressed in the discussion are mine and may not necessarily reflect the opinions of the other co-workers.

4. METHODS

4. METHODS

This section of the thesis consists of a description of the preparation of tape-slide presentations and the equipment used. Also included is an account of the library service for tape-slide presentations. The following section (5. Results) is concerned with their assessment. This sequence of presentation was adopted because it illustrates best the reasons for the different experiments conducted between 1968 and 1973. In addition, the method selected allows the experience gained over the 5 years, for example in the preparation of the material, to be summarised more coherently.

4.1 THE PROJECT TEAM

At one time or another between 1968 and 1973 the following medical graduates and educationists worked on the project.

Harden, R.	Lecturer and Senior Lecturer, Dept. of Medicine
Lever, R.S.	Lecturer, Dept. of Medicine (initially full later part time)
Stevenson, M.	Lecturer, Dept. of Medicine (initially full later part time)
Lindsay, A.	Part time Lecturer, Dept. of Medicine
Kennedy, H.	Part time Lecturer, Dept. of Medicine
Carswell, A.	Part time Lecturer, Dept. of Medicine
Wilson, G.M.	Professor, Dept. of Medicine
Dunn, W.R.	Lecturer, Dept. of Education
Holroyd, C.	Lecturer, Dept. of Education

All members were concerned with planning and evaluation. The two lecturers (W.R.D. and C.H.) from the programmed learning unit in the University both played major roles in providing the necessary background of educational theory and statistics. In addition, they taught us the techniques of programmed learning and two of us (R.H. and R.L.) attended an extramural course in the University run by them. Subsequently, they supervised its application as outlined later (4.2.3). As shown in Tables 12, 13, 14, 15 the doctors acted as medical editors (this function is outlined in 4.2.2. and 4.2.3) in collaboration with subject specialists. The latter helped in preparation of the material (see 4.2.1 and 4.2.3) but did not form part of the project team itself.

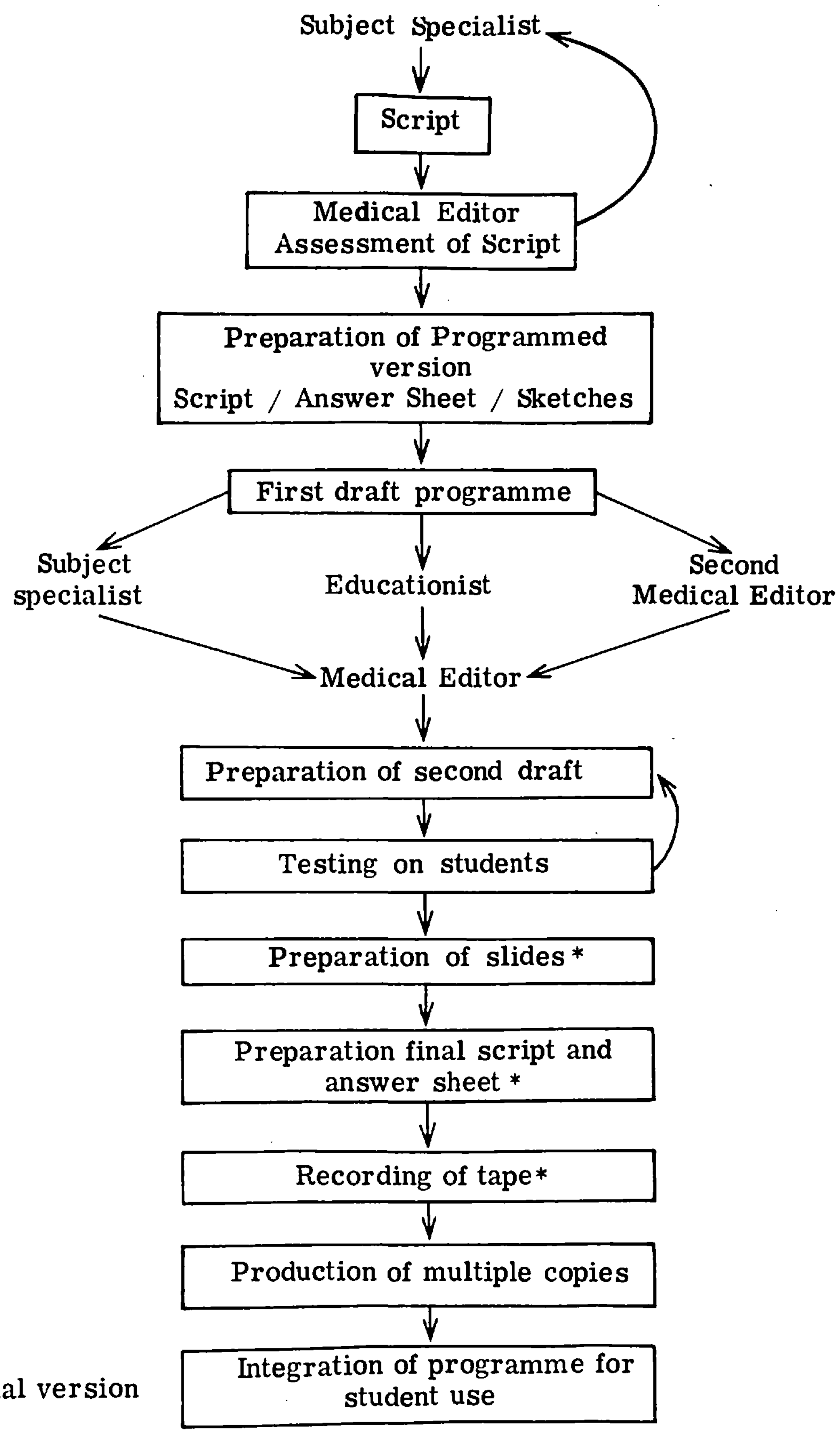
Other groups or individuals involved in the work included Mr. G. Donald and his department of Medical Illustration at the Western Infirmary (see 4.2.5) and the University Television Service (4.2.8).

4.2 PREPARATION OF PROGRAMMES

Although tape-slide programmes can be obtained from outside sources such as the Medical Recording Service Foundation the amount of material is still relatively limited and rarely covers a complete topic such as endocrinology comprehensively. The material used in Glasgow therefore was prepared within the department of medicine (see Lever 1971).

In outline (see Fig.2) a tape-slide programme is prepared as follows. First, the subject specialist provides a script for the medical editor who programmes the material and produces a draft of the script together with an answer sheet and rough sketches of the illustrations. These are circulated to other members of the project team and subject specialist for criticism and discussion before a second draft is prepared. The presentation is then tested on a small number of fourth year medical students. Slides are designed,

Fig. 2. PREPARATION OF PROGRAMME



* final version

the final version of the script is prepared and the tape recorded. Multiple copies of tape and slides are then produced. The final package is then integrated and a specimen, for use with the simple hand-operated equipment, is shown in Fig.3. These stages of preparation are considered in greater detail in the following sections.

4.2.1 SUBJECT SPECIALIST AND HIS SCRIPT

Four subject specialists were involved in the nine programmes on diabetes mellitus made in 1968 as shown in Table 12. An additional consultant physician was concerned with the revision of these programmes. For the thyroid programmes (see Table 13) the subject specialist was also one of the medical editors (R.H.) The third week of the endocrine course is more heterogenous and correspondingly more subject specialists were involved as shown in Table 14. A consultant nephrologist and a registrar (in renal disease) acted as subject specialists for the eighteen renal programmes (Table 15). Most of these people normally lectured in their specialty to the integrated year and the aim of the programmes was to cover the same material.

A subject specialist has two main functions: to provide the original script and to advise on the accuracy of the final presentation. As indicated earlier, he may double as the medical editor. However, as a rule, subject specialists are not trained as programmers and because they are usually busy clinicians and the editing process is time-consuming most of the preparation of programmes has been left to the medical editors.

The form in which the original script is presented varies as indicated in the Tables 12-15. For the programmes in diabetes (D1-5)

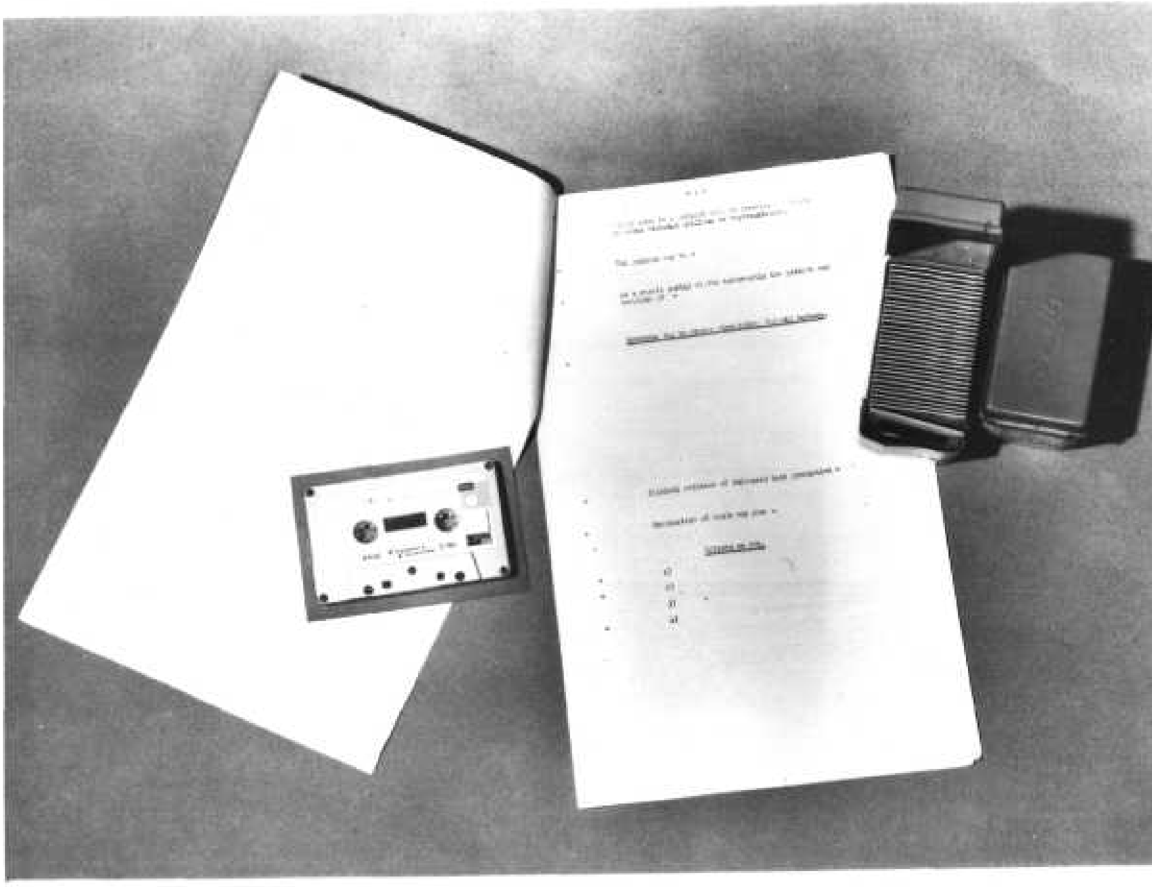


Fig. 3. A tape-slide programme for use with the hand-operated system: cassette-tape, slides (in storage box for stack-loading into hand-viewer) and answer sheet.

Table 12

D I A B E T E S M E L L I T U S

No.	Title	Subject specialist	Script	Medical Editor	Year	Tape Running Time
D1	Symptoms & Diagnosis of Diabetes Mellitus	Lecturer (A)	Non-prog. Tape/slide programme	RL	1968	25 mins
D2	Coma I	"	" "	RL	"	22 "
D3	Coma II	"	" "	RL	"	25 "
D4	Complications I	"	" "	RL	"	32 "
D5	Complications II	"	" "	RL	"	32 "
D6	Treatment I	Consultant Physician (B)	Dictated	RL	"	32 "
D7	Treatment II	" "	"	RL	"	32 "
D8	Ocular Complications	Prof. of Ophthalmology	"	RL	"	35 "
D9	Childhood Diabetes	Consultant Paediatrician	"	AL	"	31 "
		R E V I S I O N O F P R O G R A M M E S				
D10	Nature of Diabetes Mellitus	Consultant Physician (C)	Hand-out	RL	1971-72	16 mins
D11	Clinical Features	" "	D1	RL	"	22 "
D12	Diagnosis	" "	D1	RL	"	25 "
D13	Hyperglycaemic Coma I	" "	D2 & 3 Hand-out	RL	1972	17 "
D14	Hyperglycaemic Coma II	" "	" "	RL	"	29 "
D15	Hyp o glycaemic Coma	" "	D3 and Discussion	RL	"	25 "

Table 13

THYROID DISEASE

Number	Title	Subject Specialist	Script	Medical Editor	Year Produced	Tape Running time
T1	Non-toxic goitre I	RH	-	RH & RL	1968	32 mins
T2	Non-toxic goitre II	RH	-	RH	1968	43 "
T3	Assessment of Thyroid Function	RH	-	RH	1968	50 "
T4	Clinical Features of Thyrotoxicosis	RH	-	RH	1968	30 "
T5	Treatment of Thyrotoxicosis	RH	-	RH	1968	46 "

Table 14

ENDOCRINOLOGY (THIRD WEEK)

Number	Title	Subject Specialist	Script	Medical Editor	Tape Running Time
E1	Cushing's I	Consultant F	Handout	M.S.	24 mins
E2	Cushing's II	"	Handout	M.S.	20 "
E3	Andreno-cortical insufficiency	"	"	M.S.	25 "
E4	Hirsutism	Consultant H	Handout and discussion	M.S.	13 "
E5	Diabetes Insipidus	" I	Handout	M.S.	15 "
E6	Acromegaly	1973 - borrowed from Newcastle (programmed version in preparation)			
E7	Calcium Metabolism I	Consultant J	Handout and discussion	M.S.	22 "
E8	Calcium Metabolism II	" "	"	M.S.	11 "
E9	Complications of steroid therapy (available as handout T.S.P. in preparation)	" F	Handout	R.L.	

(Hypopituitarism and dwarfism were covered by lectures but will shortly be available as tape-slide programmes)

Table 15

RENAL DISEASE

Number	Title	Subject Specialist	Script	Medical Editor	Year	Tape Running Time
R1	Renal Structure	Consultant Physician (D) (in renal disease)	Dictated	RL	1969	21 mins
R2	Renal Function I	"	"	RL	"	28 "
R3	Renal Function II	"	"	RL	"	25 "
R4	Acute Glomerulonephritis I	"	"	RL	"	35 "
R5	Acute Glomerulonephritis II	"	"	RL	"	24 "
R6	Nephrotic Syndrome	"	"	RL	"	34 "
R7	Urinary Tract Infection I	Registrar in Renal Disease(E)	"	AL	"	45 "
R8	Urinary Tract Infection II	"	"	AL	"	23 "
R9	Chronic Renal Failure I	"	"	AL	"	24 "
R10	Chronic Renal Failure II	"	"	AL	"	40 "
R11	Regular Haemodialysis	Consultant Physician (D)	"	AL & RL	"	44 "
R12	Chronic Pyelonephritis	Registrar (E)	"	RL	"	32 "
R13	Acute Renal Failure I	Consultant Physician (D)	"	RL	"	22 "
R14	Acute Renal Failure II	"	"	RL	"	29 "
R15	Acute Renal Failure III	"	"	RL	"	30 "
R16	Acute Renal Failure IV (dialysis)	"	"	RL	"	30 "
R17	Renal Tubular Disorders I	Registrar (E)	"	RL	"	35 "
R18	Renal Tubular Disorders II	"	"	RL	"	25 "

most of the source material was already available as two non-programmed tape-slide presentations, although some additional material was needed. For other scripts, some subject specialists dictated a precis of their lecture which was later typed; and some prepared a hand-written precis or a hand-out designed for students in the lecture course, the latter were amplified by discussion between the medical editor and subject specialist.

4.2.2. MEDICAL EDITOR: PROBLEMS IN FIRST DRAFT PROGRAMME

The medical editor undertakes most of the detailed preparation of a programme and also co-ordinates the activities of the rest of the team. As indicated in Table 12, the author of this thesis has been a medical editor for eight of the original diabetic programmes (D1-8 inclusive) and for thirteen of the eighteen renal programmes (Table 15) and has been involved in the revision of some of the diabetic programmes. This revision was necessary, not because the material had become out of date, but because we had gained valuable experience which enabled us to improve the design of the programmes.

Details of the process by which the medical editor transcribes the subject specialist's script into a programmed version are given in the following sections.

4.2.2.1 Assessment of the script

4.2.2.1.1 Statement of objectives. Although an important principle of programmed learning is a clear statement of objectives (see Mager 1962), it is often difficult to achieve in medical education. In our experience subject specialists rarely provide an explicit statement of objectives and thus responsibility for their inclusion lies with the medical editor. The difficulty lies in the form such statements should take. On the one hand there is a 2,500 word statement in a course on gynaecological oncology (Wilds and Zachert 1967a), on the other, our own more brief statements in the early programmes. Both have disadvantages. Although the former is likely to be explicit and the items sufficiently precise to be testable the whole is clearly of such an unwieldly length as to limit its usefulness. However, as is apparent from the extracts quoted below our initial technique was also of limited value.

The three quotations are from the programmes on diabetes:

Symptoms and diagnosis (D1)

"After listening to this lecture you will know the various ways in which diabetes may first appear. You will also know the symptoms which should make you suspect this diagnosis and how to confirm your diagnosis by investigations."

Diabetic coma I (D2)

"After listening to this presentation you should be able to recognise diabetic coma clinically, and you will know the urine and blood tests that are necessary to confirm your diagnosis."

Diabetic coma II (D3)

"After listening to this presentation you will know how to treat diabetic coma. You will be able to differentiate it clinically from hypoglycaemic coma. You will also know how to confirm the presence of hypoglycaemia and how to correct it."

As can be seen these aims are too vague to be tested as Mager (1962) suggests they should. No indication is given as to how the student should demonstrate he has achieved his goal.

We later approached the problem of stating objectives in a different way and extracted the salient points from the subject specialist's original script; these were written in a form similar to that used in a multiple choice examination except that only positive i.e. correct items were included (see Appendix B). The list was returned to the subject specialist to ensure the items were correct and to enable him to check if it was complete. In practice, this was relatively successful although the analysis tended to be lengthy and the scope of the objectives covered was limited. Nevertheless, it gave a starting point for discussion and at least helped to delineate the material covered by each programme.

4.2.2.2 Preparation of Programmed Version

The principles and practical aspects of programmed learning have been well reviewed (see Lysaught and Williams 1963; Austwick 1964; Stolurow 1966; De Cecco 1968; Markle 1969; Bjerstedt 1972; Hartley 1972).

My own technique for writing the draft programme changed with time and my current practice is to read the subject specialist's script several times thoroughly and then to list the salient points to be covered. Ideally, and for reasons which I cannot explain, I find it best to leave the project at this stage for a time (up to a few weeks) and to return to it on a day free of all other commitments. By this time I usually know how I shall handle the material. The time taken to complete this first stage may vary from six to 20 hours. With experience this was reduced.

4.2.2.2.1 Linear Programme. It was decided to use a linear programme as outlined (3.3.1 and 3.3.2). In Skinner's programmes (1954) the size of the step was so small that errors were unlikely. This principle has been questioned (see Leith 1969; Davies 1972) and in common with others (Weiss and Green 1962; Reinecke 1967) we consider that larger steps are more appropriate for university students. In addition, in our programme, all frames do not require a response.

The first task of the medical editor, therefore, is to rewrite the subject specialist's script in a programmed form. Generally, this involved complete reorganisation of the sequence (the best sequence for a lecture is not necessarily the best for a tape-slide presentation).

The technique of writing such programmes is best described by illustration and extracts (from current programmes) are quoted in the sections which follow. These are arranged to illustrate particular problems.

4.2.2.3 Students previous experience

New subjects are easier to understand and remember when connected to an existing framework of knowledge (Ausubel 1962). A problem arises when students begin the course with differing background knowledge. Although all clinical students studying endocrinology should theoretically have a working knowledge of the relevant anatomy and physiology, the spectrum of knowledge varies widely. This can be dealt with in a number of ways: one possibility is to assume that the students remember all the necessary material as they have already been taught it. This is rarely justified in our experience. Another possibility is to assume that the students remember nothing at all and to teach all the background material again. This is also impractical and makes for long and boring presentations. Some of our early programmes (e.g. R.I.) included too much basic material and the students reacted unfavourably. A third possibility is to summarise the revision material on the answer sheet. The audio-tape simply instructs the student to read the revision section and he can therefore take as much, or as little, time as he wants over it. I have used this technique to revise the normal actions of insulin in the tape 'Nature of Diabetes Mellitus' (Table 16).

Finally, the revision material can be covered using a question and answer technique. This can be very useful for short sections of the programme. For example, students should already know from their physics that a more convex or swollen lens focusses the light rays in front of the retina resulting in blurring of vision. This was revised in programme D11 as shown in Fig.4.

Thus the student's previous knowledge has not only been revised but also placed in a new context. The above extract also illustrates the major difference between the format of programmed tape-slide presentations and a lecture. Almost invariably subject specialists present their script in the form of a lecture. Transcription to the programmed form therefore is an important task for the medical editor. Also illustrated in this sequence is the frequent use of questions. Here the steps between frames are relatively small (although not as small as in a strict Skinnerean programme).

The same technique can also be used to revise difficult concepts such as the development of metabolic abnormalities (hyperglycaemia, metabolic acidosis and electrolyte imbalance) in hyperglycaemic coma (D13). This is illustrated by the excerpt shown in Fig. 5a and 5b.

As can be seen the questions in this instance covered relatively large "steps" and the answers summarise the data previously covered in biochemistry for example the details of the Kreb's cycle were not included. In this way the relevant material is revised and the students will link their earlier biochemical and

Table 16

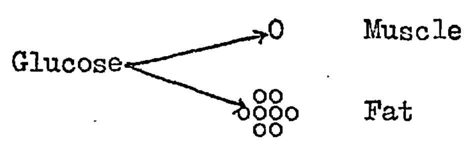
INSULIN *

Release

Insulin release from the β cells in the pancreas is stimulated by food intake, especially by carbohydrate intake.

Actions of insulin

Striated muscle and adipose tissue



a) Insulin facilitates the uptake of glucose by increasing the permeability of the tissues

b) Insulin increases storage of glucose

i) stimulates formation of glycogen (in striated muscle)

ii) stimulates formation of triglycerides and fatty acids(in adipose tissue)

c) Insulin is antilipolytic

∴ the overall action of insulin is to lower the blood sugar

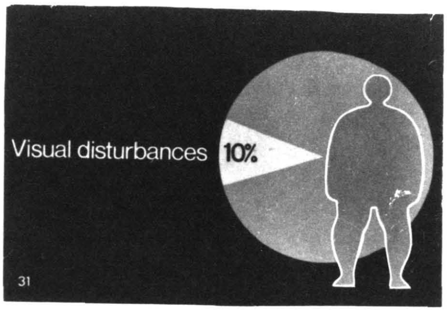
Antagonists to insulin

Endocrine factors - growth hormone
cortisone (also causes increased gluconeogenesis)
ACTH
glucagon
thyroxine
upper gastro-intestinal hormones

In a normal person there is a balance throughout the day between insulin and its antagonists.

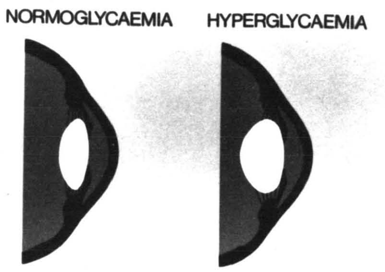
* A revision section included in the answer sheet of the programme on the "Nature of Diabetes Mellitus".

Fig. 4



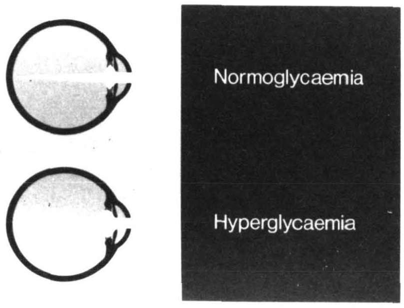
Another presenting complaint in ten per cent of the older age group is that of visual disturbance. There are a number of different causes for this complication in diabetic patients. One of these is swelling of the lens.

Why do you think diabetics should develop a swollen lens? *



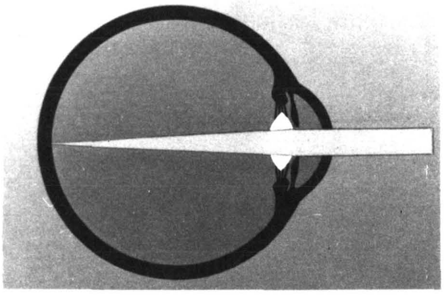
This is related to the hyperglycaemia which results in a higher glucose and consequently water content of the lens, and so lens swelling results.

Why should this cause blurring of vision? *



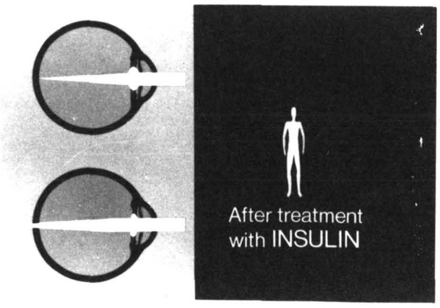
Rays of light are focussed by a normal lens on the retina. If the lens is swollen, however, there is an increased curvature and therefore the light rays are focussed in front of the retina.

Do you think this condition is likely to be permanent? Give reasons for your answer. *



No. The hyperglycaemia will resolve with treatment. The lens will then return to normal shape and so the rays will once more be focussed on the retina.

So blurring of vision may be the presenting complaint in an older diabetic. It may sometimes present in a juvenile diabetic after treatment has been started with insulin. Why do you think this is? *



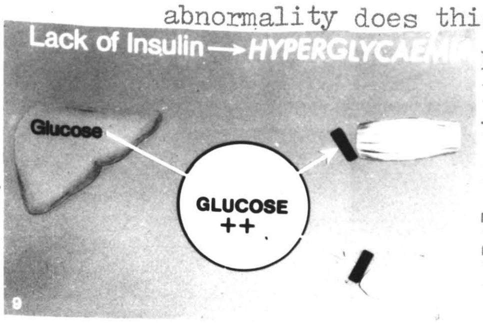
In a juvenile diabetic, blurring of vision may occur due to shrinkage of the lens which has followed treatment with insulin. But again, this is only a transient phenomenon.

So if blurring of vision should occur in any diabetic patient don't order new glasses for three months. The condition may spontaneously resolve.

Extract from "Clinical Features of Diabetes Mellitus"

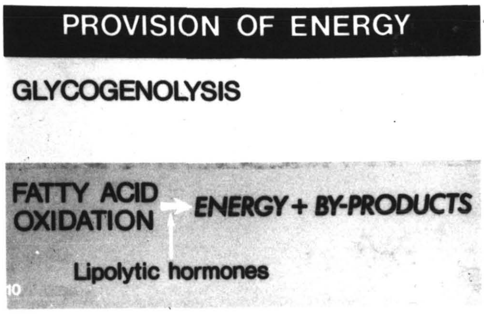
Slide 8: What are the effects of insulin lack? What biochemical abnormality does this result in? * (tape stop)

Fig.5a

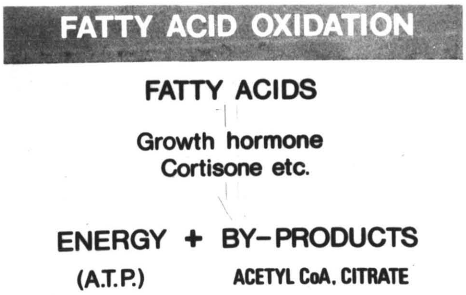


Hyperglycaemia. This results from two main factors. First of all, the peripheral uptake and utilisation of glucose by fat and muscle is inhibited. Secondly, gluconeogenesis is increased because insulin's inhibitory effect is removed. Therefore glucose is added to the peripheral pool. The sum effect of these two things is a rise in the blood sugar, and although there is an excess of glucose in the blood, it is relatively useless because the peripheral tissues can't take glucose up and use it without insulin.

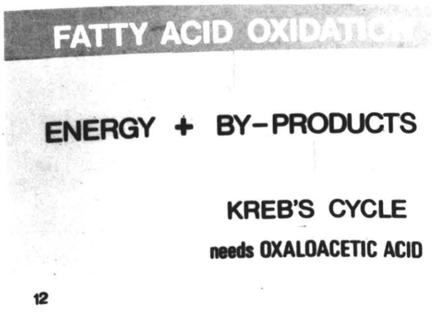
However, all tissues, for example the muscles, still require energy to function. How is this energy provided and what hormonal action favours this metabolic pathway? *



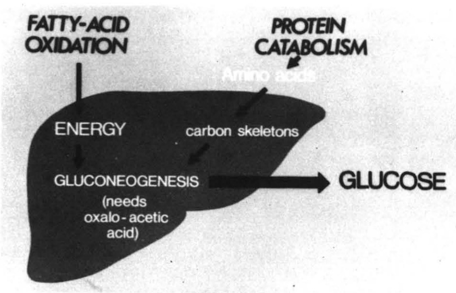
You might have said the breakdown of the body glycogen. This is perfectly true, but glycogen only forms a small part of the body's store of energy, and it would be used up in a relatively short period of time. The main source of energy comes from fatty acid oxidation. This is encouraged by the lipolytic hormones, for example growth hormone and cortisone. When fatty acids break down they provide energy but they also produce by-products. Do you know what the by-products of fatty acid oxidation are? *



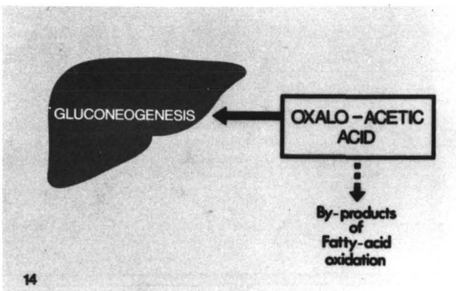
The by-products of fatty acid oxidation are acetyl CoA and citrate. How are these normally disposed of? *



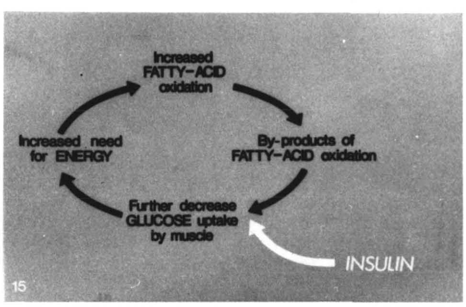
The by-products are normally disposed of by the Krebs cycle. To do this, however, oxaloacetic acid is required. Look at the next page on your answer sheet and you'll see that oxaloacetic acid is also required for gluconeogenesis. Let's consider gluconeogenesis briefly. In addition to oxaloacetic acid, carbon skeletons and energy are both required. Where are these obtained from in states of insulin lack and why are they so readily available? *



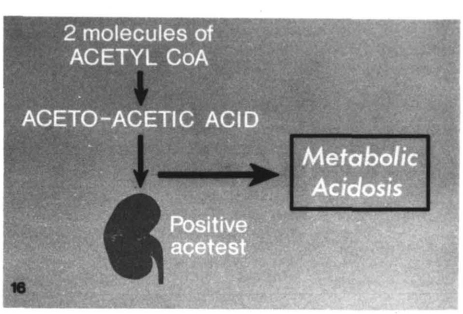
Energy is again provided by fatty acid oxidation but of course this will produce more by-products. The carbon skeletons are readily available in states of insulin lack because you'll remember that insulin is anabolic. When there is insulin lack, protein catabolism is increased, protein breaks down, first to amino acids and then to carbon skeletons.
So you can see oxaloacetic acid is a key substance. It's required both for gluconeogenesis and also for the disposal of the by-products of fatty acid oxidation. Which demand do you think will predominate in states of insulin lack? *



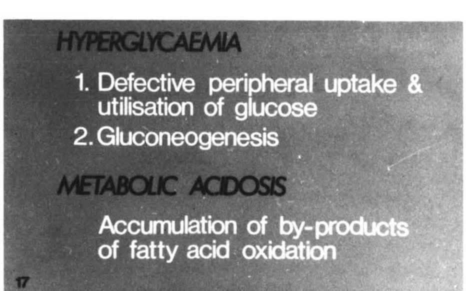
Gluconeogenesis uses almost all the available oxaloacetic acid. It's therefore not available to dispose of the by-products of fatty acid oxidation. They therefore accumulate. Turn over the page in your response sheet and you'll see that these by-products have the effect of further decreasing glucose uptake by muscle. What do you think is the effect of this on further fatty acid oxidation?
Complete the diagram in your answer sheet. *



Because accumulation of the by-products further decreases the glucose uptake by muscle, there is an increased need for energy. Therefore there is further fatty acid oxidation and so more by-products are produced. Thus a vicious circle is formed. This can <u>only</u> be broken in hyperglycaemic coma by administering insulin.
What effect does the accumulation of these by-products have metabolically and how can you recognise it in a side-room? *



Molecules of acetyl CoA combine to form aceto-acetic acid. As much of this as possible is excreted by the kidney. However, the kidney is simply overwhelmed and it can't possibly excrete all the aceto-acetic acid that is formed, which therefore accumulates and produces the metabolic acidosis that is characteristic of the keto-acidotic type of hyperglycaemic coma. The excreted aceto-acetic acid gives rise to a positive acetest.



So in summary: these are the two characteristic features of the keto-acidotic type of hyperglycaemic coma.

physiological studies on insulin with the clinical features caused by the metabolic abnormalities.

It is also possible to deal with revision material in other ways. Some introductory slides can be included which the student can go through as quickly as he wishes or, alternatively, it can be dealt with rapidly on the tape. Finally a few questions can be included and if the student answers these correctly he can omit the whole or part of the programme.

4.2.2.4. The student's response

The term "response" is used here to indicate the form in which the student participates in the tape-slide presentation. This is an important issue, best illustrated by specific examples.

A commonly advocated technique (see Netsky 1960) is "tell them what you're going to tell them, tell them and then tell them what you've told them". In the programme on "The Assessment of Thyroid Function" (T3) for example a slide was shown listing five diagnostic tests. These were discussed individually with appropriate illustrations and questions were posed; finally the student was asked to write down the five tests. This had the advantage that the information was summarised on the answer sheet for future use. Even so, we soon discovered that elementary "recall items" of this type were too simple for undergraduates. This became particularly obvious when programmes were played to groups of students. (Deficiencies in programmes are more quickly exposed by groups of students). Students scan the answer sheet in advance of the tape and are able to anticipate and complete some questions before they are asked.The question itself, when it finally arrives, is greated by groans.

Many questions in the early programmes were simple recall items of this type. Generally they were too easy and slowed down the pace of presentation. We soon found that higher level responses involving interpretation of data, application of principles, or problem solving are more appropriate for the undergraduate. A useful type of response, which also ensures that the student looks at the slides properly, is to ask him to identify a lesion in a clinical photograph (e.g. a cataract, dehydration, as shown by a dry tongue, a goitre, features of Cushing's, and so on) or the abnormality in chest X-rays, E.C.G.'s, blood films or histological slides. A modification of this technique is to show first the abnormal slide with the question and then after a tape stop (to allow for inspection), the same slide reappears with the abnormality labelled.

Thus, where possible students should be asked to interpret or use data. For example, in the programme on the Clinical Features of Diabetes Mellitus (D11). They are told -

> "The basic biochemical defect in diabetes is abnormal glucose tolerance. This can be demonstrated**clinically by demonstrating** the presence***of glucose in the urine. Glucose exerts a physiological effect when it's present*** in the distal tubule and this leads to the development of 2 clinical features."

They are then asked:

> "What <u>is</u> the action of glucose on the distal tubule and what are the clinical features. Explain very briefly the mechanism involved?"*

Footnote: * = tape stop
, *= as discussed in section 4.2.8. Repetitions such as these have a place in a spoken text jarring though they may seem in written form.

Thus the student is reminded that glucose causes an osmotic diuresis when it is present in the distal tubule. He is then led to deduce two of the clinical features of diabetes mellitus, polyuria and thirst.

Responses should be as demanding as possible. For example, precise interpretation of glucose tolerance test data is included in the programme on "The diagnosis of diabetes mellitus" (D12). Also, in the same programme, the student is asked to interpret some results (blood sugar and urine tests) in 2 patients and therefore learns the problems associated with the diagnosis and management of a possible diabetic patient with an altered renal threshold. Finally, another example of problem-solving occurs at the end of the programme on the assessment of thyroid function (T3) where 4 case studies are given. One of these is illustrated below:

Tape (for slide 71)
This is the last patient. She was a 26 year old girl who noticed a goitre about two years previously and was referred to the thyroid clinic suspected of being thyrotoxic. These are her results.* (Tape stop)

<u>Slide 71</u>

Thyroid uptake ^{131}I	5 hours 58% dose 48 hours 65% dose
$PB^{131}I$	0.06% dose/L. plasma (normal range < 0.30% dose)
$PB^{127}I$	5.2 ug/100 ml
T3 resin uptake	28% (normal range 25-35%)

Tape restarted
"These results show high uptake values with normal $PB^{131}I$, normal chemical $PB^{127}I$ and normal T_3 resin uptake. These results therefore suggest that she is not thyrotoxic but is euthyroid. The most likely cause for the high uptake value is iodine deficiency. This is the most likely cause

of the goitre. If she was given triiodothyronine the high uptake values would fall to low levels".

These case studies involve interpretation of data and problem-solving at a fairly high level. Generally they are popular with students.

4.2.2.5 Answer sheets

Part of a specimen answer sheet, which relates to the previous examples from hyperglycaemic coma, is included as appendix C.

Answer sheets perform several functions: they are a source of visual material, which may be revision (see previous section) or new information. The latter often consists of subject matter which requires only rote learning since we found that this was not successfully achieved by audiotape. An example is shown in the answer sheet (appendix C) dealing with the factors accelerating the passage of potassium from the extracellular fluid to the intracellular fluid.

Secondly, the answer sheets were so designed that when completed correctly they formed a summary of the lecture. This has led us to rely on overt (i.e. written) responses rather than covert (mental) ones although the controversy over their relative merits was recognised (see Stolurow 1966; Leith 1969; Bjerstedt 1972).

Since the answer sheets are retained by the students they can be used for revision. For these reasons answer sheets play an important part in our programmes: a feature lacking in most "standard" audiovisual programmes (e.g. most tape/slide presentations and 8mm film).

4.2.2.6 Integration of slides and answer sheet

There are two visual elements in the programmes - the slides and the answer sheet. Originally I sketched out a rough plan of the script and the slides together using foolscap paper turned horizontally; draft slides on the left and script on the right. My current practice is to design the rough draft of the slides and the answer sheet first and to write the script at a later stage. Phillips (1969) uses the same technique and Kapandji (1964) used a similar system for his illustrated lectures on the upper arm and knee; a number of lecturers I have spoken to plan their presentations around the slides.

Rough sketches of the illustrations are prepared by the medical editor using felt-tip pens as we have found that some colour is useful even at the early stages. Designing the visual element first ensures that all the important teaching points are shown visually. It also allows the slides and answer sheet to be integrated without too much repetition between the two.

Repetition is likely to occur when a list of features appears on a slide because the student will also require the list on his answer sheet for future reference. There are several ways to avoid this: the list can be written in the answer sheet only, while the audiotape simply instructs the student to read the relevant section. This was the technique used to cover the causes of diabetes insipidus (E5). Alternatively the student may be asked (by audiotape) to list, in specially designated spaces on the answer sheet, as many causes of the disease as he knows. After a tape stop, a slide with the complete list appears and the student is given time to complete gaps in his sheet. Here the principle of challenge is employed but this is only useful if the students can be expected to know at least some of the causes.

A further possibility is that the slide can present the data in a different form from the answer sheet, for example a diagram or a specimen case history could appear on the slide and the list of clinical features on the answer sheet.

Finally, the information can be presented on the slide and the student can be asked to copy the list into his answer sheet. Though useful in primary education "copy items" are of doubtful value in a university (see Markle 1969).

4.2.2.7 Integration of slides, answer sheet and audiotape

The whole presentation is linked by the audiotape, which directs the student's attention to the relevant point on the slide or answer sheet. Slides contain only the essential points and it is important that these are not lost in a mass of information. Audiotape, on the other hand, gives more detail and elaborates on the essentials. The tape can also be used to give additional points of interest which are not vital to the theme; these can be spoken at a faster rate which helps to speed up the pace of a presentation without also increasing the rate at which new and important information is delivered. The speaker on the audiotape can also emphasise the important points by the tone of his voice.

The script should be in spoken, idiomatic English capable of delivery in an informal manner (see Engel 1971). It should be directed towards an individual student rather than a large class or a meeting both of which require different handling (see Hawkins and Hammersley 1966). This is another way in which tape-slide presentations differ from a conventional lecture.

4.2.2.8 Points for consideration during the preparation of a programmed course

If a course of tape-slide presentations is to be prepared there should not be too much overlap between the individual units of the topic. This is alleged by students to be a common fault in the traditional lecture course and it was also a fault in our early programmes as we then believed that each unit should be able to stand on its own and inevitably some repetition resulted. For example, the histology of the glomerular capillary is discussed both in renal structure (R1) and in the nephrotic syndrome (R6). Repetition also occurs between the treatment of the oliguric phase of acute glomerulo-nephritis (R4) and the treatment of acute renal failure (R15). Exact repetition is obviously undesirable as it becomes boring and irritating to the students. To some extent it can be minimised by planning the whole of a large topic in advance, and here again the medical editor plays an important role. For example, in the course of diabetes mellitus the detailed consideration of renal threshold could have been discussed in 4 different presentations - the introductory talk on "The nature of diabetes mellitus" (D10), the presentation on the "Clinical features" (D11), the "Diagnosis of diabetes mellitus" (D12) or in "Treatment". By advance planning a decision was made to include the main discussion at the end of the presentation on "diagnosis". A similar problem arose with the adrenals - where the basic physiology of the gland and tests of its function were common both to Cushing's syndrome and to Adrenocortical Insufficiency. They are discussed in detail once (in Cushing's syndrome) and students are instructed to study the adrenal presentations in a set order. This technique also enables material taught in one presentation to be tested or reviewed in a later unit but it does mean that presentations are not necessarily complete in their own right.

Finally, the medical editor checks that the unit, when completed, will last for approximately the right length of time - in our experience about 20 minutes tape running time. This will take the student about 30-35 minutes to complete allowing for the time it takes the student to respond.

We have found it better to make two short tapes rather than one long one. Thus, it was possible to divide a long tape on hyperglycaemic coma into a tape on the "definitions and the underlying biochemical abnormalities" (D13) and another on the "clinical features and treatment" (D14). A student can easily do the two units together if he wishes to with very little extra effort but a natural break is built into the presentation should it be needed.

4.2.3 DRAFT PROGRAMME: DISCUSSION BY MEDICAL EDITOR WITH SUBJECT SPECIALIST AND EDUCATIONIST

The medical editor now has a script, an answer sheet and rough sketches of the illustrations. These are circulated to the subject specialist, to one of the educationists and to the second medical editor.

The subject specialist checks that the programme is factually correct and that nothing important has been left out. Quite commonly they change the emphasis on particular points. The educationist concentrates on the structure of the programme and the nature of the responses. It is also helpful to have his opinion as a person unqualified in medicine on the clarity of the material. The second medical editor also reads the draft and, in practice, provides an extremely useful second opinion since she has knowledge of the medical content and of the techniques of programming.

The various comments are discussed and a revised version is produced. If there have been major changes the programme is recirculated; otherwise the agreed modifications are simply incorporated.

4.2.4 PRELIMINARY TESTING OF PROGRAMME

The revised draft, together with the rough sketches for the illustrations, are tested on four or five medical students from the fourth year (the group of students for which the programme is designed). One at a time, the students work through the programme while the medical editor observes their performance. This gives considerable help: on whether the level of presentation is appropriate, on the design and wording of questions and on the layout of the answer sheet. The programme is modified accordingly.

We have also found it useful at times to test the programme on a second medical editor. Poor programme design, especially of the responses, is often picked up in this way.

4.2.5 PREPARATION OF SLIDES

The sketches are discussed with Mr. G. Donald (Director of the Department of Medical Illustration at the Western Infirmary) who has advised on illustrations throughout the project. Graphics are prepared by artists under his supervision. Medical editors check the final art-work for accuracy. They are occasionally consulted on colouring or symbols or to clear up ambiguities.

For programmes made in 1968-1969 (D1-9, T1-4, R1-18) black and white drawings were used. Slides which contained words only were typed on a proportionately-spaced I.B.M. Executive typewriter (bold face No. 1). In both cases, the negatives were coloured by hand to emphasise new or important points. Some of the drawings were made into positives and tinted.

Since 1969, full use of colour had been made in the programmes (D10-15, E1-8) and this has greatly widened the scope of the presentations. However, care is needed to avoid confusion with colour coding and a change of technique was necessary with slides that were previously typed as the negatives would not blend happily with coloured art work. Letraset is a possible solution, since it can be applied on a coloured background. This is effective and different weights or styles of lettering can be used for emphasis, however it is time-consuming. Less so is the I.B.M. Composer typewriter (price approximately £2,000) which uses different type faces for stress. Colour could then be added by diazo-photography (see Brinkmann 1963).

Art-work was supplemented by photographs of patients, investigations and equipment and these required a good medical photographer. In contrast, photography of the art-work was relatively simple as a Leitz Reprovit was used (see Morton 1969).

Initially slides were numbered on the mount only, as the presentations were primarily intended for use with automatically synchronised equipment. Slide numbers were therefore not projected. This proved unsatisfactory if students wanted to check or review slides. A number, which also appears when projected, is now added to the bottom left hand corner of art-work prior to photography.

Slides were sent to a commercial company (originally Humphries Fotofacilities Limited, 71-81 Whitfield Street, London, W1 and now to Filmstrip Services Ltd., Imperial Studio, Maxwell Road, Boreham Wood, Herts.) who prepared an internegative, i.e. a master negative (see Graves 1969) from which multiple copies are made. Currently the internegative costs approximately 3p per frame if the material is sent in the form of a film strip (if sent as individual slides the cost per frame is 37½p, the higher cost is due to the different technique used and, in contrast to a filmstrip, colour corrections can also be made to individual frames). Subsequent copies cost about 1p depending on the quantity ordered. This is the cheapest method of duplication if large numbers of copies are needed.

4.2.6 PENULTIMATE VERSION OF SCRIPT

The next version of the script was best prepared by two medical editors working together. The editor of the programme read the script aloud, acting as the tape-recording, and her colleague, acting as student, followed slides or answer sheet as instructed. The script is heard for the first time, hitherto it had only been checked in a written form and, as emphasised elsewhere, the difference is important. Prose and conversation have different styles and an attempt is made to ensure the script is in spoken form. Idiomatic expressions "it's", "I'd" and "let's" are used. Also, as emphasised earlier (see 4.2.2.4) repetitions, distasteful in prose, are actually desirable in spoken English to avoid ambiguity. For example "it" can be confusing in the sound-track of a tape-slide programme although acceptable in print where the eye can, if necessary, scan rapidly back to locate the parent noun. The solution in speech is to repeat the noun.

Although the script for each slide is corrected at this stage, the flow of presentation as a whole is lost. Therefore, after a suitable time interval (one-two weeks) it is useful to read the script aloud once more, two medical editors again working together. Some obvious mistakes in style will then become apparent.

The script is shown to the subject specialist for a final check. It is also given to the person making the recording (if not the subject specialist - see 4.2.8 and 6.1.1) as he may like to alter some of the wording to suit his personal style. Over the last two years the script has also been read by the producer (from the Television Service who will supervise the recording). He has also made useful comments on the readability of the scripts.

4.2.7 THE FINAL SCRIPT

In theory, no further changes should be made at this stage but only rarely is a script recorded without some alterations - fortunately these are usually trivial. Multiple copies of the script are needed for the recording session. These are prepared by stencil, which has the added advantage that stencil paper is quieter to handle and less liable to "crackle" during recording.

The script is laid out in such a way that the text relating to anyone slide is confined to a single page. The speaker then knows that there is a natural gap between one sheet and the next. Rustling of sheets, if recorded, can be edited out.

4.2.8 RECORDING

Recordings are made, to professional standards, by the television service of the University of Glasgow (Mr. R.M. Maclean, Director of Audio-Visual Services of Universities of Glasgow and Strathclyde; Mr. J. MacRitchie, Director of the University of Glasgow Television Service, Southpark Avenue, Glasgow) using a Ferrograph recorder at 7½"/sec. Initially, two versions of the recording were produced, a reel for use with the automatic system (see 4.3.1.1.1) and a cassette for use with the hand-operated equipment (4.3.1.1.2).

Early programmes were recorded in a small television studio but there is now a specially designed sound studio where the speaker is isolated in a small sound-proofed booth. Recording equipment and other personnel are housed in an outer room, separated from the booth by a glass partition. Communication with the speaker is possible via an audio link. The slides can be projected onto the wall of the booth if the speaker wishes to see them during the recording session.

Initially, recordings were made by a technician but over the last two years a "television" producer has also been present. The standard of performance has improved as a result. The medical editor is also present during the recording to deal with last minute problems. We have yet to decide whether the speaker should be a professional or the subject specialist himself. Both have been tried and as discussed later (6.1.1) there are problems with each.

Part of the script is rehearsed before it is actually recorded since this gives confidence to the speaker. The speaker should talk distinctly, at a pace which is slow enough to be understood and yet fast enough to prevent boredom: this can be difficult. Later when using the presentations, students may find the pace too fast or too slow but it is difficult to judge this at the time of the recording. The best approach is probably for the speaker to imagine he is talking to an individual student. If the speaker makes a mistake he stops (or is stopped by the producer) and is directed back to a convenient starting point. The technician marks the error in his script for subsequent editing. Although editing is not a difficult procedure in itself, recordings where extensive editing is necessary are often least satisfactory as the level and pitch of the recording varies.

The speaker also now records slide numbers. Originally these were omitted as the programme was primarily designed for use with automatically synchronised equipment (4.3.1.1.1) and they were added, at the editing stage, for the hand-operated equipment (4.3.1.1.2).

The advantage of including slide numbers is that students can more easily replay part of a tape. Unfortunately, some students are distracted by slide numbers, though they can be included as part of a sentence:- "As the next slide, slide 24, shows". On balance we prefer to have slide numbers included on the tape.

For the hand-operated equipment (see 4.3.1.1.2) some indication has to be given when to stop the tape and we chose a "ding-dong" noise for this. At first, these were added at the editing stage. They are now included at the recording session. The "ding-dong" can be edited out for tapes used with the automatic system (see 4.3.1.1.1).

After the master recording is made the tape is edited. The reels ($3\frac{3}{4}$"/sec) for the automatic system were copied by the television service. The cassette copies ($1\frac{7}{8}$"/sec) are made commercially.

4.2.9 ANSWER SHEETS

The function of the answer sheets has been described earlier (4.2.5). They are produced with the illustrations and script, and the final version, is duplicated by stencil. Each sheet has a heading giving the page number and title of the programme. They are now mounted in a paper file (Wilson Easifile E.4., Frank Wilson (Filing) Ltd., Southport at £6.25 per hundred), which enables pages to be turned as in a book. Sheets are typed on one side only leaving the opposite side free for additional notes. A list of references for further reading is included.

4.2.10 FINAL PREPARATION AND INTEGRATION OF PROGRAMMES

Tape

Multiple copies of the tape were produced: as cassettes for the hand-operated players and as reels for the automatic system. The hand-operated equipment had recorded instructions to change the slides, indicated by slide numbers, and to stop the tape, shown by a "ding-dong" noise.

In the automatic system, the slide changes were activated by impulses recorded on the second track of the tape and the tape was stopped by a sensing device which responded to foil. Both impulses and foil had to be added to the tape at this stage (see 4.3.1.1.1). The preparation of each reel took about one hour*.

Slides

Strips of film containing 35mm frames are returned from the processing company; they are then cut up into frames, mounted as slides and numbered. During the first year, most of this time-consuming work was performed by members of the project team. Subsequently it was done, for a small fee, by patients in a mental hospital as occupational therapy. (In the last eighteen months film strips have been used increasingly which eliminates most of this work).

Slides for the hand-operated system were stored in orange plastic boxes (approximately 9 x 5 x 5.5 cm - see Fig.3) and those for the automatic system (booth model) were loaded in magazines which were stored in outer boxes (approximate dimensions 12.5 x 22 x 6.5 cm). Duplicate sets of each tape-slide programme for the automatic system were kept for use in the audio-visual library. Over the experimental period (see later) a large number of extra copies were needed. Because it was impossible to keep these in expensive magazines the

(* This work was done 4-5 years ago and equipment is now available commercially which enables both the slide changes and tape stops to be activated automatically by impulses (Devans tutor - see Devlin 1973, or the Magister and Mentor marked by Sigmatron Ltd.).

extra sets were stored in cardboard boxes (empty slide mount boxes) and decanted during the experiment into magazines as needed. After use, the slides were returned to the cardboard boxes.

4.3 USE OF TAPE-SLIDE PRESENTATIONS BY STUDENTS

The combination of audiotape and 35mm slides can be used either by an individual working alone at the hospital or at home, or by groups working together. We have experience of all these approaches and the following sections outline the equipment and accommodation used. I shall also describe the audiovisual library which is available for undergraduate and postgraduate students.

4.3.1 INDIVIDUAL INSTRUCTION (STUDENTS WORKING ALONE)

4.3.1.1 Equipment

Simple hand-operated sets or highly sophisticated automatic equipment can be used. Each has advantages and disadvantages which are discussed later (6.2.1 and 6.2.2).

The manner in which the two systems operate is illustrated schematically in Fig.6. Using the automatic system students load the tape and slides on a machine, (in our case a Kindermann Audio-visual tutor machine). To start the 'play' button is pressed on the recorder. As the tape progresses slides change automatically in response to a coded signal on the tape. At intervals questions are asked and the tape stops automatically. Having answered the question, the student presses a green "restart" button.

Using the hand-operated equipment the student changes the slides and stops the tape himself in response to instructions on the tape. In all other respects the systems are the same except the magnification of the slides is much less with the hand viewers.

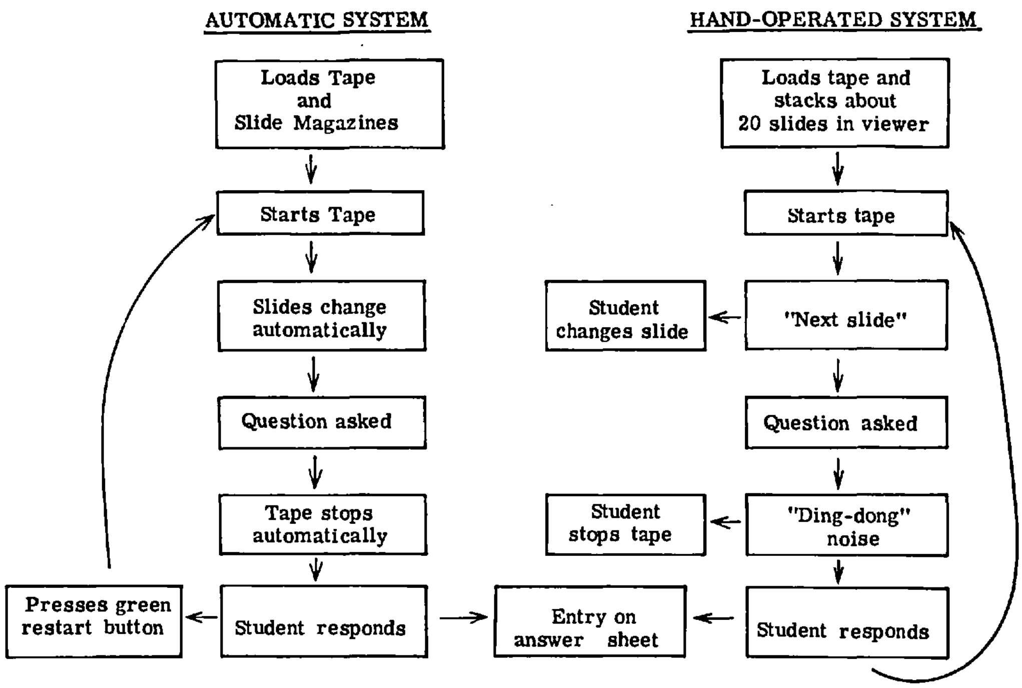


Fig. 6: The operation of the automatic and hand-operated system. The former relieves the student of the majority of the manual tasks.

4.3.1.1.1 Automatic system Ideally slide changes and tape stops should be automatic. However, in 1968 the only acceptable machine was the Frank-Kindermann audiovisual tutor machine and this needed modification before it could be used. The first version was supplied complete with a carrying-case (portable model shown later in Fig. 40) as described by Harden and Wayne (1968). The later version (Fig. 7) was supplied without a case and was suitable only for installation in study booths (Harden et al 1970a). Both models comprised a tape-recorder, an automatic slide projector, a screen and mirror system for back-screen projection, a slide synchronising unit and an automatic stop device.

The tape recorder in both versions was made by Loewe-Opta (Optacord 416D1A) and was of the reel-to-reel type. The largest reel it could accept was 4½" which was inconvenient as the Medical Recording Service released its tapes on 5" reels. The sound could be heard either through headphones or from a speaker. If additional amplification was needed for large groups a socket was also available for connection to an external loudspeaker. Although the machine was also capable of recording, only "playback" facilities were needed by students. Controls were simple and included "play", "stop", "fast forward", "rewind" and "record" bottons set in a keyboard style. "Pause", volume and tone controls were also present and a "counter" or marker, which allowed certain passages in a tape to be "marked" and subsequently located, was also included.

Different Kindermann slide projectors were used in the two versions: Kindermann 12NE Automat (portable model) and the Kindermann Automat 550L (booth model Fig. 7). Both were capable of automatic slide change and in both models it was possible to alter the slide currently being projected: that is, if the slide was out of sequence,

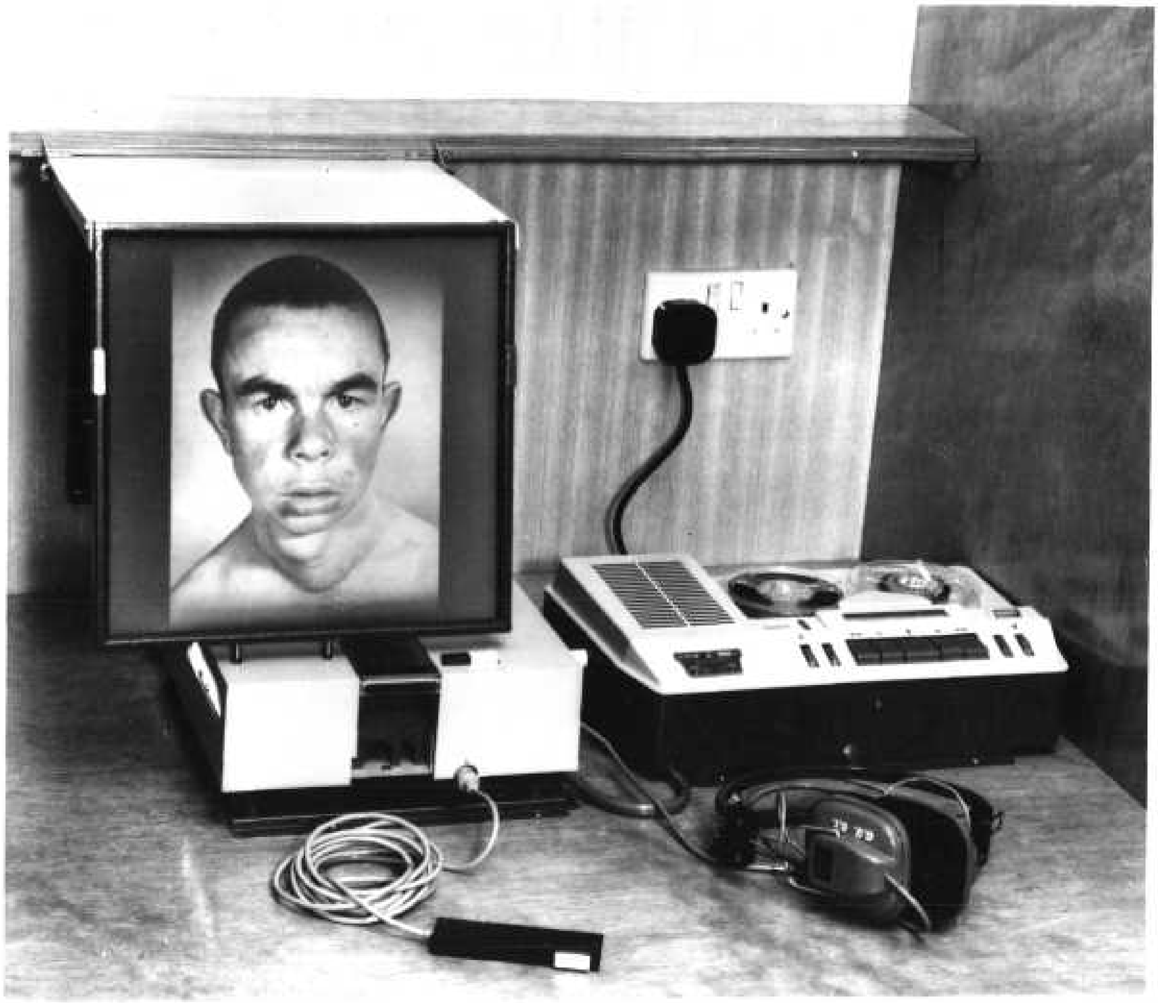


Fig. 7: The automatic projector with back-screen projection system and the tape recorder with a built-in synchroniser and automatic stop housed in a study booth.

or was projected upside down, it could be corrected without removing the slide magazine. The booth version was superior in that it also incorporated a remote control lead which allowed the students to return to earlier slides for revision. This was difficult to achieve in the portable model.

Slides were housed in magazines for both machines but in different types (see Fig. 8). The portable model took the Kindermann magazine (Kindermann No. 1048). The slides were held firmly in this as they were spring loaded and a plastic lid gave further security during storage. The booth model used the standard Leitz magazine. However, this does not grip the slides and they were liable to be dislodged. It is also necessary to put the Leitz magazine into an outer box for storage.

Both models were capable of 'front projection' on to a wall screen and both were supplied with a mirror and a small opal daylight viewing screen for 'back' projection. The portable model used a single mirror and a screen of eight inches square. The booth model (Fig.9) used two silvered mirrors and a larger screen - eleven inches square.

A unit synchronising slide changes with the audiotape was incorporated into the tape recorder. Slides changed automatically in response to an impulse of 50 cycles/sec. recorded on the second track of the tape in a mono 2-track tape player. Because the impulses were separated from the voice track, accidental slide changes (triggered off by a harmonic in the voice) did not occur. The impulses were added to the tape by depressing the "pulse record" key on the synchronising unit. A second "erase" key was present and allowed misplaced impulses to be corrected. Technically, the

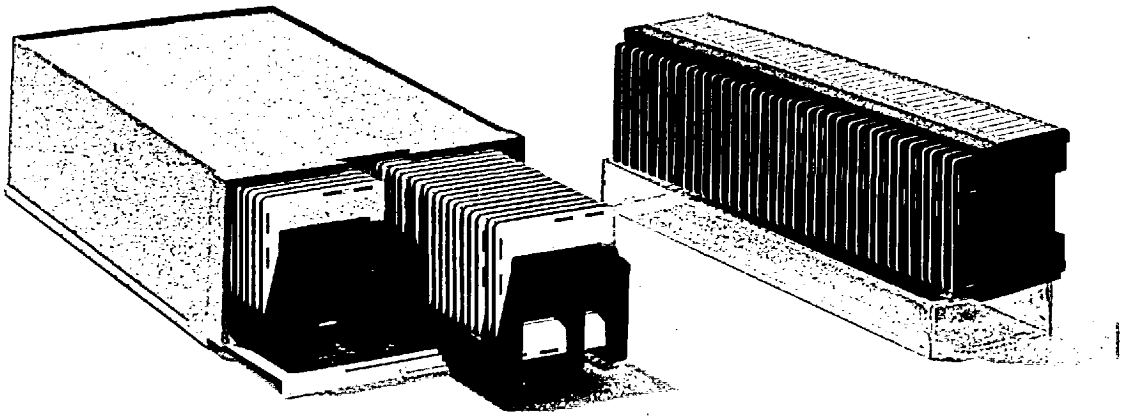


Fig. 8: Slide magazines for the automatic system. The storage box on the left holds two standard Leitz magazines (each containing up to 36 slides) which are used in the booth model. On the right, the Kindermann magazine used in the portable model holds 36 slides and is secured by the plastic lid seen underneath.

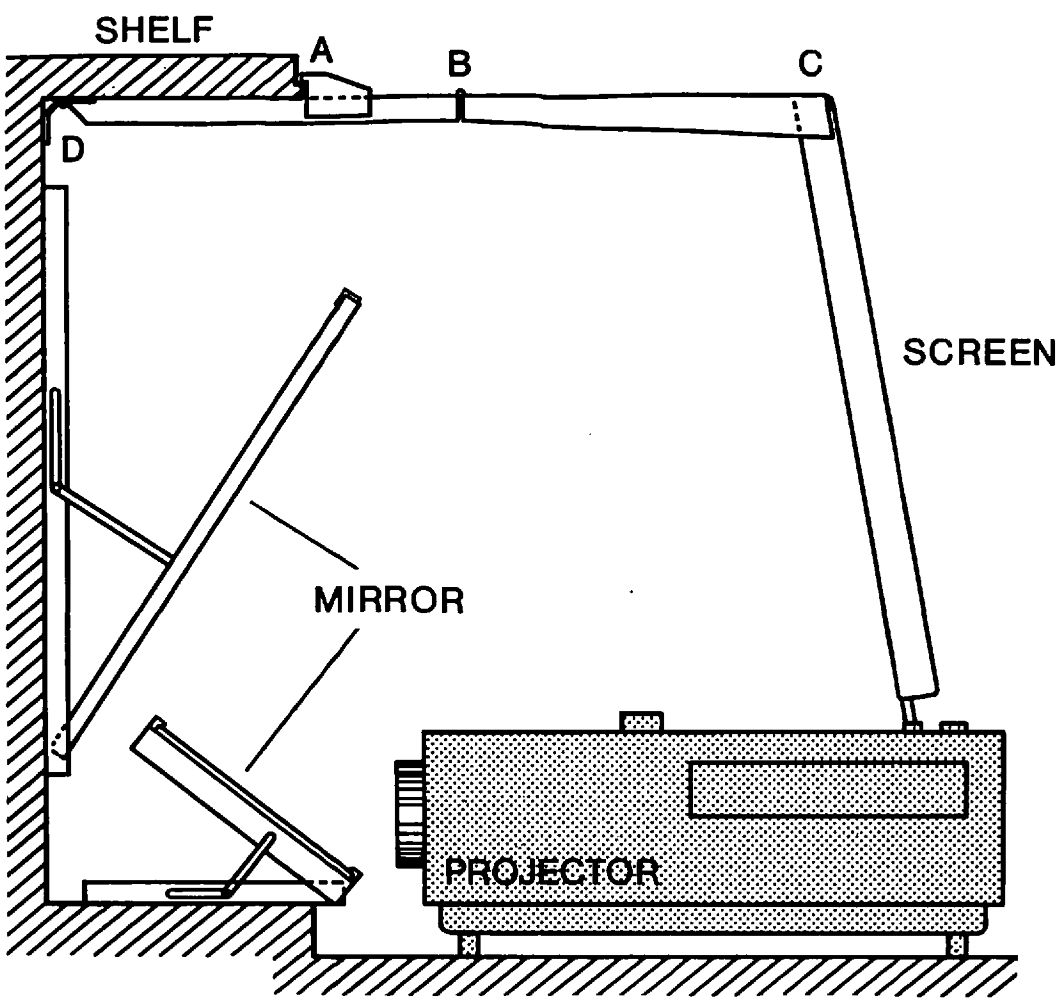


Fig. 9: Projection system for booth model of Kindermann. The image is reflected off the two silvered mirrors onto the screen from which two feet rest in sockets on top of the projector. One mirror is secured to the floor of the booth, the second onto the back wall. The screen is hinged at B and C and can be folded back on top of the shelf to allow easy access to the projector. By release of the spring clip (A) the screen can be folded flat against the wall (D also being hinged).

addition of impulses was simple, the only minor problem was to estimate how long to keep the button depressed and this came with experience. If too brief the impulse was not recorded on the tape and therefore a slide change would not occur. If the duration was too long, two impulses with a double slide change would result. Each reel had to be individually synchronised.

The portable model incorporated a sensing device which responded to a length of foil by stopping the tape (designed to halt a spool at the end of a reel). We were able to exploit this facility (although the sensing device had to be added to the later booth models) and stop the programme after each question by adding $1\frac{1}{2}$" strips of adhesive foil (such as is normally used to edit videotape and marketed by C.W. Cameras Ltd., Burnfield Road, Giffnock, G46 7TH) to the back of the tape every time a stop was required. It took about one hour (including adding the impulses for slide changes)to prepare each tape in this way. A green "restart" button was added to all machines to enable students to start the tape again easily after a stop.

4.3.1.1.2 Hand-operated equipment Money can be saved by using cheap mass-produced tape recorders and slide viewers. Typical equipment is shown in Fig.10. The following were tested.

Cassette tape-recorders There are now a large number of cassette recorders available ranging from cheap single channel ("mono") players to expensive stereo equipment. Economy was important and in 1968 the newly developed Phillips "Cassettophone" became available at approximately £13.13s.0d; it was one of the first players to have only playback (and not recording) facilities. As indicated earlier,

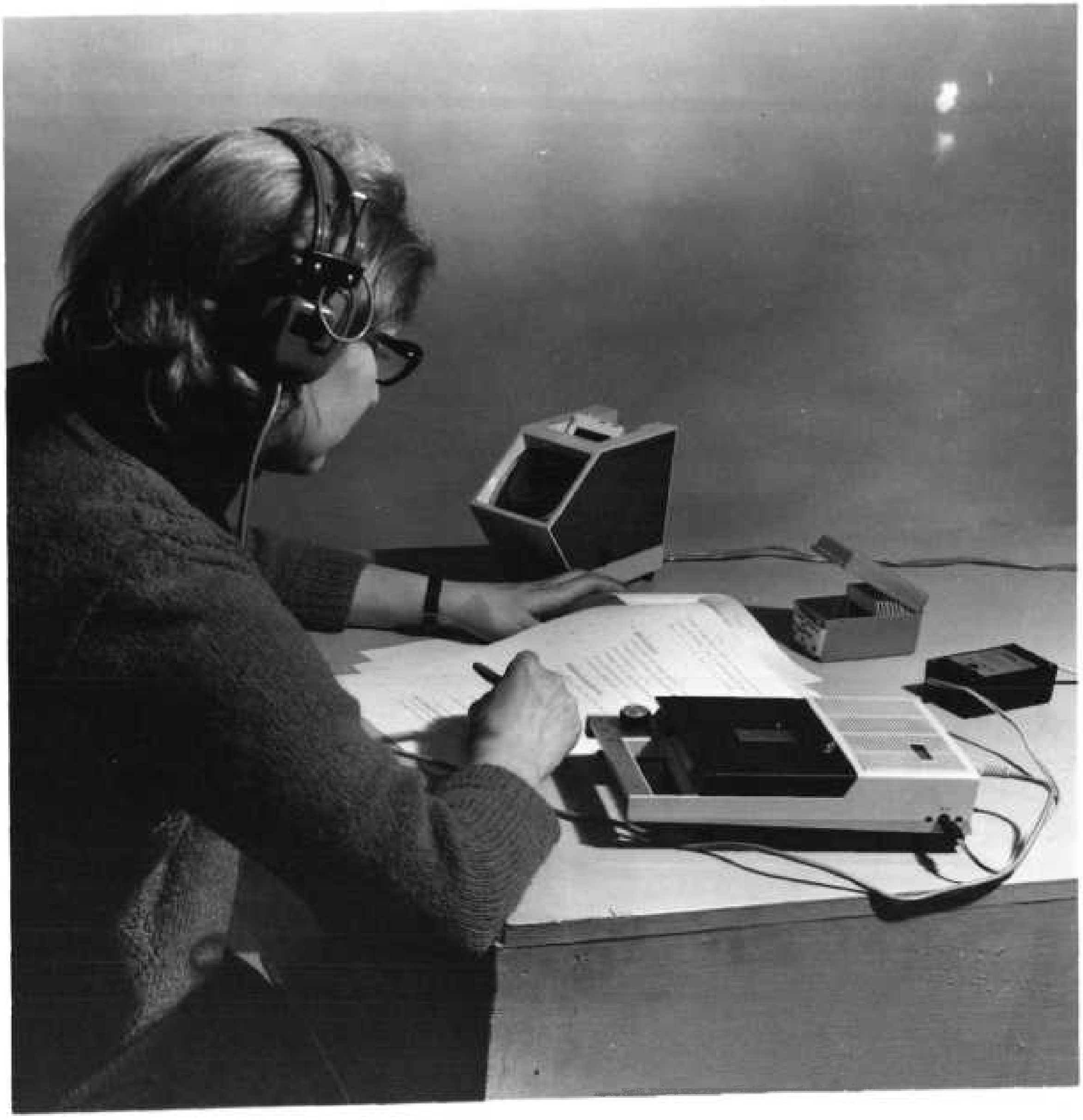


Fig. 10: Hand-operated equipment in use. The tape-recorder (Phillips cassettophone) is used with a mains adaptor and was modified to allow a headphone attachment. The slides are viewed in a semi-automatic hand viewer (Zeiss Ikon).

this was ideal for our purposes as recording facilities were superfluous. Controls were simple and comprised "play", "stop" and "fast forward". However, there was no "rewind" and this proved a disadvantage. Although it is possible, though tedious, to rewind the tape by removing the cassette, reversing it and using the fast forward control. The machine runs on batteries or on mains (a transformer is necessary). We preferred the latter as batteries last about ten hours only.

A further disadvantage of the cassettophone was the absence of a socket for headphones. The sets were adapted locally but the modification silenced the external speaker making it impossible to use the equipment without headphones. Phillips have since withdrawn this model and the replacement (Phillips N2000) has both a headphone socket and a rewind device. However, the latter is rather slow (see Table 17) which the students find a nuisance. Of the other cassette players tested a number had the unnecessary record facility (see Table 17). Although there is now an increasing number with play-back only, the Scan-Audio and the Mentor are examples - the latter, which has not been tested by us, incorporates an automatic tape-stop and slide change. In our experience, no single player stood out. If economy is an important consideration, the new cassettophone, Phillips N2000, is probably the best (Table 17). The Scan-Audio is a better machine with easier controls and a faster rewind but is more expensive. Recently, other machines have come onto the market which we have not tested.

Semi-automatic hand viewers Because the majority of programmes made in 1968-1969 had between 50 and 72 slides it was decided to use semi-automatic hand viewers (see Fig. 11). In these, it is possible to stack load 15-20 slides and it is therefore relatively easy to change

Table 17

CASSETTE TAPE-RECORDERS

Model	Rewind time (C60 cassette)	Play-back/ record facilities
Phillips 3302	54 secs	Both
Phillips 2202	59 secs	Both
Hitachi 201	1 min 0 secs	Play-back only
ScanAudio 101	1 min 15 secs	Play-back only
Ferguson 3240	1 min 38 secs	Both
Phillips N 2000	2 mins 40 secs	Play-back only
Phillips Cassettophone	2 mins 50 secs	Play-back only

Fig. 11: Semi-automatic hand viewer

From left to right - Zeiss Ikon, Photax Solarmatic, Cenei-H-Scoper and Sawyer's Panavue. Each is capable of holding between 15-20 slides.

slides in contrast to the simple viewers where one slide is inserted at a time.

The following types were tested: the Zeiss Ikon, Photax Solarmatic, Sawyers Panavue Auto, Cenei-H-Scoper "Super", Boots Auto slide viewer (Harden et al 1970b). Slides were changed by operating a lever, either horizontally (Photax, Panavue, Cenei-H-Scoper, Boots) or vertically (Zeiss). The Zeiss and Cenei-H-Scoper operated from the mains only, the Boots only from batteries; the Photax and Panavue could be used with batteries or from the mains (with a transformer). Where possible viewers were used with the mains. The Zeiss Ikon (price approximately £10) proved the most popular model with students as it was the easiest to operate.

Instead of separate 35mm slides, 35mm film strip can be used. For reasons to be discussed this may be preferable as a long-term solution. Filmstrips can be used with some small projectors with the appropriate attachment (e.g. the Elmeo, Haminette 100), with special filmstrip projectors (e.g. the Taylor-Halliday) or with a hand-viewer (Agfascop 10). Unfortunately the choice is limited as most equipment is only for half-frame size (18 x 24 mm), the American standard.

We have tested both small hand-operated projectors (the Haminette 100, Arnold's) and a simple filmstrip viewer (the Agfascop 10 see Fig. 12). The latter is simple to operate and this compensates for its rather poor magnification. This could be a disadvantage in histological slides.

4.3.1.2 <u>Accommodation</u>

4.3.1.2.1 <u>Study booths</u> Automatic equipment was housed in study booths

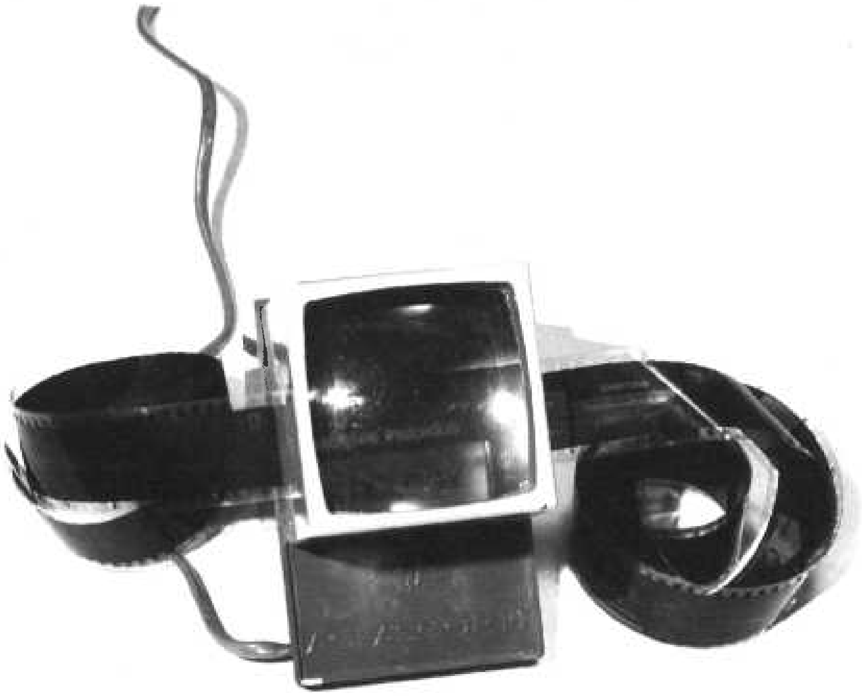


Fig. 12: Film-strip viewer: Agfascop 10

This is mains operated and simple to use. The film-strip is inserted at one side and is pulled through manually to change the frames.

(Fig.14). A room previously used for tutorials, staff meetings, group presentations of tape-slide programmes and so on was divided into two (as shown in Fig.13), one section was left as a small seminar room, furnished with a table, chairs, blackboard, slide projector, screen and a tape recorder. The other section was sub-divided into eight study booths, designed and made locally (Fig.14); four booths were placed along each long wall. Each was provided with a lockable cover to keep the equipment dust-free and as a security measure. Ventilation and lighting were both a little unsatisfactory and should be improved.

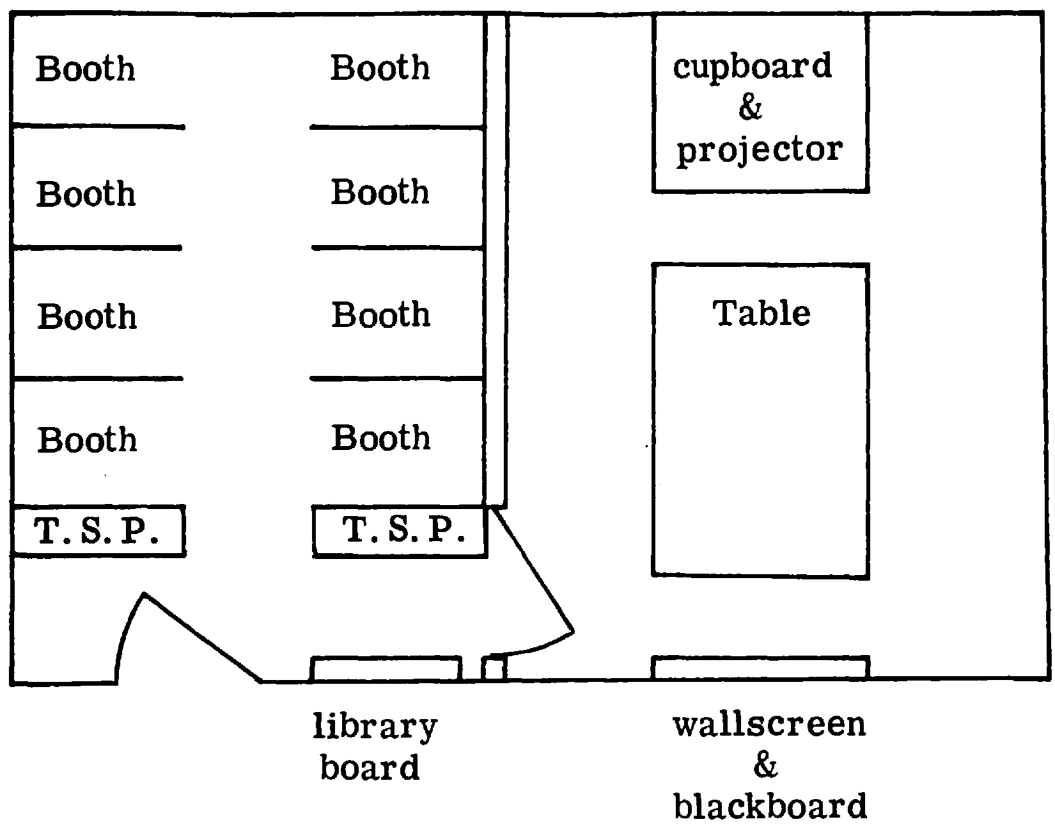
4.3.1.2.2. Accommodation provided for hand-operated equipment In the first two years (1968/69, 1969/70) during the experiment, simple equipment was laid out in the seminar room (shown in Fig 13) on collapsable desks. Subsequently (in 1970-71 and 1971-72), the equipment was available for use within the department during the day but the students were also allowed to take it home at nights or at weekends, packed in cheap suitcases (purchased from Boots, British Home Stores and Littlewoods) padded with foam rubber.

For the session 1972/73 the whole fourth year (approximately one hundred students) was taught endocrinology by self-instruction. Seven sets of equipment, using predominantly film-strip, were housed in the study booths and four in a nearby room. During the second term seven sets were also available for home use.

4.3.2 GROUP INSTRUCTION

Group instruction may take several forms: students may spontaneously elect to work together and do a presentation of their own choice, or a particular presentation may be advertised for a certain time and the students can choose whether or not to attend.

DIVISION OF SEMINAR ROOM



(not to scale)

Fig. 13: A seminar room was divided as illustrated. The tape-slide programmes (T.S.P.) are kept in open shelves outside the booths. The booth area can be shut off by a sliding door (not shown).

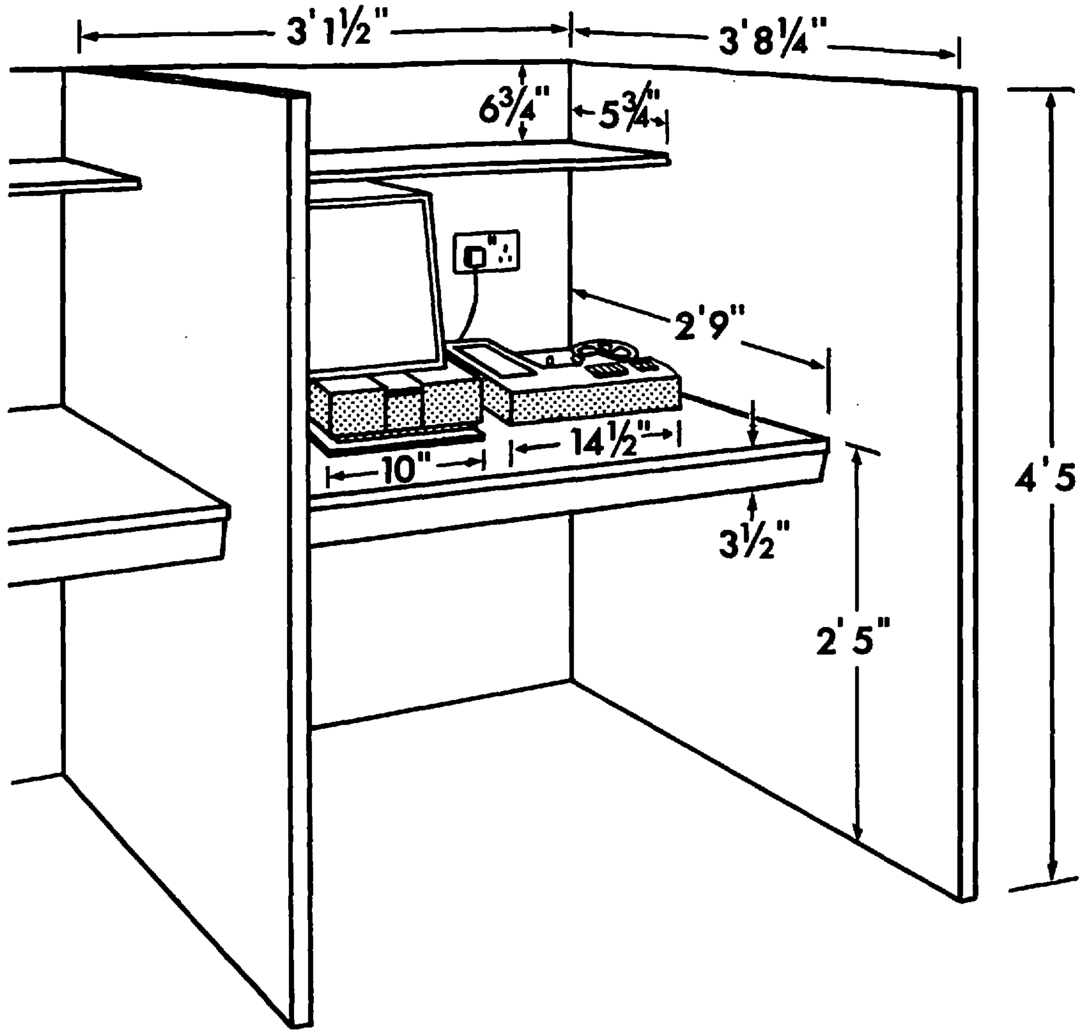


Fig. 14: <u>The design of a study booth</u>

The side walls project above and beyond the table top to allow students some privacy. Spare tapes and slides can be stored on the shelf above the booth. The student has a minimum working depth in front of the projector of 15 inches. A lockable cover (not shown) secures the equipment.

Students may also be selected for a schedule presentation. We have little experience of the first arrangement although it is commonly used in Newcastle (Amos et al 1969) where there is one set of equipment in a fairly large room with the slides projected onto a wall screen. Our own booths are designed primarily for individual use and we have had few requests for group learning.

Scheduled group presentations were given in 1968/69 to the postgraduate students; each week a tape-slide presentation was put on at a fixed time. This was voluntary and the size of the audience varied between four and twelve. However, as the restrictions of working in a group became more evident (e.g. fixed time, fixed place, pre-selected presentation) and as the facilities for individual instruction improved, this form of teaching was abandoned. The third form of group teaching was used during the experimental period between 1969 and 1972 and the results will be discussed in detail in the results section (5.3, 5.4, 5.5).

4.3.2.1 Equipment for Group Instruction

Originally a Ferrograph tape recorder and a Leitz slide projector were used (Fig.15).Automatic slide change was provided with an external Phillips synchronising unit (Harden and Wayne 1968).

Later, for some groups during the experiments, a portable model of the Kindermann was used. The slides were projected onto a wall screen (the back of the case and the mirror system being removed) and sound was amplified through an external speaker. For some of the experimental groups a non-automatic system was used; the supervisor, a member of the project team, changed the slides by remote control and stopped the tape recorder manually.

Fig. 15: Equipment for group instruction

The slides are thrown on to a wall screen by the Leitz slide projector. The Phillips external synchronising unit can be seen adjacent to the Ferrograph tape recorder.

One drawback of group teaching is that individual students work at different rates (see results section). As a means of indicating whether individual members of the group were ready to restart after a question the "Responset" (lent by Findlay Irvine Ltd., Penicuik, Midlothian) a commercially available signalling or feed-back device, was used during the experiments. This was technically successful as the supervisor had an overall view of the group's state of readiness.

4.3.3. LIBRARY FACILITIES

The audiovisual library is used by undergraduate and postgraduate students. At present, booths are open from 9 a.m. to 5 p.m. but students can also collect keys before 5 p.m. and use the booths in the evenings or at weekends. Each booth has an individual lock and key which makes checking possible and confines any damage by an inexperienced student to a single set of equipment. In practice little damage has occurred.

A catalogue of presentations, held in the library, is displayed on a Strafoplan (Fig.16:Peter Williams (Filing Systems) Ltd., London). Additional information held on the card includes the source of the programme (e.g. Western Infirmary, Glasgow, Medical Recording Service Foundation and so on), the length of presentation, the number of illustrations, a brief summary and an indication of the intended audience, e.g. preclinical, clinical, postgraduate students, nurses or paramedical personnel.

4.3.3.1 Storage and use of programmes

All the tape-slide presentations (except the programmed ones used in the experiments) are kept on open shelves outside the booths (as Fig.13 shows). Some of these presentations were prepared in the

Fig. 16: Library board

The programmes are classified by subjects. Only the titles are revealed when the cards are in position. Additional information relating to a programme can be obtained by withdrawing the card.

Gardiner Institute but a large number have come from other centres; the major source is the Medical Recording Service, who not only prepares material but also acts as distribution centre. A student collects the tape and slides from the shelves and goes into a booth to listen to the programme. We have had very few breakages or loss of slides. Generally, the students have acted in a responsible way with the equipment.

In addition to tapes held permanently in the library 3 tapes of topical interest for the fourth year (i.e. relevant to integrated year course) are borrowed from the Medical Recording Service for periods of three weeks.

4.3.3.2 Staff

One full-time secretary-technician spends about 25% of her day (more during the experiments) running the library service for students. Once a student has been shown how to operate the equipment very little help is needed - a bulb may have to be changed, for example. Other members of the project team also help in busy periods as during the experiments when a large number of inexperienced students arrive together.

4.3.3.3 Use at home

We have allowed students to borrow the hand equipment overnight or at weekends. This is popular, but it creates administrative problems unless separate sets of equipment can be provided solely for this purpose. This reduces utilisation of equipment and increases costs.

4.3.3.4 Questionnaire

After finishing a presentation, students are asked to complete a short questionnaire as a record of how much the programmes and equipment are used. The student is also asked for his name, his seniority and the time taken to complete the presentation. Space is left for comments.

Before a student starts a presentation he places the (questionnaire) card in the appropriate pocket of a plastic folder (Fig. 17). Each booth has a separate pocket and thus a card in a pocket indicates an occupied booth (Fig. 17).

In the session 1972/1973 a time clock (Time Recording Co. Ltd. International, 22 Renfrew Street, Glasgow, G2) was used to stamp cards with the date and time of commencing and finishing a presentation.

4.4 SUMMARY

This section of the thesis describes the preparation of a programmed tape-slide presentation and outlines the equipment and accommodation used.

The following section on "Results" is concerned primarily with an evaluation of the tape-slide material, their associated equipment and with the different methods of presentation.

Fig. 17: 'Occupation' of booths

Booths three and six are occupied as shown by the cards in the plastic pockets. On completing the presentation the students note what time they finished and place the card in the "used card" box.

5. RESULTS

5.1 INTRODUCTION

The plan of this thesis was to consider the preparation of tape slide presentations in the section on methods and their testing on students in the present section on results. This has meant including under "results" some of the methods used to test students.

The plan of experiments was as follows: in 1968/1969 twelve students were selected at random from the fourth year course and an attempt was made to determine whether their performance in class examinations was affected as a result of covering the endocrinology section of the course by tape-slide presentations; the students' attitudes to the programmes were also assessed. The following year, with more presentations available, more students were involved and we began a study of group presentations, comparison was made with individual instruction. In the light of the results we modified the form of the group presentations the following year (1970/1971). Comparison was made of different forms of group instruction and we also organised a lending service for the hand-operated equipment.

By 1971/1972 sixty students were involved and in 1972/1973 the entire year, 100 students, were able to study endocrinology by the tape-slide technique. In the first study most emphasis was placed on a comparison of performance in examination. For reasons alluded to (3.4) some doubt exists on the validity of such comparisons. Therefore although these were made in the following two years other factors such as the method of presentation and the students' attitudes were also assessed.

There are approximately two hundred students in the fourth year at the University of Glasgow. Of these, about one hundred attend the Western Infirmary for a formal course of so-called integrated topic teaching in medicine and surgery (Illingworth 1964). A similar course is run at the Royal Infirmary for the remaining one hundred. At the Western Infirmary, students are taught in large groups by lectures, demonstrations, seminars or panel discussions and clinico-pathological conferences. The course starts at 11.30 a.m. daily and lasts until about 4 p.m. Clinical teaching takes place between 9-11 a.m. and for this students are divided into four groups each attending a different clinical unit.

5.2 1968/1969 COMPARISON OF LECTURES AND TAPE-SLIDE PRESENTATIONS

5.2.1 AIMS

In the first experiment to be described, tape-slide programmes were substituted for part of the lecture course in endocrinology. The aims of this experiment were firstly to compare the examination results of the twelve students using tape-slide materials with those of the remaining students who were taught conventionally and secondly to assess the students' attitudes to the new system. The equipment was also assessed. In addition to the main study, the efficacy of the programmes themselves were tested on a small number of final year and postgraduate students.

5.2.2 EXPERIMENTAL DESIGN

5.2.2.1 Students

In 1968/1969, there were 98 students in the fourth year at the Western Infirmary; its composition and that of the experimental group is shown in Table 18.

Table 18

1968/1969 COMPARISON OF TAPE-SLIDE PROGRAMMES AND LECTURES: COMPOSITION OF GROUPS STUDIED

	U.K. Males	U.K. Females	Europeans	Africans	Asians	Total
Total Class	59	25	4	6	4	98
Unit* I	17	6	2	3	2	30
Experimental Group	7	2	1	1	1	12

* The total class is sub-divided into 4 units (clinics) for its clinical work. The experimental group was randomly selected from Unit I.

5.2.2.2 Programmes Used

Diabetes Mellitus (D1-D9 see Table12) and thyroid disease (T1-5 see Table13) were then available as programmed tape-slide presentations. These subjects were normally covered during the first two weeks of the three week course in endocrinology. During this fortnight, therefore, students in the experimental group used the tape-slide programmes while the rest of their year attended the conventional lectures. Otherwise, the whole year, experimental and control groups, had the same clinical demonstrations and seminars.

5.2.2.3 Equipment

Both automatic (4.3.1.1.1) and hand-operated equipment (4.3.1.1.2) were available and students completed seven presentations on each, thus gaining experience of both techniques.

5.2.2.4 Examination: form and marking system

Students were assessed by multiple-choice examinations of the true-false type (see Royal College of Physicians 1967) and scored as described by Harden et al (1969d). The answer sheets were specially designed for this type of examination, the layout being based on a feature card (Lever et al 1970). To answer a question a student puts a cross in the appropriate square. To mark the completed sheets two answer sheets are prepared: one has all the correct answers punched (correct mark + 1), the incorrect mask (-1) has all the wrong answers punched. The correct mask (+1) is then superimposed on the student's answer sheet and the crosses made by the student, are counted. This is repeated with the incorrect mask (-1). The sheets can be scored manually or mechanically by a feature card scanner and marks can be calculated.

The same examination and marking system was used in the other experiments. The only exception was part B in March 1969 which was completed on computer cards and kindly marked by F.T.C. Harris M.D. Buckley-Sharp at the Middlesex Hospital.

5.2.3 EXAMINATION RESULTS

The first multiple choice examination was held in December 1968. This covered subjects taught by conventional lectures during the autumn term (cardiology and respiratory disease). In March 1969, six weeks after completing the endocrinology course, a second examination was held. This was in two parts: the first consisted of 180 items (i.e. 30 questions each containing 6 parts) in renal disease and gastro-enterology; both topics being covered by lectures - the former in December 1968, the latter in February 1969. The second part consisted of 120 items covering subjects dealt with by tape-slide programmes - diabetes mellitus and thyroid disease.

The examination results are shown in Table 19. In December 1968 and part A in March 1969 the marks scored by the three groups were not significantly different from each other (December 1968 Group A v. Group B $t = 0.97$, $p > 0.05$; Group A v. Group C $t = 0.69$, $p > 0.05$; March 1969, part A, Group A v. Group B $t = 1.65$, $p > 0.05$; Group A v. Group C $t = 1.31$, $p > 0.05$). However after the tape-slide presentation course the experimental group (Group A) scored significantly higher marks than students in the same clinic, Group B ($t = 6.43$, $p < 0.001$) or those in the other units, Group C ($t = 8.34$, $p < 0.001$). Possible reasons for these findings are discussed later (6.6).

Marks for individual students are shown graphically in Fig. 18, 19 and 20. Before the experiment in December 1968

Table 19

1968/1969 EXAMINATION RESULTS

	Group A Experimental Group	Group B Rest of Unit I	Group C Rest of Class (Units II III IV)
No. of Students	12	18	68
Dec. 68 Mean	53 (2.9)	50 (1.9)	51 (1.1)
Part A Mar. 69 Mean	59 (3.7)	52 (2.3)	55 (1.2)
Part B Mar. 69 Mean	75 (2.6)	48 (2.9)	50 (1.2)

The number in brackets is the standard error

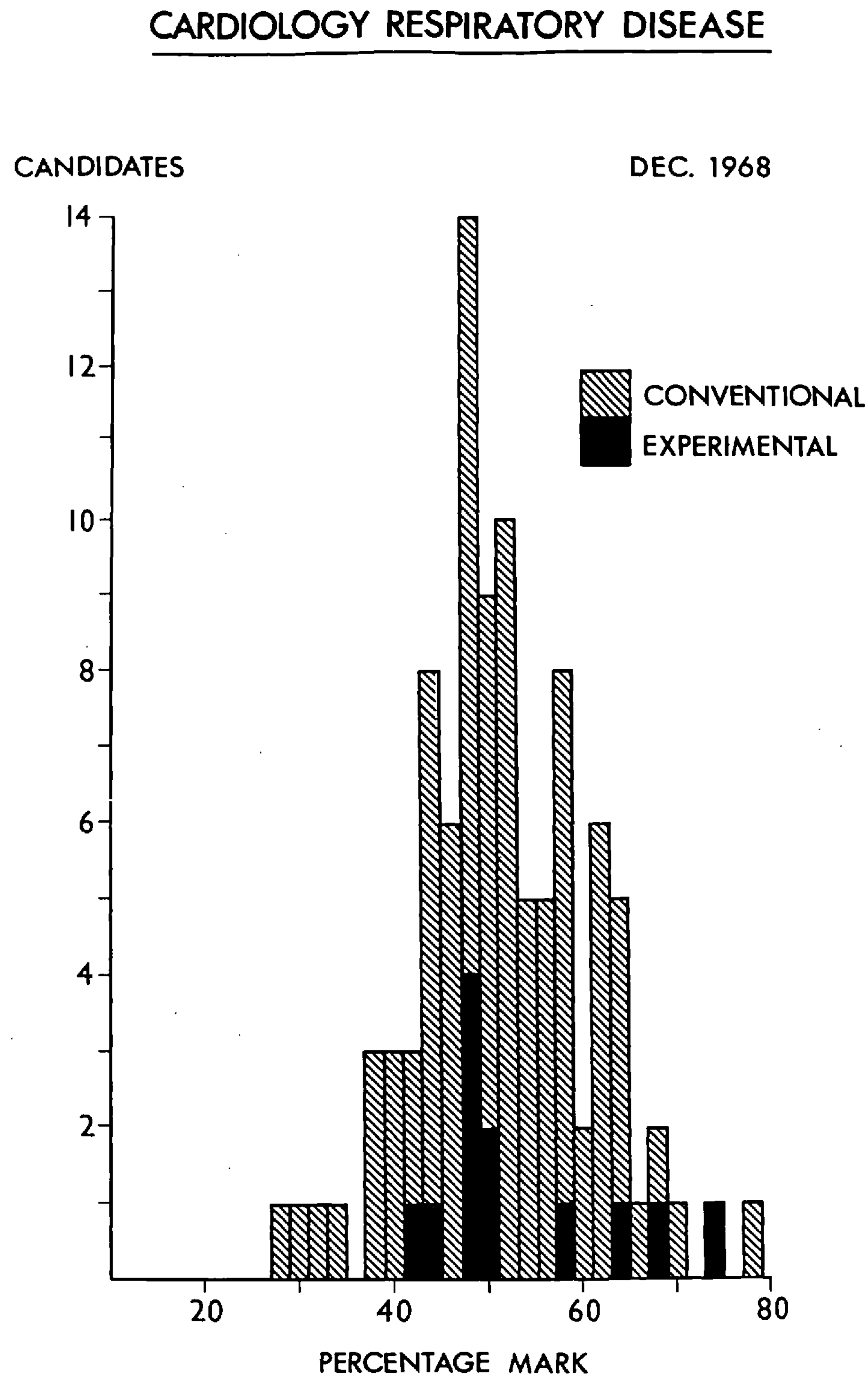


Fig. 18: Students' scores in December 1968, in examination covering the previous term's work, in cardiology and respiratory disease, taught conventionally,

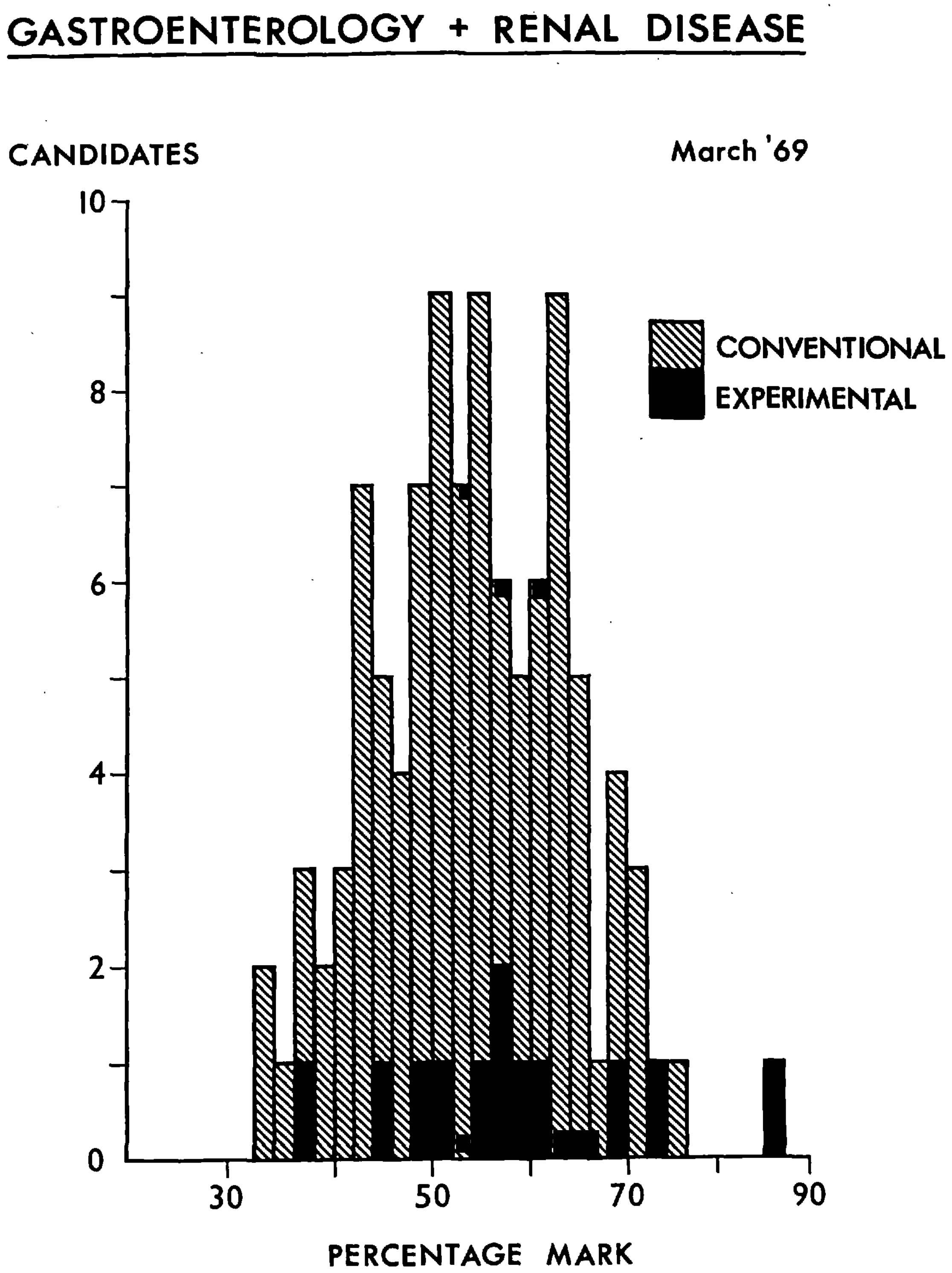


Fig. 19: Students' scores in March 1969 (Part A), covering gastro-enterology and renal disease, subjects taught to all students by conventional lectures.

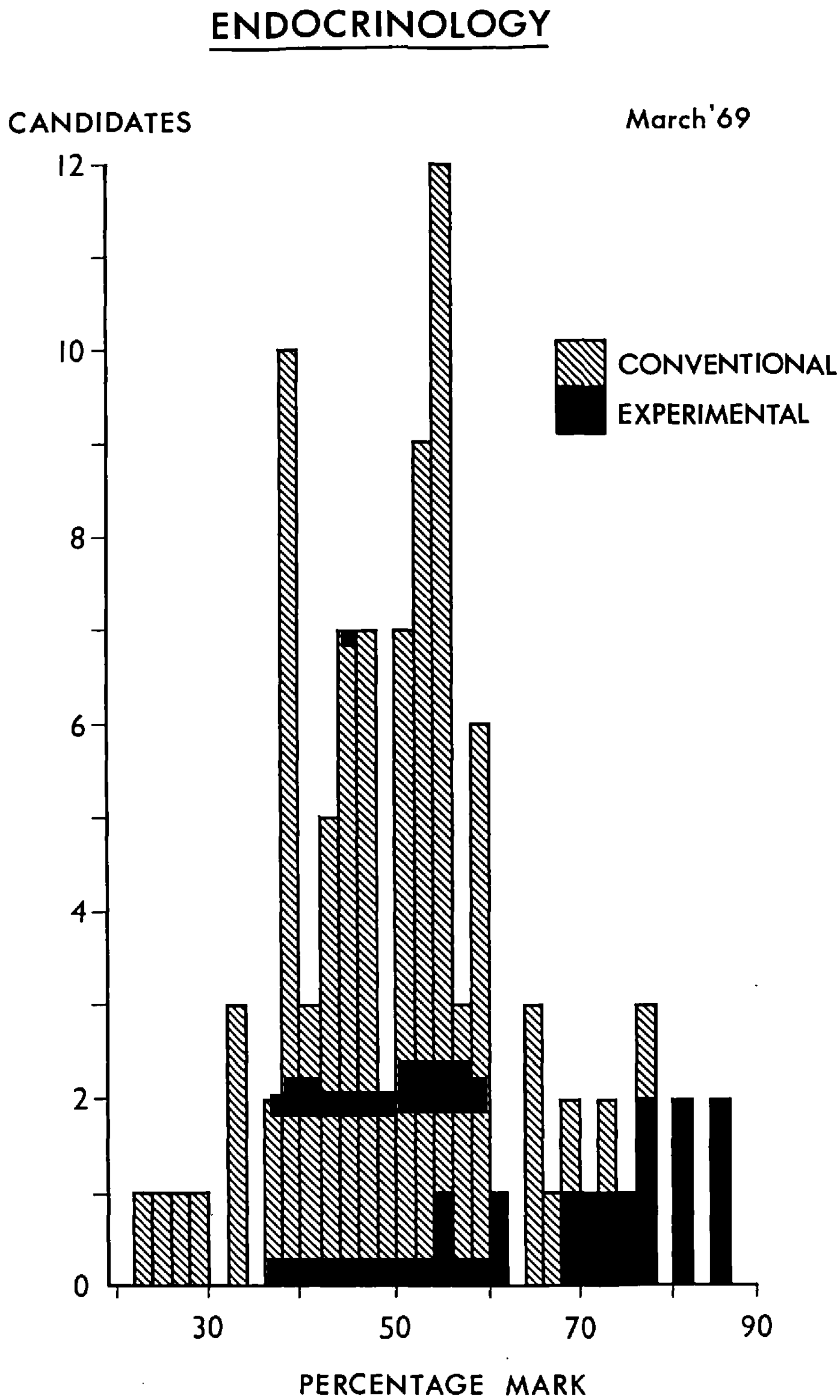


Fig. 20: Students' scores in March 1969, (Part B) covering endocrinology; the experimental situation.

(Fig. 18) and in the control situation after the experiment (Part A March 1969, Fig.19) the twelve experimental students seem evenly distributed amongst their colleagues and thus representative of the year as a whole. In contrast, in the experimental situation (Fig. 20) the twelve students not only scored higher marks as a group but also improved their individual marks in relation to the rest of the class. The latter became more apparent when changes of rank order were studied and as shown in Fig. 21 the twelve experimental students all moved into the top third of the class and they have all, with one exception, improved their position. It is interesting to note that this student was the only one with an unfavourable attitude to the experiment and who considered many of the questions too trivial to complete; he was intelligent and was also doing a B.Sc. course. The most marked improvement was shown by foreign students who previously (December 1968 and Part A March 1969) had been in the bottom third of the class.

These results have been published (Harden et al 1969c).

5.2.4 <u>ATTITUDE QUESTIONNAIRES</u>

One week after the experiment, the twelve experimental students completed the attitude questionnaire shown in Appendix D. Favourable and unfavourable statements were randomly mixed in approximately equal numbers and the students were asked to respond to the statements on a five-point scale ranging from "strongly agree" (5 points) to strongly disagree (1 point). To facilitate analysis, the marking system is reversed for a negative or unfavourable statement such as "I would <u>not</u> advise next year's students to take part in a similar experiment", here "strongly

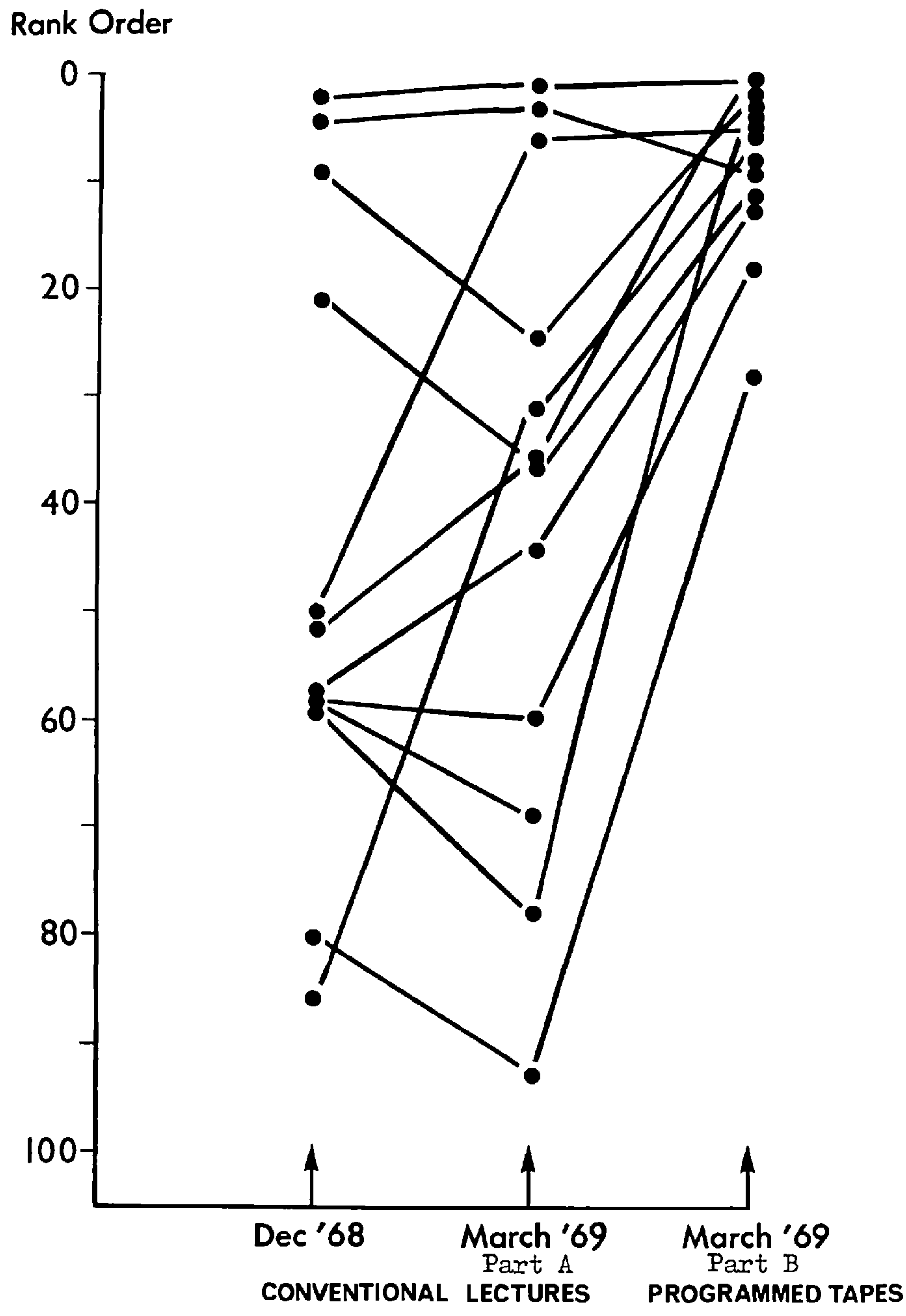


Fig. 21. Rank order of the 12 students in the experimental group in the December examination, and Parts A and B in March 1969.

agree" is scored as 1 and "strongly disagree" as 5. In this way, all favourable attitudes to the experiment score high marks (over 3) and all unfavourable ones low marks (under 3). In addition, students were also asked to list three advantages and three disadvantages of the system.

As Tables 20 and 23 show the overall reactions of the students were favourable. They felt the technique should be extended to other lectures in the course: a number of students suggesting specific subjects. Later experience has borne out their assertion that they would use the equipment outside normal office hours. The advantages cited are shown in Table 21. The ones commented on most frequently were that that it was easier both to concentrate and learn with this technique and students also liked the ability to work at their own speed. The main disadvantages (Table 22) centred on the antisocial nature of individual learning: students were separated from their colleagues and coffee drinking was interrupted as they tended to finish at different times.

Table 23 shows the overall responses to the different sections of the questionnaire. Although the hand-operated system was acceptable it also provoked the most criticisms; 35% of responses were definitely unfavourable. A more detailed analysis is given in Tables 24-27. A number of interesting points emerge. Although students preferred the automatic equipment to the hand-operated system they were uncertain whether the increased cost of the former was justified. In addition, students still found it easier to concentrate with the hand-operated system than at lectures, although the system was not as popular as the automatic one. As Table 26 shows, the students were unanimous that slides

Table 20

1968/1969 RESULTS OF GENERAL SECTION OF STUDENTS' ATTITUDE QUESTIONNAIRE

I am glad I took part in the experiment	4.6
I would advise next year's students to take part in a similar experiment	4.0
I would like to see this type of teaching replace some other lectures in the integrated year course	4.3
I learned more going through these programmes than I would have done at the lectures	3.9
Although I spent longer going through the programmes than I would have done at the lectures, it was worth it	4.4
This type of teaching requires more supplementing in tutorial discussion groups than lectures do	3.0
I shall have just as much work to do at home as I would have had if I had gone to the lectures	2.7
If the equipment was readily available I should make use of it for private study and revision	4.0
I would be willing to use the equipment at times outside normal lecture hours (i.e. at weekends or in the evenings)	4.4
I am more likely to attend an auto-instructional session than I am to go to a lecture on the same topic	3.1
This teaching method seemed more effective to me at the end of the experiment than it did at the beginning	3.4
A supervisor with medical knowledge of the content of the programmes is necessary during these sessions	2.5
A technical supervisor is necessary	4.5

Each statement was marked by the student on a five-point scale as follows:
strongly agree (5) agree (4) uncertain (3) disagree (2) strongly disagree (1).

Results shown are the mean for the group.

Table 21

1968/1969 ADVANTAGES OF TAPE-SLIDE PROGRAMMES*

	No. of Students
Easier to concentrate than at lecture	8
Learning made easier	7
Working at one's own speed is good	5
Answer sheets found valuable	4
Able to choose own time	3
One is kept busy "participating"	2
Able to repeat part of programme	2
Lack of boredom	2
Personal instruction	1
Less dependent on quality of lecturer	1
Encourages more regular attendance	1
The presentation is more systematic	1

* The students were asked to list three main advantages of this method of teaching. Their answers have been paraphrased for convenience as a number of students made similar statements

Table 22

1968/1969 DISADVANTAGES OF TAPE-SLIDE PROGRAMMES

Antisocial	5
Eye strain	4
Lack of humour	3
Longer to cover course	3
Response sheets inadequate	3
Too elementary	2
Technical difficulties	1
Background noise	1
Expense	1
Absence of lecturer	1

The students were asked to list three main disadvantages of the system. As in the previous table their remarks have been paraphrased. Not all students gave 3 disadvantages.

Table 23

1968/1969 STUDY: OVERALL RESPONSE TO THE QUESTIONNAIRE

Section of Questionnaire	Number of items	Percentage of responses Definitely favourable	Definitely unfavourable
General section*	13	72	19
Diabetic tapes	6	72	11
Thyroid tapes	6	76	7
Slides	10	75	13
Automatic system**	15	61	17
Hand-operated system***	14	51	35

All definitely favourable (agree, strongly agree) were expressed as a percentage of the total and the unfavourable statements were treated in a similar way. 'Uncertain' scored neither for nor against.

* details in Table 20

** details in Table 24

*** details in Table 25

Table 24

1968/1969 STUDY: ATTITUDES TO THE AUTOMATIC SYSTEM

	Mean Mark
I prefer this to the manually operated equipment	4.0
It is easier to concentrate with this machine than with the manually operated equipment	3.6
It is easier to concentrate with this than at lectures	4.0
The manipulation of the apparatus interfered with my learning	2.6
This machine costs about five times more than the hand-operated equipment but it is worth it	2.6
I was familiar with the operation of the equipment by the end of my first programme	4.2
Loading the tape onto the machine is a bit difficult - I would prefer cassette loading	2.2
I wished it was easier to go back to earlier material *	3.7

All the statements in the questionnaire were marked as described in section 5.3.5 with a possible total of 5.0.

(* only the portable model was available in 1968/1969)

Table 25

1968/1969 STUDY: ATTITUDES TO THE HAND-OPERATED EQUIPMENT

I prefer this to the Kindermann machine	2.3
It is easier to concentrate with this than the Kindermann	2.6
It is easier to concentrate with this than at a lecture	4.0
The manipulation of the slides and viewer interfered with my learning	2.8
The operation of the tape-recorder interfered with my learning	2.5
I was familiar with the operation of the equipment by the end of my first programme	4.5
I wished it was easier to go back to earlier material	4.0
I had difficulty loading/unloading slides	2.7
I prefer the Photax viewer to the Panavue	3.2
The Photax* gave a picture of acceptable size	3.8
The Panavue* gave a picture of acceptable size	3.9
The viewers made my eyes tired	2.7
It was easy to see all the necessary detail with the Photax	3.4
It was easy to see all the necessary detail with the Panavue	3.5
It was easier to operate the Panavue than the Photax	3.6
A simple "one-slide-at-a-time" hand viewer would be perfectly acceptable	1.7

*Magnification of Photax x 3
of Panavue x 2

The same marking system was used

Table 26

1968/1969: STUDENTS' OPINION OF THE SLIDES

The slides made a very helpful contribution to my learning	4.7
The quality of the slides was good:	
with words only	4.2
with clinical pictures	4.2
with diagrams	4.6
with X-rays	3.2
with E.C.G.'s	4.2
There were too many words on the slides	1.75
There were too many slides	2.6
Where possible I prefer 'real' pictures to diagrammatic representations	3.2
I like to see words saved by pictures and diagrams	3.6
There were too many 'trivial' slides with little on them	3.2

were useful; the quality was generally considered to be good, with the exception of the X-rays (X-rays are difficult to photograph and unfortunately the quality of tone and contrast is lost during the copying process).

The students also had a favourable response to the answer sheets (Table 27) and, in general, thought that they would be more useful than lecture hand-outs, although they were less certain of their superiority to lecture notes; they felt things had been omitted. These criticisms subsequently led to modifications and more space was allowed for notes, another point of criticism.

Only the general section (Table 20) of the attitude questionnaire has so far been published (Harden et al 1969c).

5.2.5 TIME TAKEN TO COMPLETE COURSE

The time taken for individual students to complete the course ranged from 10 to 20 hours (Fig. 22), the mean being 13 hours 20 minutes. The same material was covered by the conventional lectures in 9 hours. However, the tape-slide presentations can be divided into tape running time (8 hours 10 minutes) which is obviously the same for all students (and not very different from the lecture course) and a mean response time of 5 hours 10 minutes, this includes both the pauses needed to answer the questions and time spent replaying parts of the tape. Clearly this is responsible for the variation in total times. The foreign students were the slowest as Fig. 22 demonstrates. One took four hours longer than anyone else to complete the programmes; however this was perhaps justified by his markedly improved performance (80th in December 1968, 93rd Part A March 1969 and 28th Part B March 1969).

The times taken by individual students to complete the

Table 27

1968/1969: STUDENTS' OPINIONS OF THE ANSWER SHEETS

The answer sheets were well constructed	3.8
The answer sheets will be very useful	4.0
The answer sheets are more useful than handouts	3.6
There was enough space on the answer sheets for additional notes	2.5
The answer sheets are better than my usual lecture notes	3.0
Things were omitted from the answer sheet which should have been included	4.0

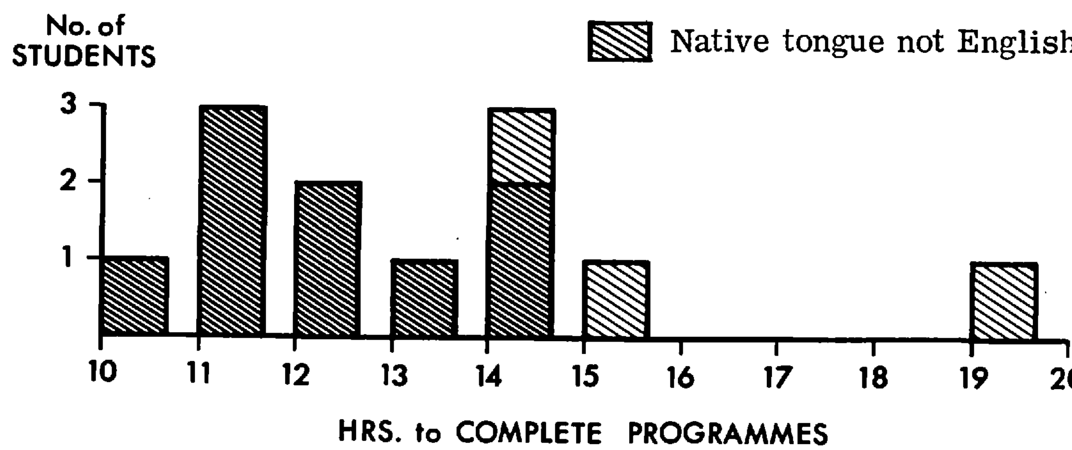


Fig. 22: Time taken to complete tape-slide programmes. (1968/1969)
(The mean being 13 hours 20 minutes).

programmes were tested for correlation with their examination marks. But as Fig. 23 shows, these factors were not closely related. Time taken to complete the programmes was influenced to some extent by the type of equipment used. When students worked with automatic equipment, they took 9% less time, on average, than when they used simple hand-operated sets.

These results have also been published (Harden et al 1969c).

5.2.6 SUMMARY OF THE MAIN EXPERIMENT 1968/1969

The main findings of the first year's experiment in 1968/1969 were that the students who were taught by programmed tape-slide presentations scored significantly higher marks in the examination, than the remainder of the class who attended the lectures, and their positions in the rank order improved. This improvement was especially marked in the foreign students. The attitude of the students to both the programmes and the equipment was generally favourable although the programmed course took longer to complete than the conventional course.

5.2.7 ADDITIONAL STUDY 1968/1969

In addition to the main experimental study described above a number of students, mainly final year or postgraduate, used the programmes and some of these completed a test (pre-test) before starting the presentations and another one on completion of the material (immediate post test). The aims of these tests were twofold; firstly to try and assess whether the programmes were an effective method of teaching and secondly, the pretest was an attempt to show students whether or not they needed to complete the course - if he scored high marks on the initial test the benefits he would accrue would be only marginal.

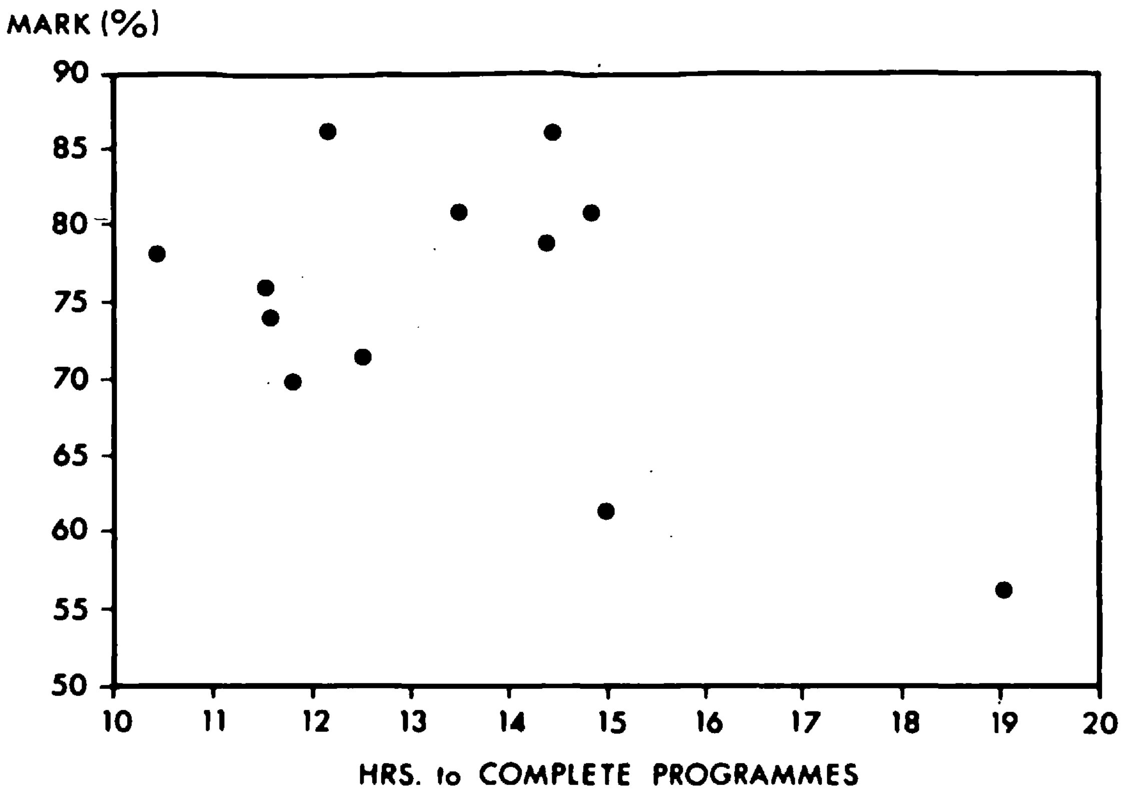


Fig. 23. <u>1968/1969</u>

Lack of close correlation between individual students' marks and time taken to complete the programmes.

Fig. 24 shows the mean scores of 8 students who completed both the pre and post tests. All showed gains in their learning as Fig. 25 demonstrates; some of this might be attributed to the pre-test although the students only knew their overall score in this test and not which items had been answered correctly.

This study has not been published.

ENDOCRINOLOGY - MARCH 1969

No. of Students	Pretest		Post-test	
	Mean	S.E.	Mean	S.E.
8	41.9	4.64	74.6	2.48

Fig. 24: The mean examination mark of 8 students who completed a multiple-choice test before and after doing the programmed tape-slide course.

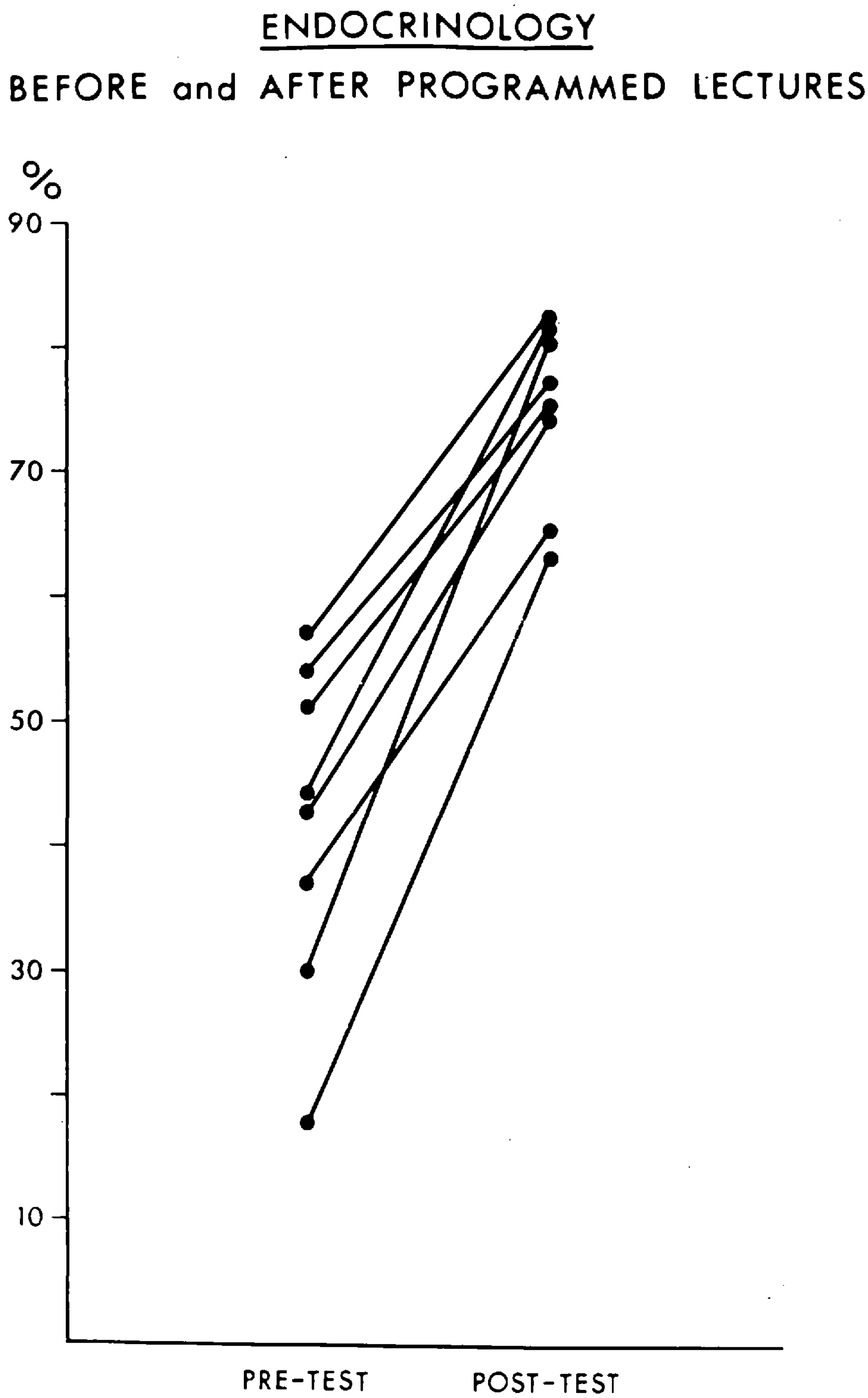


Fig. 25. The gain in scores of the 8 students (final year and post graduate) whose mean scores are shown in Fig. 24.

5.3 1969/1970 COMPARISON OF GROUP AND INDIVIDUAL INSTRUCTION

5.3.1 AIMS

The aim of this experiment was to compare group and individual instruction. The main point on test was the efficacy of group presentations as judged by examination performance and attitude questionnaires. It was also hoped to gain information on any saving in time and equipment which might result from group presentations. We have reported some of these results (Holroyd et al 1970). As in the previous year, the examination results of students using tape-slide programmes were compared with those of students taught conventionally.

5.3.2 EXPERIMENTAL DESIGN

There were 107 students in the fourth year at the Western Infirmary during the session 1969/1970, 87 male and 20 female. Of these thirteen came from overseas. On this occasion two studies were performed, as programmes in renal disease had also been prepared during the preceding year using stratified selection (Alterman 1968) thirty-two students were allocated to part of the course in renal disease in December 1969 (ie surgical disease of the kidney was taught conventionally) and a further twenty-four students for the second study in endocrinology in January 1970.

The experimental design for the renal programmes is shown in Table 28. Students doing the tape-slide course were randomly divided into four sections, each of 8 students. At any one time two sections (ie 16 students) worked together as a group while the others worked individually. The same experimental design was used in the endocrinology course where twenty-four students were divided into

Table 28

1969/1970 EXPERIMENTAL DESIGN FOR RENAL PROGRAMMES

(32 Students)

Programmes	Section A (8)	Section B (8)	Section C (8)	Section D (8)
R1-5	Group		Automatic	Hand
R6-8	Group		Hand	Automatic
R9-13	Automatic	Hand	Group	
R14-16	Hand	Automatic	Group	

The Table shows the sequence in which the four sections of students studied tape-slide presentations as a group or as individuals using hand-operated and automatic equipment. The same design was used subsequently for the twenty four students who completed the thyroid and diabetic programmes.

four sections of six. A specimen timetable is included as appendix E.

A portable Kindermann machine was used for the group presentations as described (see 4.3.2.1). Discussion was not allowed during the presentation and students indicated their readiness to proceed using the Responset (see 4.3.2.1). It was arbitrarily decided that when about 75% of the group (the exact percentage varied slightly with the size of the group) had so signalled, the tape would be restarted by the supervisor, a member of the project team. During the renal programmes a record was kept of the number of times each student was in the first 75% of responders.

5.3.3 EXAMINATION RESULTS

There were three groups of students: Group A (51 in number) was taught conventionally, by lectures, throughout the course, Group B (32 students) used tape-slide programmes to study medical renal disease and Group C (24 students) used similar material for thyroid disease and diabetes. The performance of all students was assessed in December 1969 (before the experiment began) and again in March 1970, six weeks after completion of the experimental endocrinology course. The March examination had three sections: (i) medical renal disease (in which Group B used tape-slide presentations) (ii) diabetes and thyroid disease (in which Group C used tape-slide presentations) and (iii) other subjects not covered by tape-slide presentations and comprising among other things gastroenterology and surgical renal disease. Thus, two control situations were available for comparison: the examination of December 1969 and the examination in other subjects during March 1970.

Despite random selection Group B was significantly superior to Group A, Group C or to A and C combined in both of the control examinations (see Table 29 I and II). Group C, on the other hand, was not significantly different from Group A or from Group A and B combined.

In the section of the March 1970 examination covering renal disease the students who had used the tape-slide programmes (Group B) scored significantly higher marks (mean of raw scores 41) than either Group C (35.7: $t = 2.73$, $p < 0.01$) or Group A (32.1: $t = 4.8$, $p < 0.001$) or Groups A and C combined (33.3: $t = 4.522$, $p < 0.001$). However, as indicated, they were intrinsically better students from the outset. Nevertheless when their marks (percentage) in the section on renal disease are compared with either their December 1969 results or those in the other subjects in March 1970 their performance is significantly superior in the section taught by tape-slide programmes (Renal v. December 1969: $t = 5.22$ $p < 0.001$; Renal v. Other Subjects March 1970 $t = 7.21$ $p < 0.001$).

In endocrinology the marks scored by students using tape-slide programmes (Group C - mean of raw scores 38.5) were significantly higher than either Group A (31.7: $t = 4.25$ $p < 0.001$) or Group A and B combined (33.65: $t = 3.005$ $p < 0.01$). However, although Group C's marks were higher than Group B's (36.7) this difference was not significant. Nevertheless, as before, Group C's performance in endocrinology (taught by tape-slide presentations) was significantly superior to that in cardiology and respiratory disease during December 1969 ($t = 6.58$, $p < 0.01$) or to that in other subjects during March 1970 ($t = 10.24$, $p < 0.001$). Furthermore, the changing relation of Groups B and C following the tape-slide course (B better than C before course and C better than B - albeit insignificantly - after the course) was such as to suggest benefit from the tape-slide programmes.

Table 29

1969/1970: THE CONTROL EXAMINATION RESULTS

I. DECEMBER 1969: Cardiology and Respiratory Disease (percentage marks)

Group A	–	43.04 (mean)
Group B	–	48.68 (mean)
Group C	–	42.72 (mean)

Group B

v. Group A	$t = 2.70$,	$p < 0.01$
v. Group C	$t = 2.05$,	$p < 0.05$
v. Group A + C	$t = 2.75$,	$p < 0.01$

Group C

v. Group A	$t = 0.13$,	$p > 0.05$
v. Group A + B	$t = 1.09$,	$p > 0.05$

II. MARCH 1970: Other Subjects (raw scores)

Group A	–	62.2 (mean)
Group B	–	74.8 (mean)
Group C	–	64.8 (mean)

Group B

v. Group A	$t = 3.76$,	$p < 0.01$
v. Group C	$t = 2.461$,	$p < 0.02$
v. Group A + C	$t = 3.90$,	$p < 0.01$

Group C

v. Group A	$t = 0.76$,	$p > 0.05$
v. Group A + B	$t = 0.49$,	$p > 0.05$

Group A – studied conventionally throughout

Group B – used tape-slide programmes for medical renal disease

Group C – used tape-slide programmes for diabetes mellitus and thyroid disease.

Examination results for students working alone and in the group are shown in Figs. 26 and 27. In endocrinology, the differences observed with the different techniques were not statistically significant. However, in part of renal disease, students working individually performed significantly better than their colleagues in the group ($t = 2.187$, $p < 0.05$). This was only observed on one of four occasions and because there was no tendency for similar change in any of the other three sections studied it should be interpreted with caution.

5.3.4 ATTITUDE QUESTIONNAIRES

After each presentation, students completed a brief questionnaire on the time taken and their general comments. In addition, in March 1970, they were asked to complete a more extensive attitude questionnaire (shown in appendix F). Results of the comparisons of the preferred method of presentation (eg automatic or hand-operated equipment) is shown in Table 30. By far the most popular method was the automatic system operated individually. Interestingly, the traditional lecture would have been preferred to either the hand-operated equipment or to group presentations. (This was a hypothetical issue as the students concerned did not attend the equivalent lectures). However, the striking fact that emerges from this table is the unpopularity of group presentations. A similar picture emerges when the results are analysed, excluding the option of a lecture (Fig. 28). Students consistently prefer the automatic system and dislike group presentations. Simple hand-operated equipment was preferred by a small number.

Reasons for the unpopularity of group presentations were not completely clear but comments on the questionnaire gave some

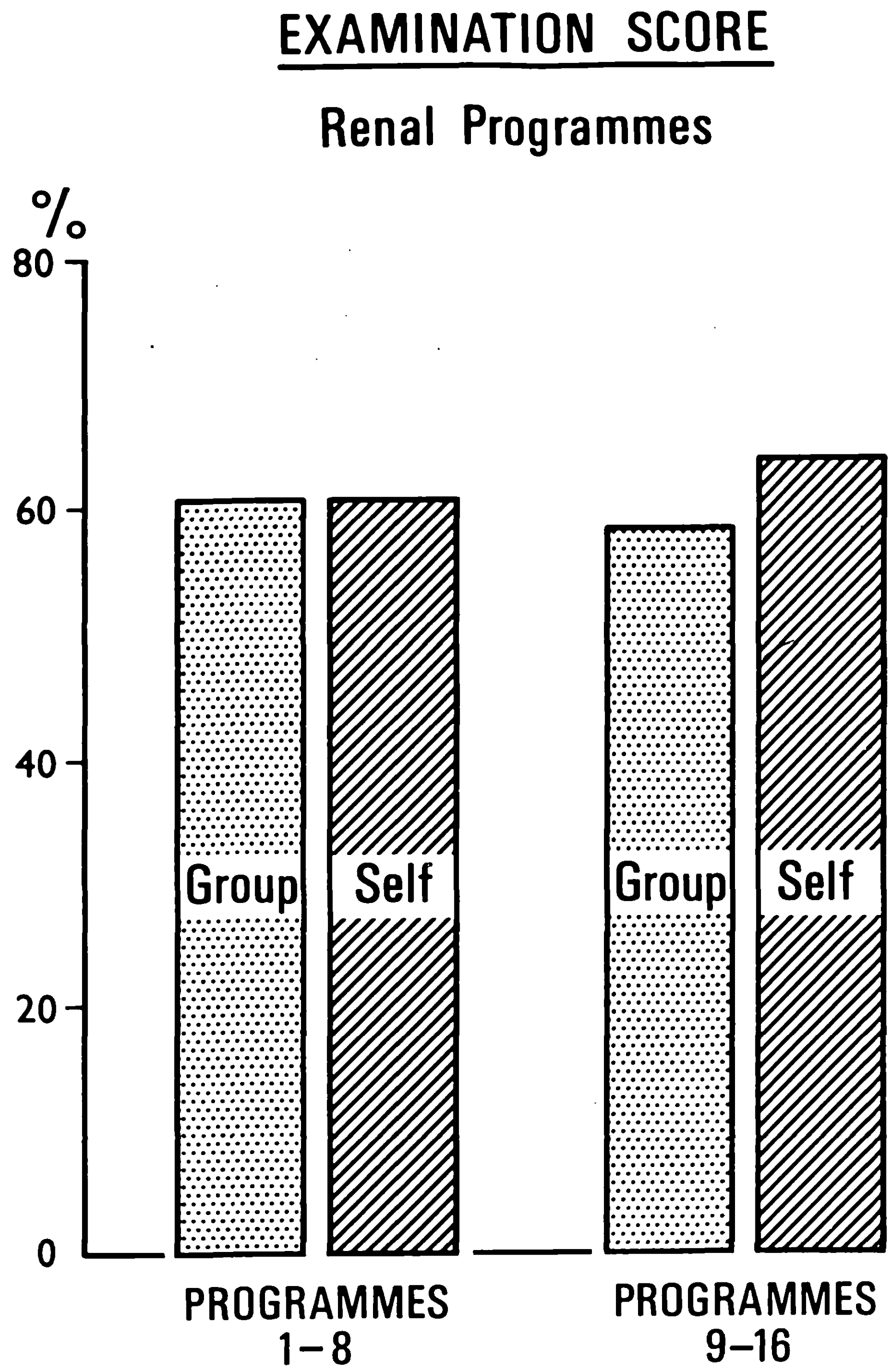


Fig. 26. March 1970 Examination:
Comparison between mean scores of students working in a group and individually on the renal programmes.

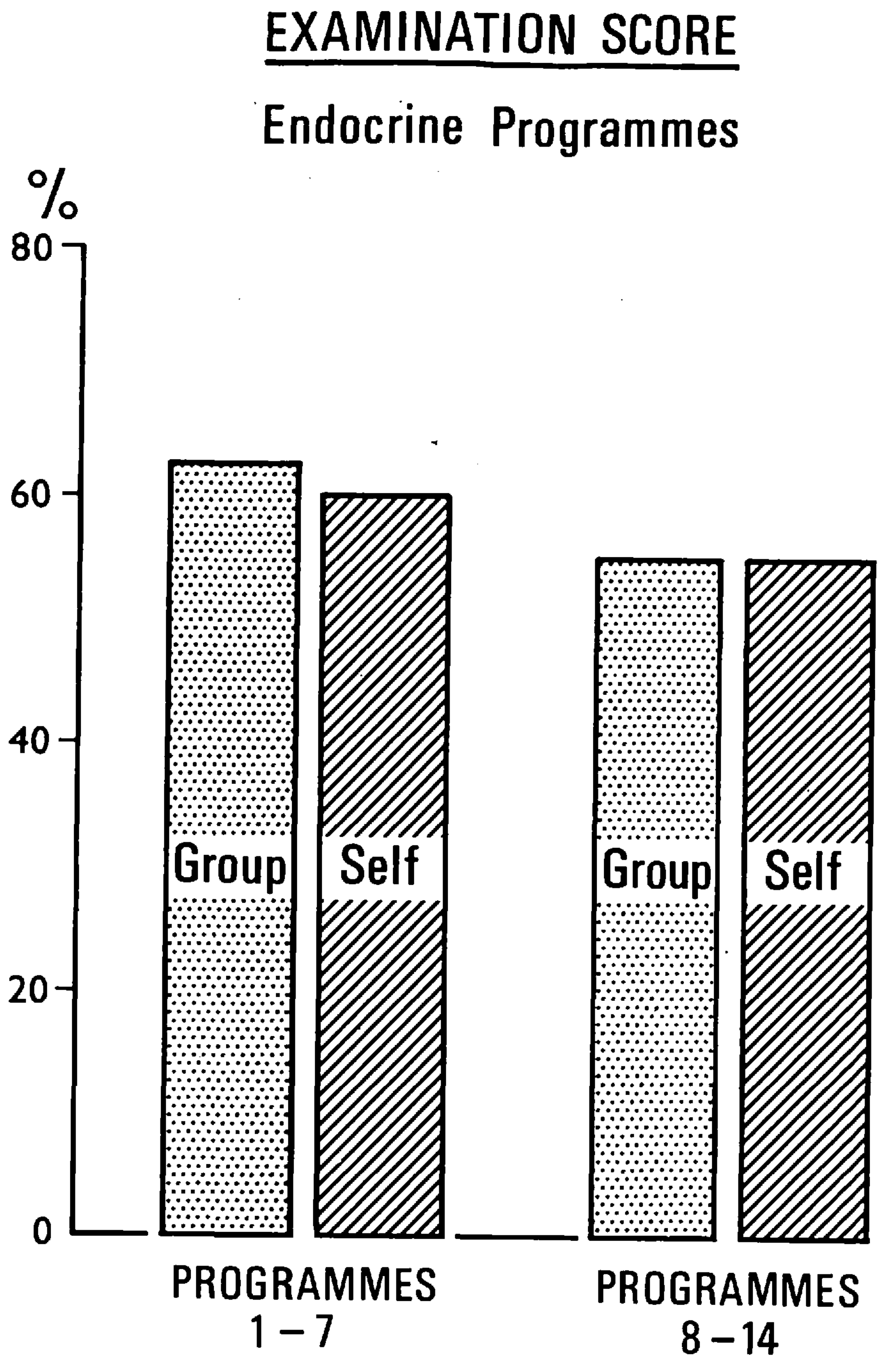


Fig. 27. March 1970 Examination:

Comparison between mean scores of students working in a group and individually on the endocrine programmes.

Table 30

1969/1970 STUDENTS' PREFERENCE FOR DIFFERENT PRESENTATION TECHNIQUES

Method	No. of Times Chosen
Automatic	125
Lecture	98½
Hand-operated	67½
Group Presentation	32

The students were asked to indicate which of 2 methods they preferred in 6 comparative pairs (eg automatic or hand-operated; group v lecture etc). The total number of times each method was chosen is given above. The highest mark that could be scored was 162 (ie 54 x 3).

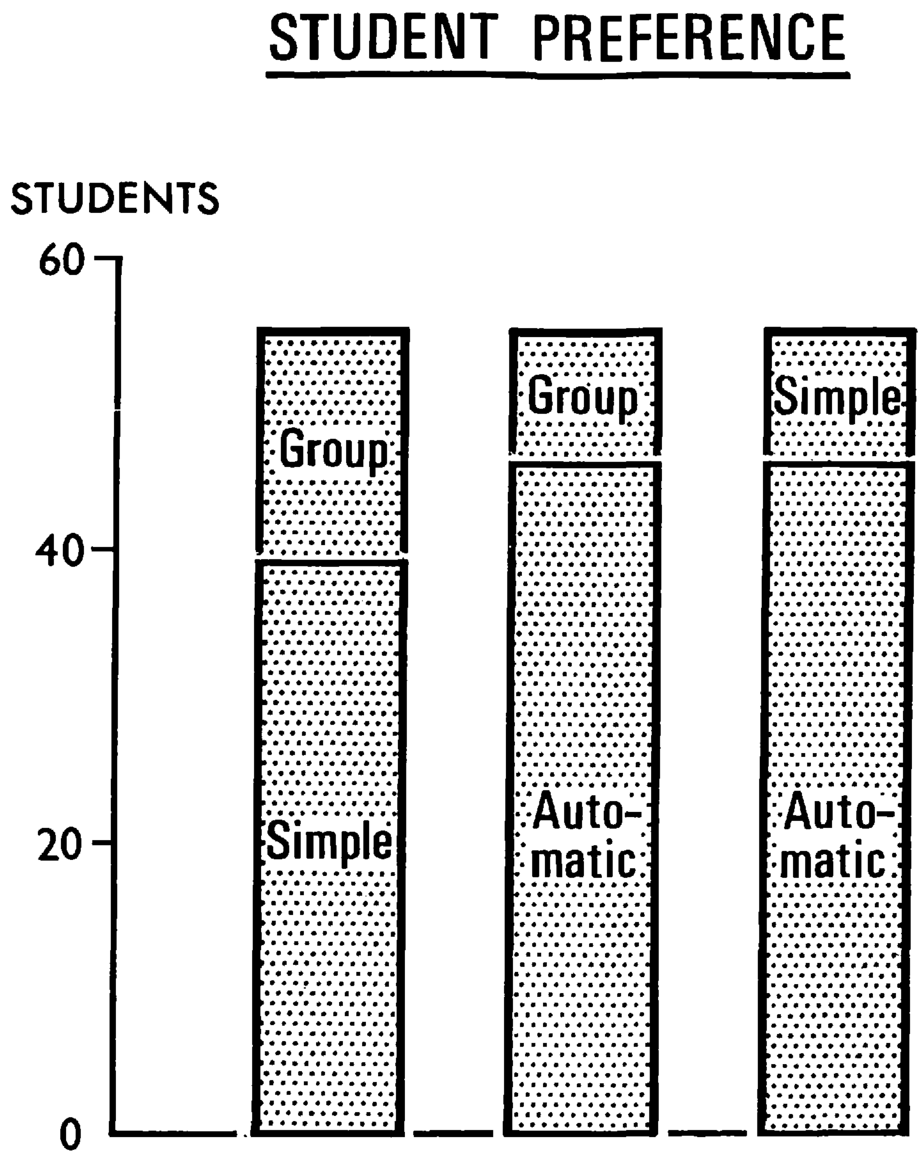


Fig. 28. Attitude questionnaire in March 1970
Result of three pairs of comparisons (ie group v simple, group v automatic, simple v automatic) showing relative preference for each method.

indication. Not surprisingly, many students strongly resented their inability to control the tempo of presentation. Although they had signalled when they were prepared to advance the tape was restarted only when approximately 75% had responded. Inevitably therefore, the time interval was too short for a minority and too long for the majority. Another source of dissatisfaction was the phenomenon of "contagious criticism" (see Holroyd et al 1970). We have frequently noted that minor inadequacies in a programme (eg trivial questions see 4.2.2.4) pass unremarked by a student working alone. However, in a group, students openly comment on such faults and a critical and sometimes frivolous atmosphere develops. Also, seemingly minor physical difficulties can become important; chairs provided for the group sessions were less comfortable than those in the booths. Students preferred the automatic system to the simple equipment because they were relieved of the manual tasks and they liked the larger screen size.

5.3.5 TIME TAKEN TO COMPLETE COURSE

Students working in groups saved about 8-9% of time. Thus, students working individually completed the sixteen renal programmes in 12 hours 26 minutes (sum of mean time for each programme), whereas the group finished in 11 hours 17 minutes - a saving of 55 minutes (8%). Similar results were found in endocrinology: group 11 hours 11 minutes, individuals 12 hours 6 minutes, saving 69 minutes (9%). The groups take a fixed and relatively predictable length of time. In contrast as Figs. 29 and 30 show individuals show a wide range of times; the renal course (Fig.29) was done by the two quickest students (one doing R1-R8, second R9-R16) in 10 hours 15 minutes whereas the slowest took almost 4 hours longer (14 hours 8 minutes).

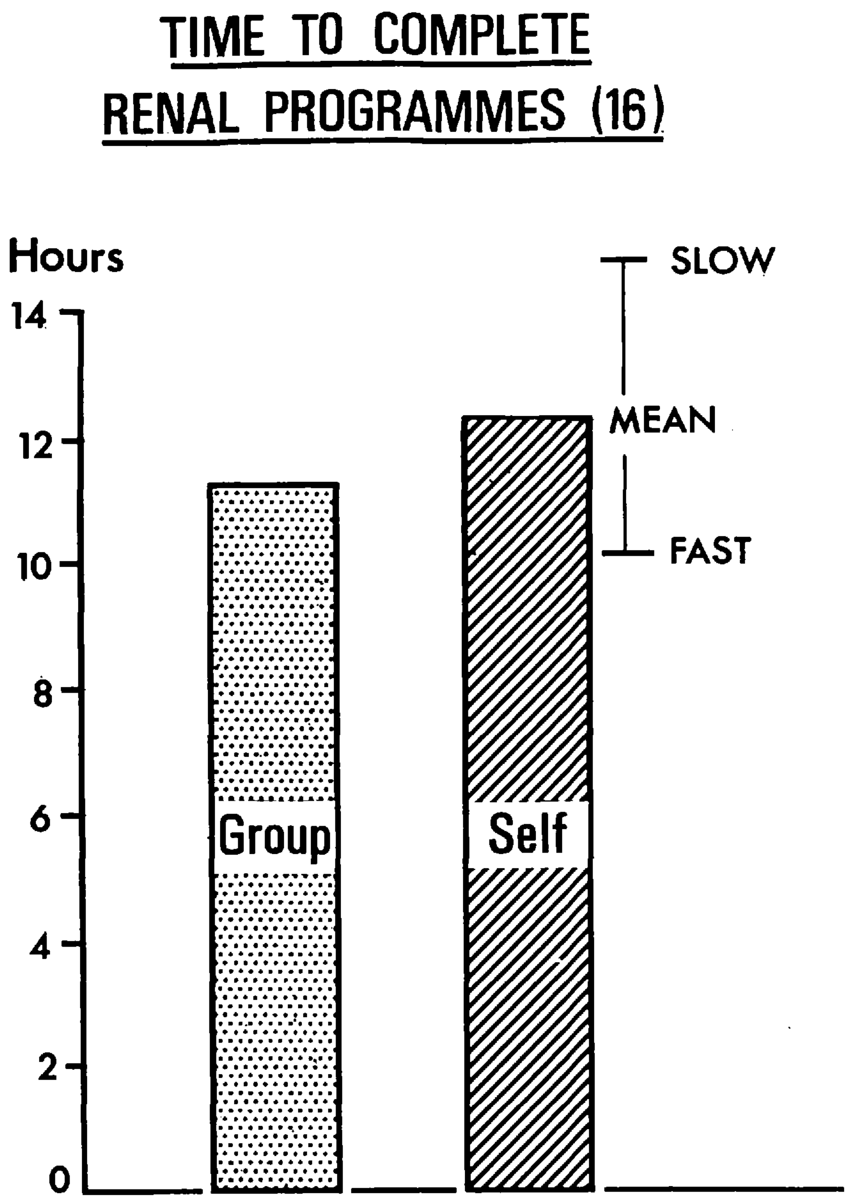


Fig. 29. 1969/1970: Comparison of time taken (in hours) to complete the 16 renal programmes by group presentation and by working individually (mean time). The range of times taken by individuals is also shown.

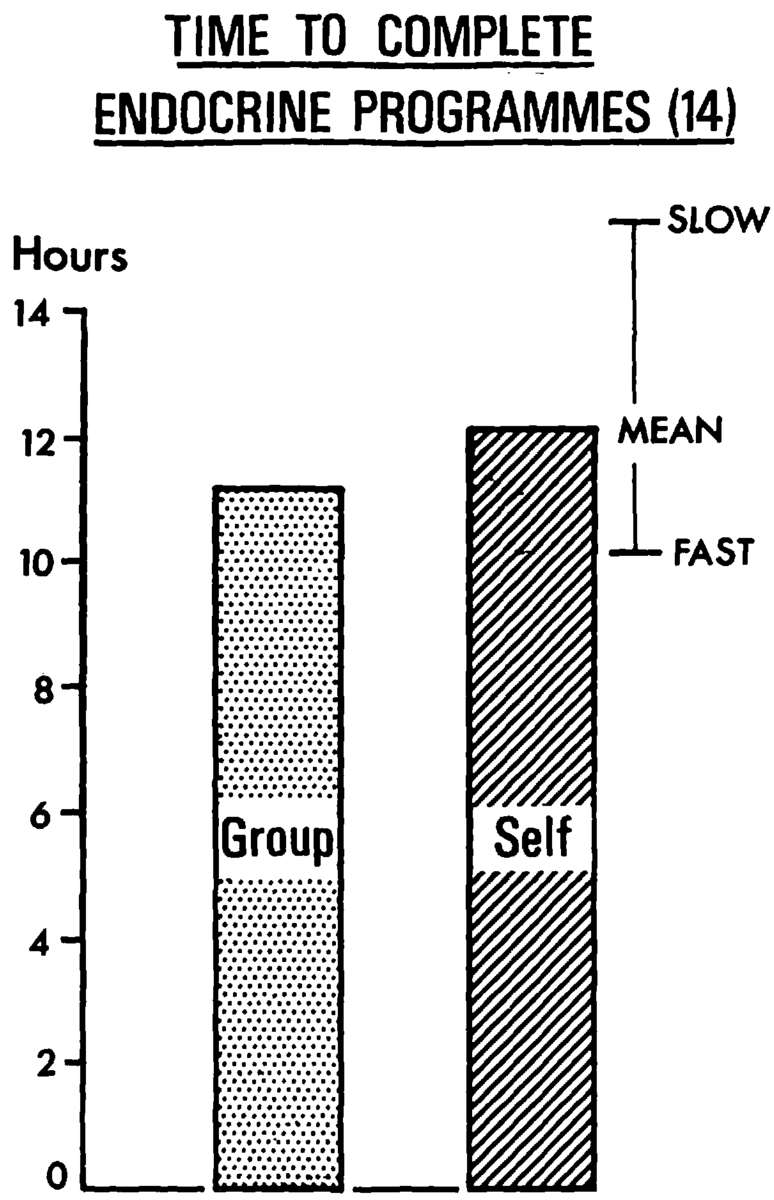


Fig. 30. 1969/1970: Comparison of time taken (in hours) to complete the 14 endocrine programmes by group presentation and by working individually (mean time). The range of times taken by individual students is also shown.

Similar results were obtained in endocrinology (Fig. 30) where there were over five hours between the slowest and the fastest (15 hours 40 minutes and 10 hours 16 minutes respectively).

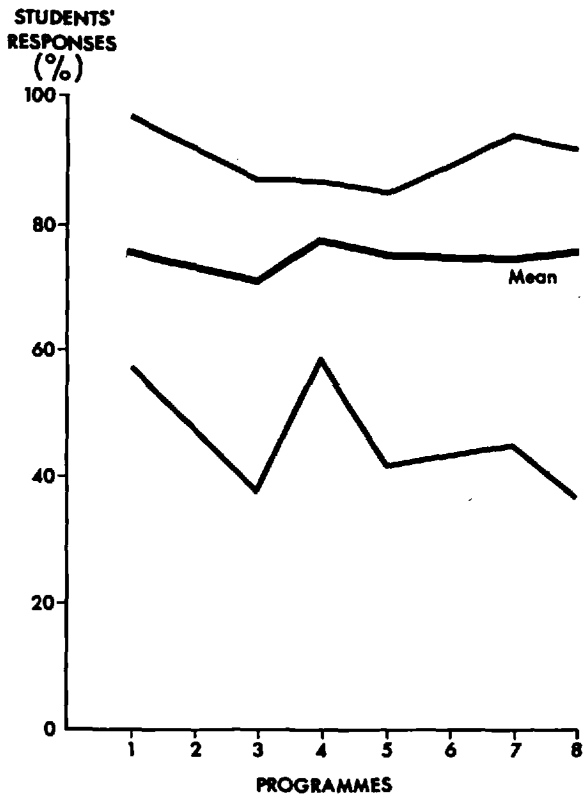
5.3.6 "RESPONDERS" IN GROUP PRESENTATIONS

As described earlier (5.3.2) during the renal programmes a record was kept of the number of times each student was a "responder" i.e. when he was amongst the first 75% of the group indicating readiness to continue. It was therefore possible to calculate the frequency with which individual students were amongst the "responders". We were interested to see if we could identify, within an individual student, a consistent pattern of response behaviour. However, the results showed considerable variation in performance (Fig. 31). Although in one of the groups one consistent "responder" and one consistent "non-responder" were identifiable, the majority of students varied considerably. Nor was there a clear relationship (Fig. 32) between the frequency with which students were in the responding group and their examination results (for renal group 1 $r = -0.06$, $p > .005$).

5.3.7 SUMMARY

The main finding of the 1969/1970 session was the confirmation of the improved performance of students using self-instruction as compared with their colleagues attending lectures.

Depsite the students' preference for the automatic system and their dislike of the groups their marks were fairly comparable. A significantly improved performance of students working individually was only demonstrated in one of the four sections studied.



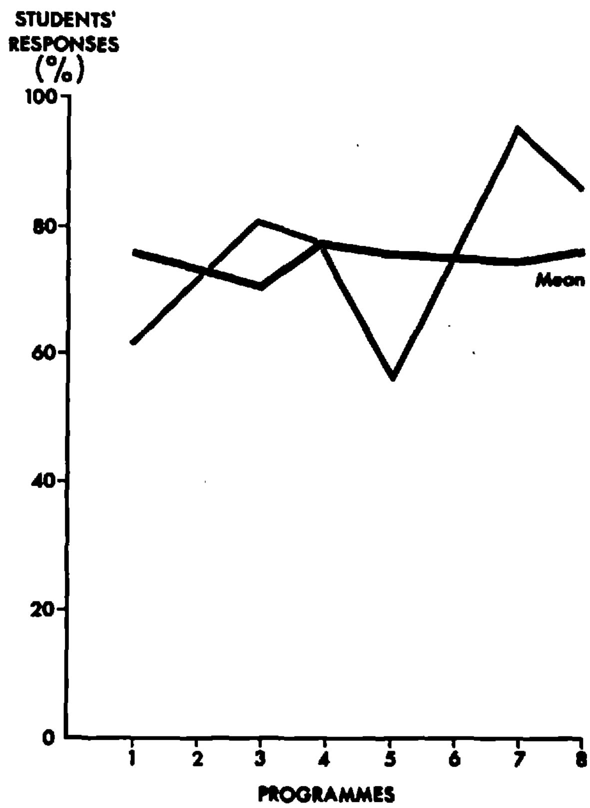


Fig. 31. <u>1969/1970 Renal Group 1</u>. The frequency with which each student was a "responder" is shown in each of the renal programmes (R1-8). Only one student was consistently above and one consistently below the mean (upper figure). Most students showed the response pattern illustrated in the lower figure, varying above and below the mean in different programmes.

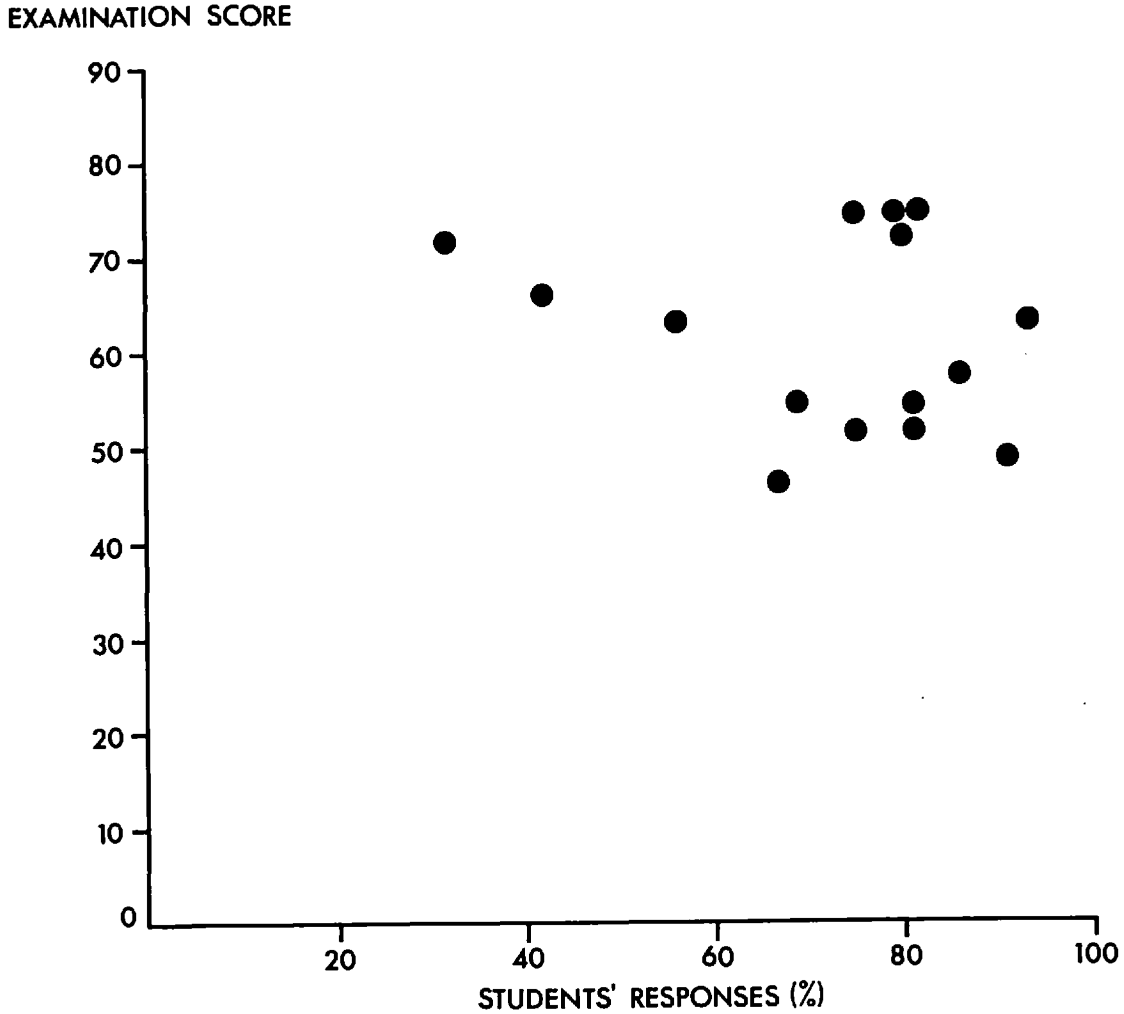


Fig. 32. <u>Renal Group 1</u>

The frequency with which each student was in the group of "responders" is expressed as a percentage along the x axis. Their examination scores for the corresponding renal programmes (also expressed as a percentage) is plotted on the y axis (r -0.06).

5.4 THE 1970/1971 STUDY: FURTHER INVESTIGATION OF GROUP AND INDIVIDUAL INSTRUCTION

5.4.1 AIMS

The aims on this occasion were to test two new forms of group instruction and to investigate a different use of the hand-operated system. In addition, the performance of students using self-instruction was compared with that of the lecture-taught group.

5.4.2 EXPERIMENTAL DESIGN

There were ninety-six students in the fourth year for the session 1970/1971, 75 male and 21 female. Thirty-two students were randomly selected from the year to use both the renal and endocrinology programmes in place of conventional lectures. The same programmes were used as in the previous year. Before the course began in February the whole class completed a multiple choice examination on endocrinology. Both endocrinology, covered in February 1971, and renal disease, completed in March 1971, lasted for three weeks. During the first two weeks of these courses, lecture and tape-slide groups used their respective techniques; during the final week, both groups studied in the conventional manner.

During this session, 1970/1971, there were four methods of presenting tape-slide programmes. Automatic and hand-operated equipment were available as before, but during the experimental period the students were also allowed to borrow the latter for home use overnight or at weekends. The form of group presentation was modified because of the previous year's unfavourable reaction. It had been suggested that the group was unpopular because it was too impersonal and that this might be remedied by relaying the audiotape directly to the student through headphones. A second suggestion was that discussion should be allowed during the presentations. Accordingly, two groups were organised; in one (Group A) no discussion was allowed and the sound was heard through individual headphones; the "Responset" was used, as before, by the student to indicate when he was ready to proceed. In the second group (Group B) discussion of the questions or of any difficulties was encouraged. The slides were projected onto a wall screen and the tape was amplified through a loud speaker. Thus Group A differed from our previous experiment in having headphones, Group B in having discussion. It was not considered justified to have a further control group without either headphones or discussion because students taught individually were available for comparison and it was already known that group presentation without discussion and headphones was inferior to this.

Another innovation this year was that we allowed students greater freedom to arrange their own timetables when working individually. The booths (automatic equipment) and hand-operated equipment could be booked in advance, in hourly blocks during the day. However after 5 p.m. by prior arrangement, students could use the booths in the evening (a key being borrowed before 5 p.m.) or take the hand-operated equipment home. Thus, during this time, there were no restrictions on the time the equipment could be used. Students were subdivided into four sections and all students had experience of all methods of presentation.

5.4.3 EXAMINATION RESULTS

The marks obtained in the multiple choice test in endocrinology during February 1971, before the course began,are shown in Fig. 33. The marks range from zero to almost 50% emphasising the point that students come to a course with widely differing knowledge. It is

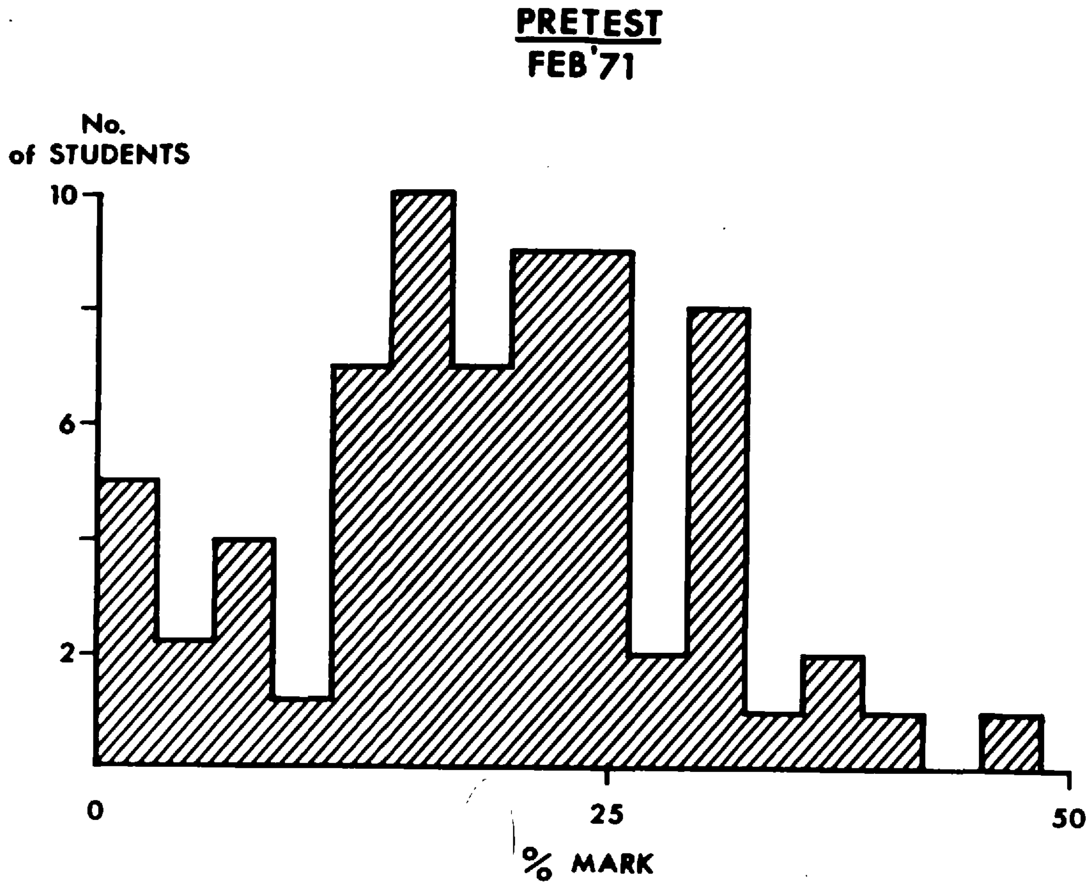


Fig. 33. February 1971. The results of a multiple choice test in endocrinology completed by all students in the integrated year before the course began.

therefore difficult to plan a conventional course which makes allowances for these variations. It was not possible to calculate the gain achieved during the course as the questions in the subsequent examination in March 1971 were different.

Results for the year are summarised in Table 31. During all the control periods the marks scored by the experimental group were not significantly different from the rest of the class. However, as in previous years, for the parts of the course covered by tape-slide presentations the mean mark of the experimental group was higher than that of the rest of the class. Also, as in the previous year when the different methods of presenting tape-slide programmes were compared, no important or significant differences were apparent (Table 32). Nor, as would be expected after random allocation, were there differences between the four sections of students (Table 33).

However, subject matter (or the skill in presenting a subject) may be important since, whatever presentation technique was used, students scored their highest marks on diabetes mellitus and generally their lowest on the second set of renal programmes (R9-16) see Table 33. This difference could be attributed to the programmes or to the examination (the lecture group also scored its lowest marks on the renal programmes).

There is no suggestion from the data in Table 33 that a particular subject was best taught by one or other form of tape-slide presentation, although it is apparent whichever topic and whichever technique is examined that tape-slide programmes were superior to the conventional lectures.

We hope to publish these results.

Table 31

1970/1971 EXAMINATION RESULTS

	Experimental Group	Rest of Year
Neurology: control	59 (2.1)	58 (1.7)
Endocrinology:		
Week 1 - experimental	78 (1.9)	65 (1.5) *
Week 2 - experimental	68 (2.3)	58 (1.6) *
Week 3 - control	60 (4.0)	61 (1.8)
Renal Disease:		
Week 1 - experimental	72 (2.3)	66 (1.5) *
Week 2 - experimental	63 (2.2)	52 (2.0) *
Week 3 - control	39 (2.4)	43 (1.4)

In the control periods all students were taught by lectures. During the experiments, tape-slide programmes were used by the experimental group.

Comparison was made by t test of mean marks for experimental and control groups. Values of "p" less than 0.05 are indicated by an asterisk.

Table 32

1970/1971 EXAMINATION MARKS: SECTIONS V. METHOD OF PRESENTATION

	Automatic	Hand-operated	Group A (without discussion)	Group B (with discussion)
Section I	82.6(D)	71.9(RI)	69.4(T)	65(RII)
Section II	69.1(T)	58.4(RII)	74.7(D)	73.0(RI)
SECTION III	75.1(RI)	77.7(D)	69.4(RII)	71.7(T)
SECTION IV	58.1(RII)	62.8(T)	67 (RI)	78 (D)

D = Diabetic Programmes

T = Thyroid Programmes

RI = Renal Programmes (R1-R8)

RII = Renal Programmes (R9-R16)

Table 33

1970/1971 EXAMINATION MARKS:
SUBJECTS V. METHOD OF PRESENTATION

	Automatic	Hand-operated	Group A (without discussion)	Group B (with discussion)	Lecture
Diabetes	82.6	77.7	74.7	78	65
Thyroid	69.1	62.8	69.4	71.7	58.2
Renal I (R1-R8)	75.1	71.9	67	73	66.4
Renal II (R9-R16)	58.1	58.4	69.4	65	52.1

5.4.4 ATTITUDE QUESTIONNAIRES

All students completed a brief questionnaire after each presentation and also a final more detailed questionnaire (shown as appendix G) in March 1971.

Fig. 34 shows the students' opinion of group versus individual presentation of tape-slide programmes in the years 1969/1970 and 1970/1971. In 1970 students had overwhelmingly preferred working individually to working in a group. Almost identical results were obtained in 1971 in Group A where students used headphones. However, when discussion was allowed in Group B, the students' attitude altered and 44% of students now preferred the group.

The students' opinions of the hand-operated equipment had also altered in 1971 when they were allowed to take it home (Fig. 35). 47% of students now preferred it to the automatic system.

The students were asked which of the four methods they liked most and which they liked least (Fig. 36). A number of points emerged: overall the automatic system was the most popular, liked by many students and disliked by fewest; the group without discussion (Group A) was very unpopular, and finally a "love-hate" reaction seemed to exist with both the hand-operated equipment and the group where discussion was encouraged (Group B), being liked most and disliked most by an almost equal number of students. Students were requested to give reasons for their choices: their replies are summarised in Tables 34-37. Those who favoured the automatic system found it easy to operate and it did not interfere with their concentration; on the other hand, 2 students found their attention tended to wander and the equipment distracting because of its erratic behaviour. The hand-operated system was liked as it could be used at home and some students

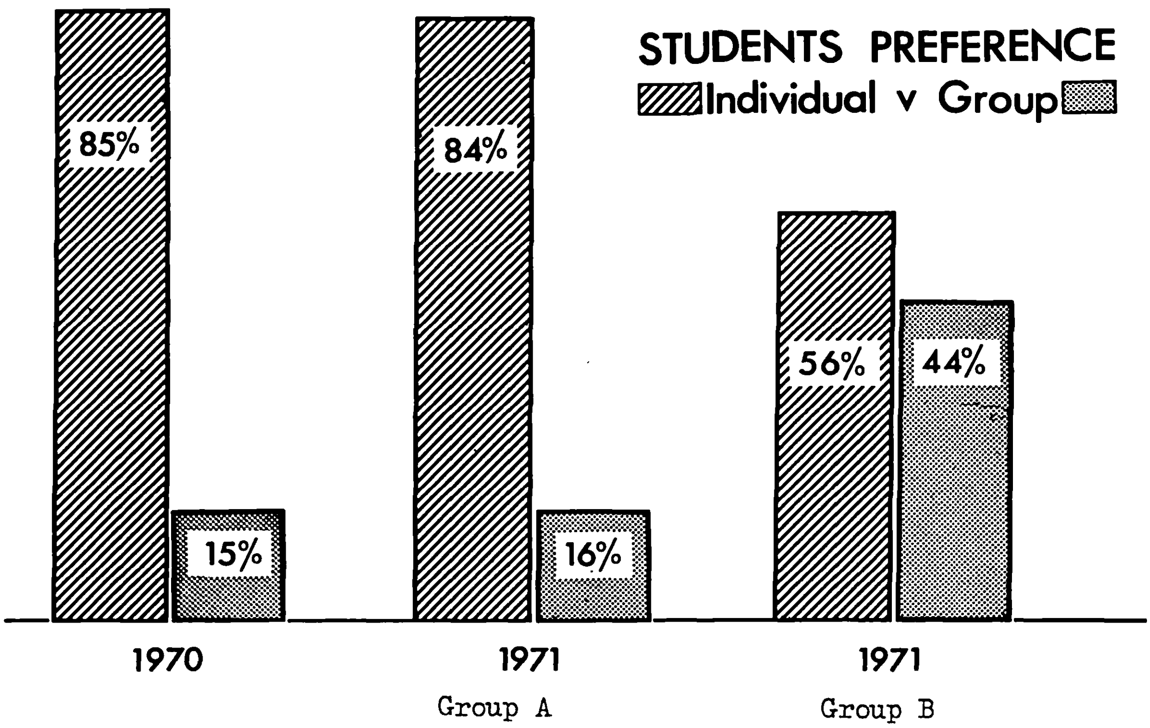


Fig. 34. The students' attitude to group presentation: No discussion was permitted in 1970 nor in Group A in 1971 (the latter group wore headphones). Free discussion was allowed in Group B in 1971.

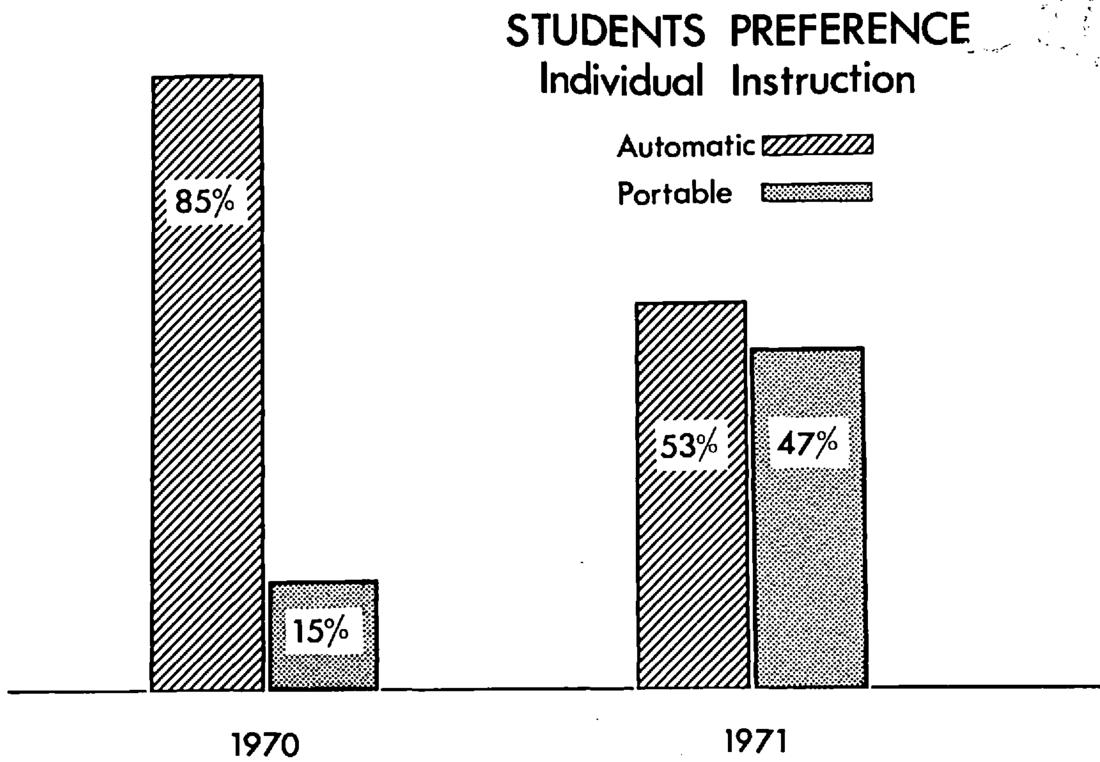


Fig. 35. In 1970 the hand-operated (portable) equipment was only used within the department. In 1971 it was also available for loan overnight or at weekends.

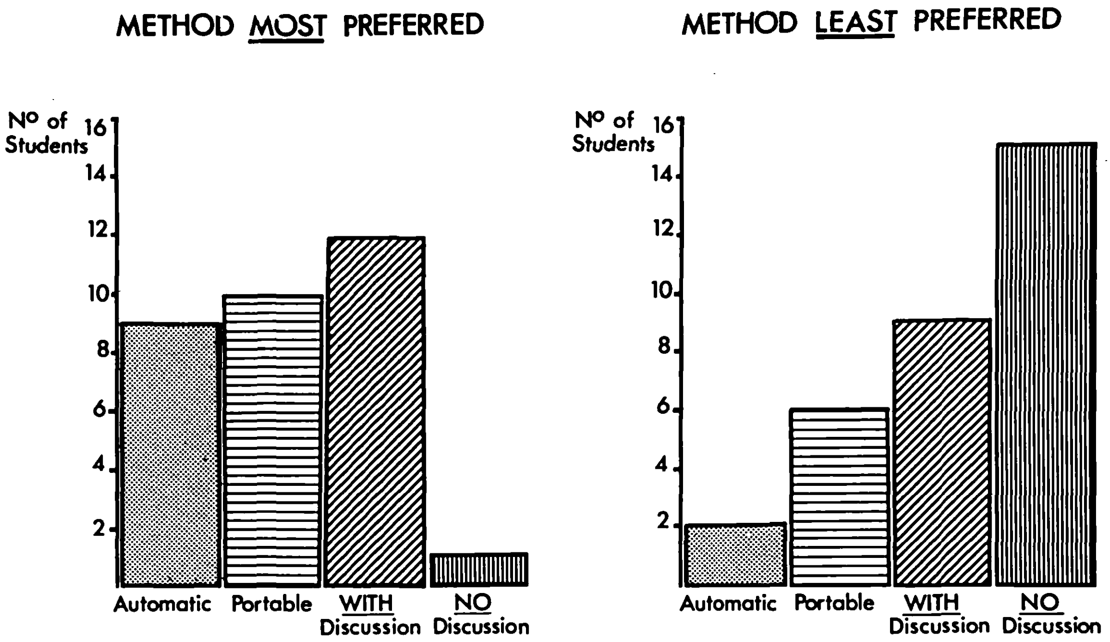


Fig. 36. 1970/1971: Attitude questionnaire.
The students were asked to indicate which was the method they preferred most and which the least and give two reasons for their selection.

Table 34

1970/1971 ATTITUDE QUESTIONNAIRE - AUTOMATIC SYSTEM

Method most preferred by 9 students because:

Ease of operation and no interference with concentration

Slides were more easily seen

Easy to concentrate in booths

Possible at any stage to rewind tape to earlier part

Greater retention of material

Balance between seriousness of tape and novelty of method

Able to do in one's own time and work at own pace

Method least preferred by 2 students because:

Attention tended to wander

Easily bored

Use of machines confined to teaching booths

Erratic behaviour of machines broke concentration

Table 35

1970/1971 ATTITUDE QUESTIONNAIRE - HAND-OPERATED EQUIPMENT

Method most preferred by 10 students because:

- Could be used at home
- Could have a break when required
- More relaxing
- Work could be spread out - less monotonous
- Able to refer to text book if working at home
- Allowed a flexible timetable
- Able to work at own pace
- Can be repeated when necessary

Method least preferred by 6 students because:

- Easily distracted when using equipment at home
- Changing slides and stopping tape a distraction
- Image on hand viewer too small
- Isolation from colleagues
- Headphones uncomfortable
- Boring

Table 36

1970/1971 ATTITUDE QUESTIONNAIRE - GROUP WITHOUT DISCUSSION

Method most preferred by 1 student because:

- Less machinery to handle
- Easy to concentrate
- Good balance between lecture and individual learning

Method least preferred by 15 students because:

- Distracted by presence of other people
- Feeling of isolation
- No discussion
- Frustrating to wait for slower members of group
- Tape frequently restarted before completed answer
- Tendency to cheat by signalling before answer completed
- Restriction of organised timetable
- Earphones uncomfortable
- No control over machinery therefore no opportunity for repetition
- Time consuming

Table 37

1970/1971 ATTITUDE QUESTIONNAIRE - GROUP WITH DISCUSSION

Method most preferred by 12 students because:

No machinery to play with

Not isolated

More relaxed atmosphere - less inhibiting

- not boring

Able to discuss questions and anything not understood

Sufficient time to think

Could not cheat with answers

Easier to concentrate because involved

Obligation to attend - absence from group noted

No headphones

Method least preferred by 9 students because:

Difficult to concentrate

Discussion made presentations very long

Discussion sometimes irrelevant

Discussion not liked

Restriction of organised time-table
(not same freedom as in individual teaching)

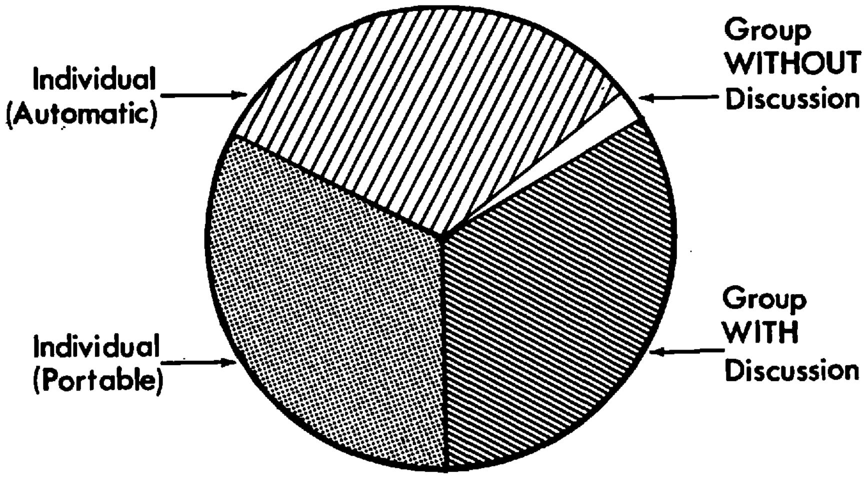
Too like an ordinary lecture

Preferred headphones to aid concentration found this an advantage, others, however, found the same feature a disadvantage. Group A (without discussion) was only favoured by one student; the 'antagonists' were numerous and found many points to criticise, in particular, the pause (to allow students to respond) was either too long or too short, also the students had no control over the apparatus. In contrast, Group B, where discussion was encouraged, was preferred by 12 students who liked the relaxed atmosphere and the facility of discussion; however, nine students within the same groups, found it difficult to concentrate and the discussion irrelevant and prolonged.

Thus, no one system is universally favoured. This is also reflected by the answers to the question 'how much time would you spend on each of the four methods of presentation if all four were made available?' The results are shown in Fig. 37. It can be seen that, on average, each student would use the automatic system, the hand-operated system and Group B for approximately equal amounts of time (31%, 33%, 34% respectively). These are mean figures and all students indicated they would make some use of individual learning and all but four would also spend some time in groups.

Opinions of the hand-operated system varied: seventeen would have liked a larger picture and fourteen did not think this necessary. There was no strong preference for battery or mains-operated sets. Students were also asked to comment on what percentage of the lecture course they thought should be replaced by tape-slide teaching. Almost 60% voted to replace half or more. It should be remembered that the experimental students did not enjoy all the advantages that the increased flexibility of a completely self-instructional course can confer (6.10).

PROPORTION of TIME STUDENTS CHOOSE TO USE EACH METHOD



<u>1970/1971</u>

Fig. 37. This figure shows the proportion of time (mean) students would choose to use each of the 4 presentation techniques.
All but 4 students would make some use of groups.
All students would make use of individual teaching.

5.4.5 TIMES EQUIPMENT AND PROGRAMMES WERE USED

The time at which specific programmes were presented to the groups was fixed (and approximated to that of the equivalent lectures). However, students, working individually, completed the same material at very variable times. This is illustrated by the five thyroid programmes (see Fig. 38) which were completed by seven students over a wide range of times, extending over a ten day period.

Automatic equipment was used by individuals mainly during the working day (Fig. 39) with peaks at lunch time and at 4 p.m. Not surprisingly the pattern for the portable equipment is different (see Fig. 40). It was used mainly during the afternoon and evening, one peak occurring at 4 p.m. and another at 9 p.m.

Students working on the programmes outside lecture hours were asked how they had spent the period of the lecture: twenty-two had engaged in leisure pursuits, eighteen had studied privately and 3 had actually attended the lecture*.

5.4.6 PERSONALITY OF STUDENTS

Results of a Maudsley personality inventory (1964 and Eysenck 1969) were correlated with the student's preference for working individually or in a group: no clear pattern or relationship could be demonstrated. This study will form part of a thesis by another member of the project team (M.S.).

5.4.7 SUMMARY

The main findings for 1970/1971 were that students using tape-slide presentations performed better in a multiple choice examination

*Although this, to some extent, compromises the comparison with the lecture group it is also known that some of the lecture group used the programmes when the portable sets were used outside the department.

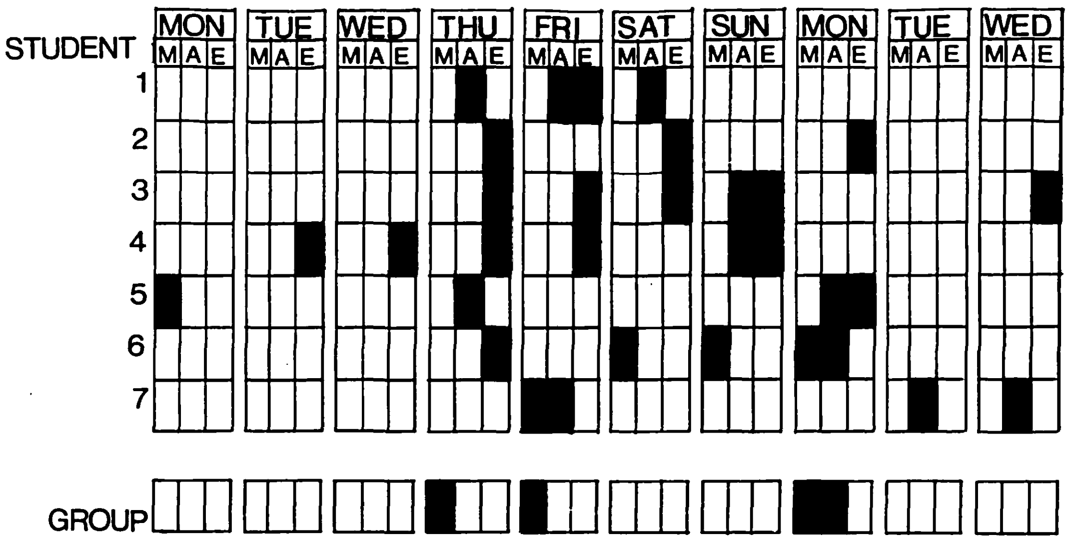


Fig. 38. 1970/1971 Thyroid Programmes.
The five thyroid programmes were scheduled for the group at approximately the same time as the lecture course. A wide variation occurs when students work individually, exemplified here by seven students.

M - morning
A - afternoon
E - evening

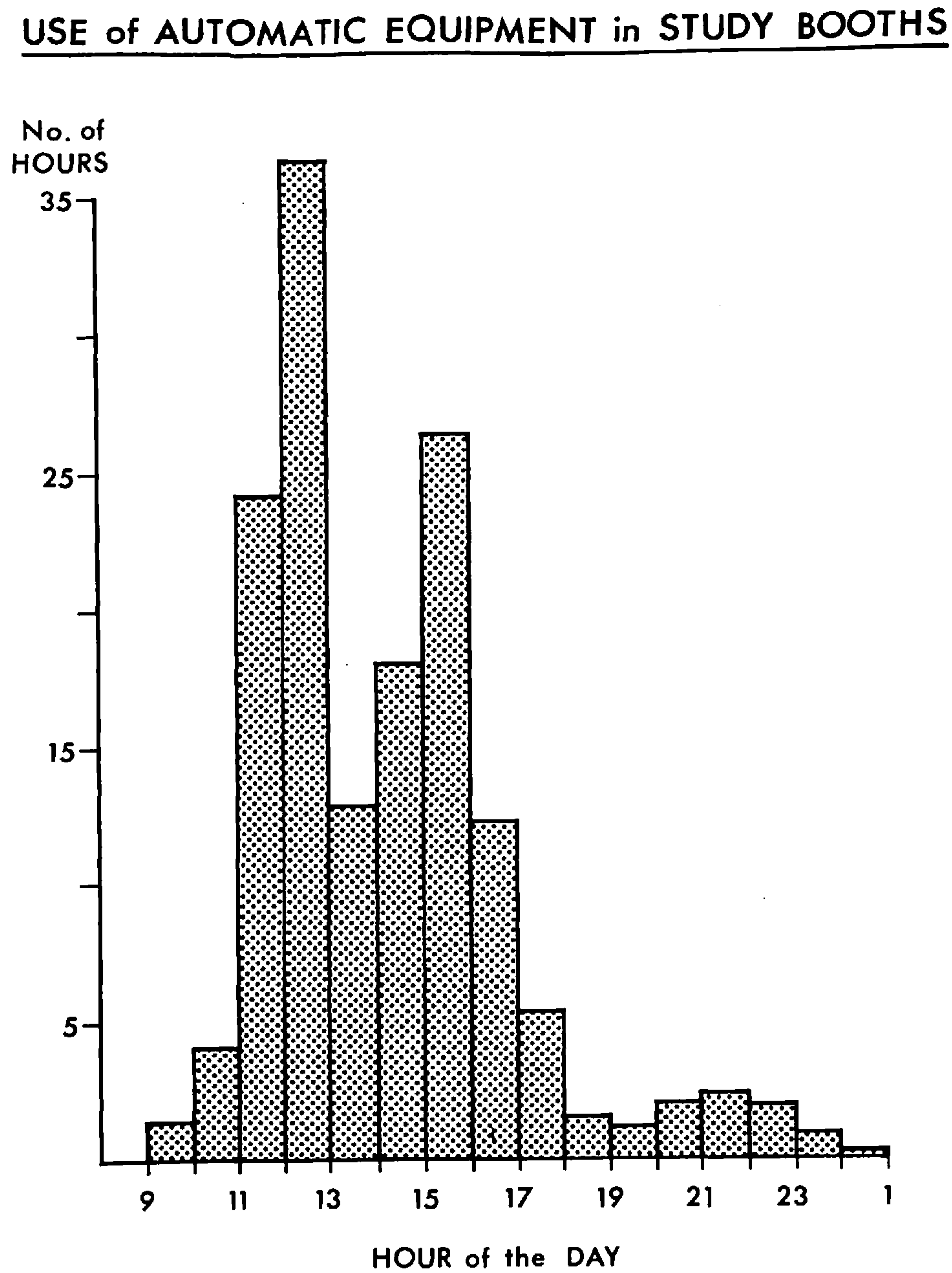


Fig. 39: 1970/1971. The automatic equipment was mainly used during the working day with peaks of high activity at midday and 4p.m.

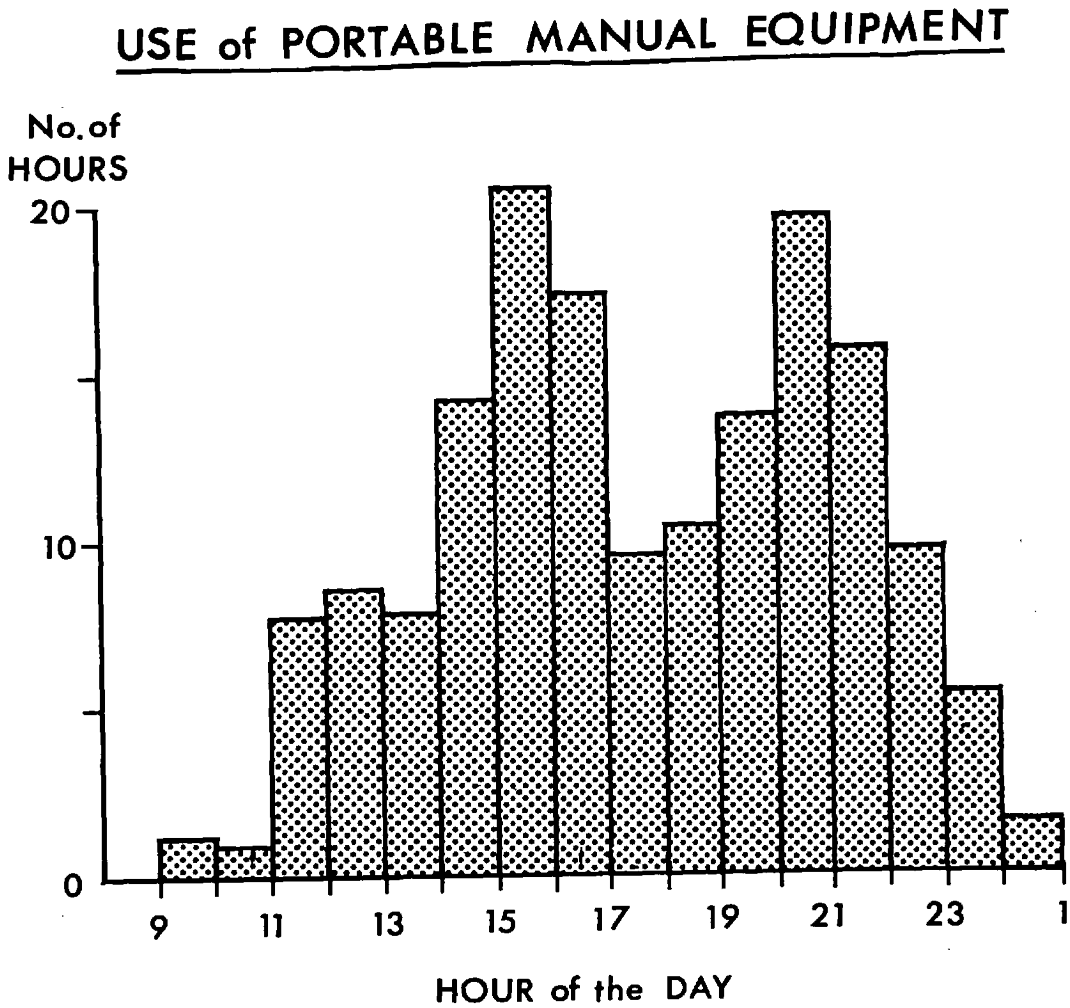


Fig. 40. 1970/1971. The hand-operated equipment was used in the department during the day and (with the exception of weekends) was used most frequently mid-afternoon. It was taken home overnight which accounts for the second peak of activity.

than their colleagues who attended the conventional lecture. An attitude questionnaire revealed that group presentations were unpopular unless discussion was allowed. Use of the portable equipment at home was clearly appreciated.

5.5 1971/1972: A FURTHER STUDY OF GROUP INSTRUCTION AND MANAGEMENT OF LARGER NUMBERS OF STUDENTS

5.5.1 AIMS

The aims for this year were to study the different contributions made by individual students within a group and to compare the results with personality tests. We were also interested in management problems created by the larger numbers. No attempt was made to assess examination performance.

5.5.2 EXPERIMENTAL DESIGN

We had increased further our capacity to teach by tape-slide programmes and during the 1971/1972 session sixty students were selected from the fourth year (total class number - 103) to use the programmes during the endocrinology section. Fifty-seven actually took part in the course, one became ill and was therefore excluded from the study.

The students were given a hand-out (appendix H) explaining the course which was subdivided into three parts (Table 38). The students involved in the experiment were also subdivided into 3 sections (Table 38). Students working individually could book in advance for either the automatic or the hand-operated equipment. The automatic system was housed in the booths and on this occasion students could either work alone or in pairs (Fig. 41 and 42). The portable equipment was used within the department during the day (Fig. 43 and 44) but, as in the previous session, the students could borrow it

Table 38

1971/1972 EXPERIMENTAL DESIGN

Programmes	Section A	Section B	Section C
Part I (D1-D7)	Individual	Group	Individual
Part II (D8-D10 T1-3)	Group	Individual	Individual
Part III (T4-5)	Choice	Choice	Individual

The students (56) were subdivided into three sections. As shown, Groups A and B had experience of both individual and group learning whereas Group C only used the programmes individually.

Individual - choice of automatic or hand-operated equipment

Group - Section A and Section B were subdivided into 2 smaller groups to allow free discussion

Choice - individual or group as preferred

Fig. 41. 1971/1972 Automatic equipment.
A student completing a thyroid programme on a portable Kindermann machine.

Fig. 42. 1971/1972. A general view of booths. During busy periods some students worked together in pairs.

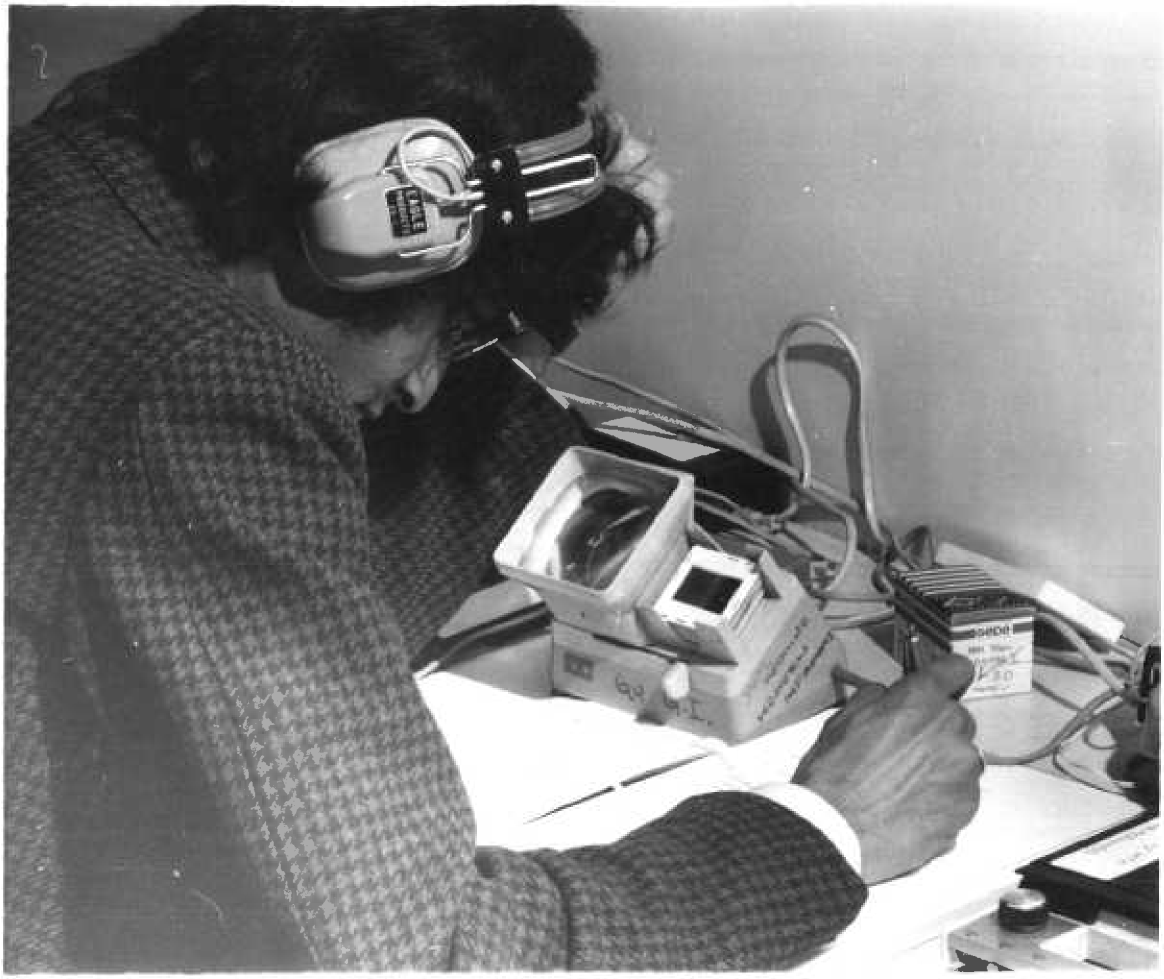


Fig. 43. 1971/1972. Hand-operated equipment.
The answer sheets can be seen mounted in
a folder. The pages are turned over as
in a book.

Fig. 44. 1971/1972. Three students using the hand-operated equipment. The suitcases used for overnight borrowing can be seen under the bench.

overnight or during the weekends. Two group presentations were run simultaneously, each with about eight students (Fig. 45) (ie Section A, and later Section B, was subdivided into two). This provided a manageable number to allow free discussion.

The supervisor noted the contributions made by each individual student to the discussion by marking a specially designed form. From our previous experience we were aware that some students contributed a great deal and some very little to the discussion and we were interested to see if this was a reflection of their personality. Accordingly, each student was asked to complete a Maudsley personality inventory. We hope to publish these findings and they may also form part of the thesis referred to earlier.

5.5.3 RESULTS

A total of 693 programmes could have been completed individually as shown in Table 39. In practice, 636 were done: 255 with the automatic system, 380 with the hand-operated equipment of which 152 were done within the department and 228 at home.

Although programmes were completed within the allocated period, a number of management problems occurred which merit comment as they altered our subsequent practice. Booking arrangements were not satisfactory as indicated by long queues of students waiting to book and later by the students comments.

A booking system is fraught with difficulties as reservations have to be made in prescribed blocks, eg 30 minutes, 45 minutes or 1 hour. Whatever is chosen cannot be appropriate either for all programmes which are of varied length, nor for all students who work at different rates. Thus, there will either be too much time

Fig. 45. 1971/1972. One of the discussion groups.

Table 39

1971/1972 TAPE-SLIDE PROGRAMMES COMPLETED INDIVIDUALLY

		Possible total:
Section A (D1 - D7)	=	91
Section B (D8-10, T1-3)	=	108
Section C (D1-10, T1-5)	=	375
		574
T3 and T4 (if completed individually)	=	62
D7 (optional extra)	=	57
		693

allowed with the result that equipment lies idle between bookings; on the other hand, if too little time is allocated, administrative problems result and students are inconvenienced.

During this session we gained valuable experience of handling large numbers of students. That everyone remained good-humoured must largely rest with the students' tolerance, possibly aided by the free coffee provided. For long term management a 'first-come, first served' system is likely to be easier to operate. In addition, in 1970/1971 all the programmes had to be completed within a fairly short period of eleven consecutive days including two Saturdays and two Sundays. If this could be extended, larger numbers of students could be accommodated more easily.

5.5.4 RENAL COURSE

During the session 1971/1972, in contrast to the two previous years, the renal course was taught by conventional lectures and demonstrations. The programmed tape-slide presentations were offered as an optional extra but not as an alternative to the traditional course. The aim was to determine what use was made of the system and which students took advantage of it.

46 students from the year (i.e. approximately 45%) did the whole or part of the renal tape-slide course and of these, 25 students completed 8 or more of the programmes. 31 of the 57 students (54%) who had previously experienced tape-slide programmes in endocrinology returned to do the renal course whereas only 15 (32%) of those without such experience attempted it.

5.6 1972/1973 SUBSTITUTION OF TAPE-SLIDE PRESENTATIONS FOR ALL LECTURES IN ENDOCRINOLOGY

The current session has yet to be fully assessed. Its aims were to test the effect of replacing all lectures in endocrinology by tape-slide presentations. These were supported by a system of tutorials and three clinical demonstrations (on diabetes mellitus, thyroid disease and the other endocrine glands, i.e. adrenals and pituitary).

Approximately 2,500 hours of machine time (100 students doing 25 one-hour programmes) were needed. Because it was only possible to provide about 1,000 hours (10 machines from 11 a.m.- 5 p.m. for 17 days) during the three weeks allocated to endocrinology, the tape-slide programmes were made available before the course began, from the beginning of October 1972. In practice students mainly used the programmes during the lunch hour and after 3.30 p.m. as they were otherwise occupied outside these times. Simple hand-operated equipment only was used. For some programmes (the revised diabetic ones D10-13 inclusive and the "other endocrine glands" E1-E8) film strip was substituted for slides.

98 of the 100 students completed the tape-slide course within the expected time (and one other did it later) and approximately 90% of these did at least 22 of the twenty five programmes (i.e. 88% of the course). Students' opinion of the course was generally favourable and was assessed in a structured interview (see Thomson 1973). Furthermore it was apparent from a brief questionnaire completed at the end of the year that students favoured a major move away from the traditional lecture towards a combination of tape-slide presentations with tutorials. Results of this enquiry, conducted by one of the fourth year students, are shown in Table 40 (Young 1973).

Table 40

1972/1973 ATTITUDE QUESTIONNAIRE

The students were asked ....

If there were an opportunity to change the format of the integrated year teaching, which option would you prefer?

	Tick one
1. No change (i.e. approximately 80% lecture, 10% tape/slide presentations, 10% clinical tutorials)	20
2. More tape/slides and tutorials with fewer lectures	
a. 33% tape/slides, 33% lectures 33% clinical tutorials	36
b. 45% tape slide, 10% lecture 45% clinical tutorial	31
3. Your own alternative (please comment)	10

Completed by 97 students (approximately 98% of the class)

Courtesy G. Young (1973)

5.7 COSTS

5.7.1 THE COSTS OF PRODUCING A TAPE-SLIDE PRESENTION: 1968/1969 ASSESSMENT

We have previously assessed and reported (Dunn et al 1969) the approximate cost of producing and presenting tape-slide programmes. Such costing is notoriously difficult because of assumptions made and because salaries form such a large and variable component (see 6.9). Our estimate for a single programme in 1968/1969 was £190. £115 of this was allowed for the preparation of the programmed script, for payment (on an hourly basis) of medical editors, educationists, subject specialist and, 67 hours in all, most of this spent by the medical editor. £24 was allowed for recording (for details see Table 41) and editing the tapes, £29 for the preparation of the slides (details in Table 42) and £22 for administrative expenses.

5.7.2. COST OF PRESENTING PROGRAMMES ON AUTOMATIC SYSTEM (1969 ASSESSMENT)

5.7.2.1 Machines

Allowing for breakdown and servicing and for the hours in which they could be used (9 a.m. to 5 p.m.) 27 Kindermann machines (Table 43) would be needed to present to 100 students a tape-slide course which entirely replaced the 126 fourth year lectures (not the demonstrations etc.). The capital cost of the equipment was then £200 plus £40 for a three year service contract. An additional £25 was allocated for storage (of programmes etc.). If these costs were written off over three years this would amount to £2,385 per annum or £23.85 per student per annum. Proportionately more machines (Table 43) would be needed to cover the entire university fourth year in Glasgow (200 students currently and 275 eventually if the recommendations of the Royal Commission report (1968) are implemented.

Table 41

RECORDING AND EDITING OF TAPE

(1969 Assessment)

	£ p
Set up and recording of script	8.50
Initial editing of script	2.00
Preparation of master copy	2.50
Hire of studio	10.00
TV administrative expenses	1.00
Total	24.00

Table 42

PREPARATION OF SLIDES

(1969 Assessment)

	£ p
Selection and designing of new slides by programmer	4.00
Consultation between programmer and medical artist	2.50
Preparation of slides (average 60)	20.00
Mounting and collating	1.00
Cost of mounts	1.50
Total	29.00

Table 43

ESTIMATED REQUIREMENTS FOR PRESENTING PROGRAMMES

(1969 Assessment)

	Number of Students Taught		
Automatic System	100	200	275
No. of machines	27	54	75
Technicians	1½	2	2½
No. of programmes	14	25	35
Hand-operated System			
No. of machines	100	200	275
Technicians	1	2	2½
No. of programmes	50	100	138

5.7.2.2 Programmes

Allowing for the high initial cost of a programme (£190) and £6 for subsequent copies and that the 14 copies needed (for 100 students Table 43) should have a four year expectancy of life, £13,400 would be spent annually on programmes. Again, proportionately more money would be required for the higher numbers (Table 44).

5.7.2.3 Technician/Librarian

For the automatic system we allowed the time of one and one-third technicians to cover the needs of 100 students. Her salary was estimated at £900 in 1969. Additional help would be needed for the larger numbers (Tables 43 and 44).

5.7.2.4 Total Costs for the Automatic System

Thus, a total amount of £16,985 would be required annually to replace the lecture course (126 lectures) by 200 programmed tape-slide programmes if presented by the automatic system. This would cost approximately £170 per student and each machine hour (assuming each programme takes approximately one hour) would cost about 85p.

5.7.3 COST OF PRESENTING PROGRAMMES BY HAND-OPERATED SYSTEM (1969 ASSESSMENT)

5.7.3.1 Machines

In 1969, we assumed that ideally each student would have a set of hand-operated equipment allocated to him personally for the year. The cost of the equipment was approximately £20 at that time and an additional £10 was allowed for repairs and £10 for storage. Again, written off over three years this would amount to £1,333 per annum or £13.33 per student. The higher number of students would need proportionately more (Tables 43 and 45).

Table 44

COST OF PRESENTING PROGRAMMES ON AUTOMATIC EQUIPMENT
(1969 Assessment)

Costs per annum	Number of students taught 100	200	275
Machines	£2,385	£4,770	£6,625
Technicians	£1,200	£1,800	£2,250
Programmes	£13,400	£16,700	£19,700
Total	£16,985	£23,270	£28,575
Cost per student	£170	£116	£104
Cost per student machine hour (assuming 200 hours)	£0.85	£0.58	£0.52
Cost per student hour (assuming 126 lectures)	£1.35	£0.92	£0.83

Table 45

COST OF PRESENTING PROGRAMMES ON HAND-OPERATED EQUIPMENT
(1969 Assessment)

Costs/annum	Number of students taught		
	100	200	275
Machines	£1,333	£2,667	£3,667
Technicians	900	1,800	2,250
Programmes	24,200	39,200	50,600
Total	£26,433	£43,667	£56,517
Cost/student	£264	£218	£205
Cost/student machine hour (assuming 200 hours)	£1,32	£1.14	£1.03
Cost/student hour (assuming 126 lectures)	£2.09	£1.73	£1.63

5.7.3.2. Programmes

A larger allocation of programmes was allowed for the hand-operated system, one between two students, as it was assumed that the material would be mainly used outside the department. Thus, £24,200 would be needed annually to provide the necessary programmes (50) for one hundred students (see Table 45).

5.7.3.3 Technician/Librarian

It was considered that one technician would be adequate to cover the requirements of 100 students when the hand-operated system was used, as less administration would be involved with the programmes used at home.

5.7.3.4 Total Costs of Hand-operated Equipment

Because of the high costs of the programmes (£24,200 annually) the total annual budget needed to replace the lectures with programmes presented on the hand-operated system would be £26,433 or £264 per student. Each 'machine' hour therefore costs £1.32. We have published some of these estimates (Dunn et al 1969).

5.7.4 REAPPRAISAL OF COSTS IN LIGHT OF SUBSEQUENT EXPERIENCE

Some of the estimates made in 1969 can clearly be modified in the light of subsequent experience. During the last year, for example, it has been proved possible to teach 100 students endocrinology using 17 sets of hand-operated equipment (eleven within the department and an additional six for use at home during the second term). Although a larger number of machine hours were needed than were available during the three weeks of endocrinology (see 5.6) the calculations were based on ten machines operating in the department within the working day. If additional machines are available for borrowing overnight or at weekends, as during the second term, the capacity is markedly increased. It should be possible for 100 students to cover the whole year's course using far fewer than 100 sets of hand-operated equipment. At most, thirty should suffice, allowing five spares for breakdowns and repairs. This would greatly reduce the cost of the equipment.

Similarly, the number of programmes needed was an overestimate. In 1973, the maximum number of copies of each tape made was ten. In practice, more copies are needed for the first programmes in a series as all students start at the same time; however, they quickly diversify so that fewer copies are needed of later programmes. Between five and ten (average seven) copies of each would be adequate. Again this would reduce the costs. In addition, with film-strip money is saved: no mounting or expensive storage is required.

Thus, it is possible to administer a tape-slide course with fewer copies of programmes and fewer sets of equipment than were anticipated. However, were the anlysis of the costs of producing a programme to be repeated it is probable that salaries (per hour) would be higher but that time spent per programme, with increasing experience, would be reduced.

6. DISCUSSION

Some of the themes taken up in discussion derive directly from work done on tape-slide presentations; others, less directly connected, are concerned more with future extension of the work. This sequence has been used in the discussion.

6.1 PREPARATION OF TAPE-SLIDE PROGRAMMES

Preparation of a tape-slide presentation is essentially an individual matter although some guidelines must be followed if the material is to be programmed. Our technique has been detailed in the methods section. It is worth emphasising again that because the preparation is time-consuming (70 hours initially for the master copy) and becomes easier with experience it is probably unwise for one doctor or for one department to attempt the work unless it is proposed to make a major investment in it.

At one time, as a source of new material, it was considered adequate to record a lecture given by an expert, (often a visiting or guest lecturer) and to copy his slides. This approach is doomed - a good lecturer is good because he senses and responds to his audience, points of interest can be emphasised, explained or elaborated depending on the reaction. Transferred to an audiotape much of this improvisation becomes meaningless. Also lecturers may indicate points of interest on slides and these become irritating to the isolated listener. Humour, spontaneous in a lecture, becomes false on tape.

Initially, in an attempt to save time, we tried recording lectures as a way of obtaining a script from the subject specialist. This exercise clearly demonstrated the unsuitability of recorded lectures for self-instruction: transcripts were voluminous and it took the lecturer far longer to edit and precis these than it would have done to write down a summary of the main points. The technique we eventually used has been described.

Another important question is whether the programmes should be prepared by the subject specialist or by a medical editor. The former is familiar with his topic but unfamiliar with audiovisual techniques; the latter, less familiar with the topic, but more familiar with the technique of presentation. From personal experience of both I strongly favour a primary role for the medical editor in the preparation of a programme. Subject specialists are usually busy and many of them are relieved to have the work taken away from them. Also, in the long run, it is probably more efficient to train a few people to act as medical editors than to indoctrinate a succession of subject specialists in educational techniques. This modified role enables the specialists to act as advisors in their subject. They are usually helpful and seemingly content to play a relatively small part. It is, of course, possible for an enthusiastic subject specialist to prepare a programme in the absence of a medical editor but it will probably become less and less common as more centralised production units are developed.

One possibility to consider is the use of married women doctors as medical editors. The work is compatible with the demands of a family. During the project in Glasgow, six married women (including the author of this thesis) have been involved and successfully combined their work and their home life, including five successful pregnancies. Other groups have used students to programme material (Massey et al 1971; Stevens et al 1973). Although these were reported as successful, in my view students are unlikely to become involved on a large scale.

Another possibility to consider is for educationalists to programme the material and for the doctors to act as a source of material and as advisors. We have no personal experience of this method although it is commonly used in computing.

6.1.1 PREPARATION OF SCRIPT

The design of the material is made much easier if the objectives of the course and of each presentation are clearly stated. As referred to earlier this is often ignored by subject specialists and despite our attempts it remains a difficult problem to resolve satisfactorily.

A further difficulty is to decide how much previous knowledge can be assumed: if too much the programme may be meaningless, if too little it will be boring. As outlined in the introduction (4.2.2.4) responses are an important feature of our programmes. Eraut (1967) considers that more learning takes place when students make a response and moreover that subject matter is not effectively learned when it is not immediately used by the student to make an active response. The form in which the response is made may also be significant. Thus a possible disadvantage of the rigid multiple choice format used in some tape-slide machines is that it only demands recognition of the correct answer. In our programmes, the student has to formulate his reply and consequently this type of answer may be more demanding and possibly more lifelike.

The purpose of the audiotape is to amplify the visual and to add interest to the presentation, both by the nature and content of the commentary and the style of delivery. Because the listener will probably be a single student and not a large group, a more informal approach is needed. Scripts should be written in spoken-style and in idiomatic English. In general, this requires single short sentences where key words are repeated (Engel 1971). An informal commentary also has the advantage that it gives the illusion of speeding up the pace of presentation.

The choice of speaker is important. The advantages of a clearly delivered commentary hardly need stressing. In many ways the best person to record the script would be the subject specialist since he can inject personal interest of the subject into the recording. However, not all subject specialists speak well and some who can, become inhibited by the ritual of recording. For this reason we experimented with drama students. The delivery of the material was excellent and the recording sessions were easier. However in places it was difficult to get the pronunciation and emphasis correct even though both a medical editor and a producer were present. On many occasions, the faults were mere nuances, but nevertheless some students commented that the speaker was obviously not medically qualified.

Doctors, on the other hand, are familiar with the terminology and usually with the subject matter, unless it is of a highly specialised nature. A compromise we are currently testing is to ask a few doctors with a good speaking voice to make all the recordings (of which some are the subject specialists).

Wakeford (1972) reported a study of this problem. As the subject specialist was ill three of the five scripts on congenital abnormalities were recorded by another doctor. However, his delivery was not ideal in either pace or emphasis and so for the last 2 tapes a professional commentator from the BBC was used. At the medical school where the programmes were prepared a questionnaire, completed three months after the course,revealed the majority of the students had no preference (40%) or had noticed no difference (49%). The programme was then transferred to another medical school where the first three scripts were re-recorded by their own professor of anatomy. 51% of these students preferred this recording, 40% still had no preference but only 3% now noticed no difference. No firm conclusions can be drawn from this. It is possible that the recording of the Professor of Anatomy had real merit (this could have been tested by transferring it back to the first medical school); but it is equally possible that his students voted for his recording for other reasons. They may have preferred a familiar voice.

By and large the evidence suggests that recordings are best made by a doctor with a good speaking technique. In my view it would generally be impractical to use a familiar voice as this would necessitate re-recording all tapes obtained from other centres.

6.1.2 PREPARATION OF SLIDES

The design of the slides is important as stressed earlier and collaboration with a good department of medical illustration is essential. A compromise has to be met between high-speed of production and good quality art work (Barker 1971). Guidance on the design of lecture slides is given by Zollinger and Howe (1964) and Davis and Solomon (1972). Different media (books, films and slides) require different illustration techniques (Doray 1968). It is interesting to note how the relative importance of graphic art has diminished as photography has been used more for recording clinical features and surgical techniques. However, illustrations have a great capacity to summarise an elaborate point - one diagram can replace a lengthy description (Drake 1954) which Hammersley (1964) considers an important role of the artist. Effective art work should be both simple and legible (Drake 1963; Bourg 1971). For the visually inclined, illustrations are also a good way of demonstrating inter-relationships between events. However, care is necessary in the design, especially where colour is used, otherwise it is possible to imply relationships where none exist (4.2.5).

In a tape-slide presentation contact with the audience is lost and care must be taken when the programme is designed that the slides and commentary do not become dissociated. For example, if a clinical photograph is projected, only the visible clinical features should be discussed. Other clinical features, aetiology and management of the disease, should be considered on different slides. In addition, no visible lecturer is present to direct the student's attention to the pertinent points in the slides. Special provision must be made for this, either by the commentary or legend selecting the important points from the unimportant detail (see Johnson 1956) or by breaking down a complex point into a number of stages each with its own illustration. Thus, we found it better to revise the metabolic pathways concerned in the synthesis of the thyroid hormones by dividing the material into five slides and so building up the final diagram (see Fig. 46). In a lecture the single slide (shown at the bottom of Fig. 46) might have been sufficient. Slides can also be used to change topic. For example, after discussing diagnosis it might be appropriate to have a slide with "treatment" to indicate the new theme. Appreciation of these seemingly simple points has led to a progressive increase in the number of slides. The early (non-programmed) tape-slide presentations contained approximately one slide a minute. Subsequently the rate almost doubled.

Dwyer (1971a) studied the relative effectiveness of different types of illustrations. He concluded that the use of illustrations

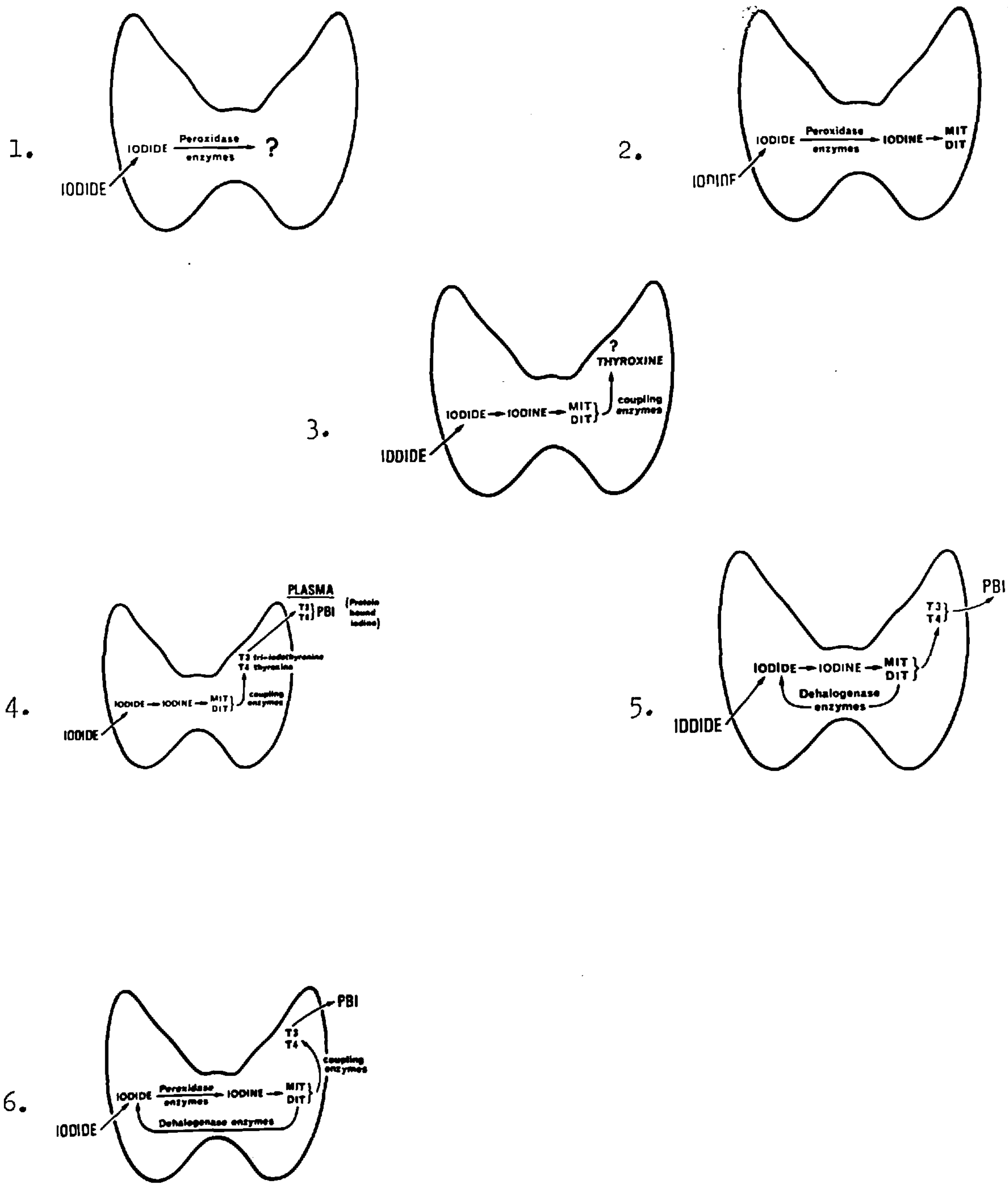


Fig. 46. A sequence of five slides (1-5) showing the metabolic processes involved in the synthesis of the thyroid hormones.

Only a small amount of new information is revealed at any one time so that the complex final diagram is built up gradually.

The sixth slide appeared as a revision slide later in the programme; it could possibly be used alone in a 'live' lecture.

(slides or television) does not invariably improve learning. For some forms of learning (i.e. the learning of terms) an audiotape alone was as effective as a tape-slide presentation. Abstract line drawings were superior to photographs for students working at a fixed rate in a group although the latter, which were more detailed and realistic, were superior when students worked individually (Dwyer 1970). A further study showed the coloured simple line drawing to be the most effective illustration technique overall (Dwyer 1971b). Whereas this may be so in illustrating the anatomical relationships of the stomach, the clinical feature of myxoedema would be better shown by a photograph. Diagrams or line drawings are useful for illustrating concepts but where realism is important, such as with clinical features, clinical photographs are clearly superior.

In an inconclusive study, comparisons were made between coloured cartoons, which included humerous visual illustrations in addition to verbal material, and slides with the text only (the verbal material was the same) as a means of communicating information in a tape-slide presentation concerned with behavioural objectives. The students (trainee teachers) reacted more favourably to the cartoon version although no difference in achievement was observed between the two groups (Baker and Popham 1965). Later, based on the results of a further study (when more advanced subject matter was designed and used for more advanced learners) Popham (1969) suggested (for similar topics and similar learners) that the additional costs of preparing cartoons might not be justified.

The use and value of colour in self instruction has also been investigated. Katzman and Nyenhuis (1972) were able to demonstrate that colour made presentations more interesting although only some forms of learning were improved. Other studies on the effectiveness of colour television (over black and white), reviewed by

Webster and Cox (1973), also failed to show that colour produced any improvement in learning although some resulted in a more positive emotional reaction in the viewers. Webster and Cox (1973) used colour changes selectively on captions to emphasise important points (the programmes themselves were in colour). They found that these changes were only effective when the colour convention was established and explained to the subjects (school-children age 9-11 years). Further work on the best use of colour is needed: although colour seems to engender a more favourable reaction and this may be important in relation to the acceptance and use of self instructional teaching material - particularly if employed on a large scale.

In medicine, colour slides must have undisputed value in certain situations on the clinical side, jaundice, anaemia and pigmentation, and for the histologist, selective stains.

For all these reasons it is difficult to make broad generalisations. The form of each illustration should be decided on the information that is to be conveyed. Thus the slides in a presentation may contain text only, diagrams, realistic photographs and cartoons (although I personally dislike humerous cartoons) as appropriate. A practical point to consider for possible future developments would be to design all the slides in the horizontal format, clinical photographs for example are usually vertical, so that film strips could be produced if desired.

6.1.3. 'PREVIEWING'

One disadvantage of audiovisual presentations is that it is very difficult for a student to judge whether or not he needs to do the presentation as he cannot skip read as he would with a book.

There are several possible solutions to this problem: one is to give a short summary of the presentation (or list the objectives), a second and probably better method is to include a short test with each package. If the student obtains a high mark he will only achieve marginal benefits from doing the programme.

6.1.4 SUMMARY

As with any form of communication it is important to achieve the highest possible standard. Poorly produced programmes alienate students and staff from self-instruction and students today have been accustomed from an early age to the highly professional standards of broadcast television. Unconsciously, all university teaching material is judged against these standards, However, perfection is elusive and a balance has to be met between a reasonable standard of production and economy of time and resources.

6.2 EQUIPMENT

As indicated in the introduction (3.3.3.11) there is a wide range of equipment available. It is therefore relatively easy for a department to test the potential of tape-slide presentations without making a major investment and hence the obligation of a long-term commitment. 35mm slides are standard in this country and there is a wide choice of viewers and projectors. With tape, there are now 2 standards: ¼" tape on a reel and cassettes (see Fletcher 1972). However, in practice the disadvantages of having two systems are small. For professional recordings and preferably for the master recording of any teaching tape, ¼" tape is required (for technical details see Morgan 1972); for students' use cassette copies are easier to handle and can be played on inexpensive equipment.

6.2.1 AUTOMATIC SYSTEM

Automatic equipment offers both automatic slide change and automatic stop. The student is relieved of these manual tasks and is left free to concentrate on the programme which theoretically could benefit learning as the student's immediate response to a question is to try and answer it. In contrast, with the hand-operated equipment he has first to stop the tape.

A major disadvantage of the automatic equipment is its expense, although cheaper systems (such as the Mentor marketed by Sigmatron Ltd.) are now becoming available, they are still more costly than simple hand-operated equipment. Secondly, until an accepted standard emerges for the impulses to operate the slide changes and tape stops, systems at different centres may be incompatible with each other which hinders free interchange of material (see Fletcher 1972). However, the National Council of Educational Technology

(N.C.E.T. 1973) published their recommendations for a uniform standard earlier this year and if these are accepted the problem will cease to exist.

Many problems were encountered with the Kindermann audiovisual tutor machines. The booth version proved unreliable. Pulses added for automatic slide change on one machine would not necessarily be re-played on another. Other faults also occurred. Spare parts were difficult to obtain because the equipment came from Germany. Finally, the equipment came as a "package" deal. If one of the components failed, the entire apparatus was unusable. Part of these difficulties undoubtedly occurred because technology was less advanced in 1968 when the equipment was bought. Equipment is now readily available with impulses for both slide change and tape stop. In addition, the units are interchangeable, thus if the projector breaks down it can be replaced by another while the original is repaired. As the results section showed the automatic equipment was popular with our students and it would probably have been more so had it been reliable.

6.2.2 HAND-OPERATED EQUIPMENT

Hand-operated equipment is cheap: a play-back unit and viewer can be bought for between £20 and £30. Because it is portable it can be used equally well in the hospital or at home. In our experience one of its most attractive features was its reliability and few breakdowns occurred. Slides occasionally stuck in the viewers and with heavy use the play-back units occasionally became faulty. However, it is almost as cheap to buy a new one as to have it repaired and a reserve stock of viewers and recorders can be kept.

The student has to operate the equipment himself and theoretically this could interfere with his learning but it remains to be shown that this occurs in practice and also that it is more distracting than turning over the pages of a book. Hand-viewers give poor magnification, which could be important where good definition is needed for example in slides of histological sections. Small projectors could improve the magnification, but with these each slide has to be inserted individually unless a semi-automatic loader is used in addition (for example the Hanimette 100).

Although cost is important, certain minimal requirements are necessary for hand-operated equipment; for example a 'rewind' facility should be present to allow students to replay short sections of the tape. This feature was absent on the Phillips cassettophone but is now present on most cassette players.

6.2.3 RECORD V. PLAY-BACK ONLY EQUIPMENT

It is generally better to make the master recording on a different tape-recorder from those used by students for replay. For recording, a high quality machine is used (see 4.2.8), for playback multiple relatively cheap units are quite adequate. After editing, cassette copies can be made commercially from the master tape.

Problems arise with the production of programmes incorporating impulses for automatic slide change and tape stop. However, it is still preferable, for reasons of cost, to separate the production of these programmes from their subsequent use. One system that allows this is marketed by Sigmatron Ltd. who sell 3 pieces of equipment - an impulse generating unit which allows the addition of the two impulses to ¼" tape, thus the master recording can still be on a high quality machine. The cassette copies, prepared commercially, can be played back on their second unit the 'Mentor'; a play-back only tape recorder which replays both the script and the recorded impulses to stop the tape and to trigger off the slide changes in an automatic projector such as the Kodak Carousel. The third unit, the

Magister, is self-contained and is capable of recording the text and impulses on cassettes and can also act as a play-back unit in combination with a suitable projector.

6.2.4 SLIDES OR FILM STRIPS

Most departments are using 35mm colour transparencies as slides. Film strip is an alternative (Hansell 1951). When only a few copies of a programme are needed slides are satisfactory. However, in 1969, to produce sufficient copies of the course on renal disease, 10,000 slides were needed which led us to consider the use of film strip. It is cheap to produce, no mounting is needed, and it is easier to store. The space occupied by a single 72 slide programme for the automatic system could house fifteen film strips (Fig. 47). In addition, slides are liable to be lost or misplaced whereas film strip, once prepared, is always in the correct sequence. Film strip is therefore easier to administer, although it is more liable to damage, but the latter is a minor disadvantage. The major problem is the lack of suitable equipment. Although widely used in the U.S.A., their film strip is a different size (half frame 18mm x 24mm). The majority of equipment is therefore unsuitable. There are advantages in retaining the full frame (36mm x 24mm) version as the standard size, as the film strip can be cut up to produce slides if required by other centres.

Film strip has obvious potential. I believe it will become more widely adopted as tape-slide programmes are increasingly used. Stimulated by demand, cassette loaded automatic equipment will be developed. Meanwhile, the small Agfascop 10 film strip viewer is adequate. (Small projectors are also available but are more difficult to load).

6.2.5 CHOICE OF EQUIPMENT

To summarise, there is no ideal set of equipment. Each potential user has to examine his local need and facilities. Consideration should

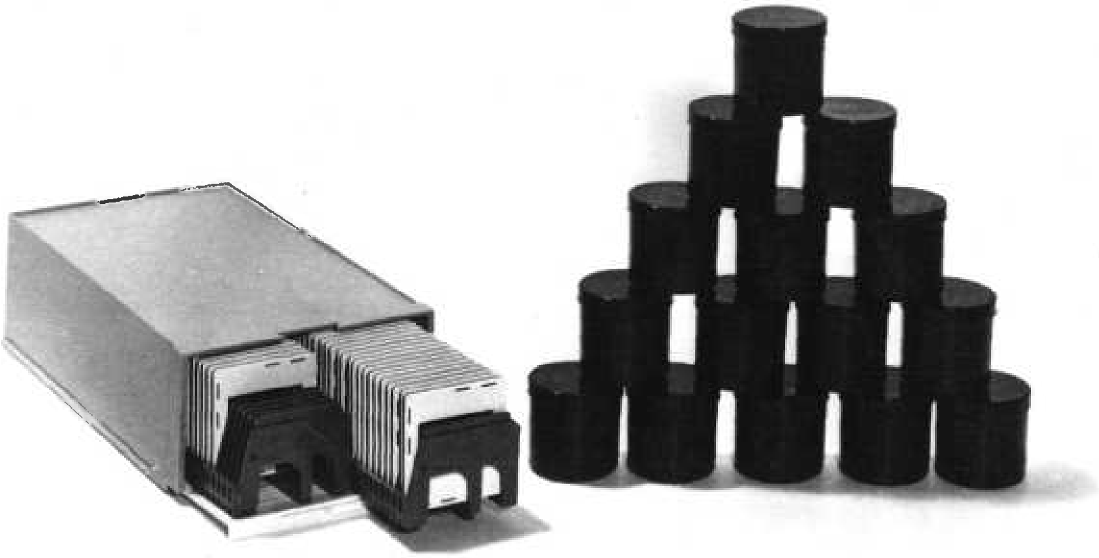


Fig. 47. Comparison of storage requirements for slides and film strip: on the left one programme stored as traditional slides, on the right fifteen equivalent programmes stored as film strips occupying a comparable space.

be given to the number of students, to the space for booths, to likely developments with film strips and cheaper play-back units and to the funds available. My recommendation to a newcomer in the field would be to buy a few simple units at first - a cassette tape-recorder and perhaps a hand-viewer for slides (as at present most of the available programmes, e.g. those produced by the Medical Recording Service Foundation use slides rather than film strip). If however, a large scale or long term commitment was envisaged, investment in automatic equipment might be justified.

6.3 EDUCATIONAL TECHNOLOGY: THEORETICAL ASPECTS

Some of the problems in medical education have been attributed to a failure to analyse the curriculum as a whole and to a lack of a clear idea of the objectives of the courses involved. It is said to be in these areas that educational technology has much to offer. Stress is now placed on the initial stages of course and curriculum analysis, on the subsequent evaluation of the educational techniques and on the design of the material (Davies 1972, Davies 1973).

Until recently, little attention has been paid to the initial planning and the evaluation of the medical curriculum (Jason 1968a) although the importance of these problems has been stressed (G.E. Miller 1967).

6.3.1 OBJECTIVES

In education, much interest has been focussed on statement of objectives and Bloom et al (1956) has suggested that they are of an ascending order of sophistication (hierarchical order). The lowest objective only teaches simple facts (for "straight recall") the normal range of plasma sodium is an example. The second, comprehension, implies that the student should be able to demonstrate his understanding for example by "stating the problem in his own words" or the interpretation of data such as may be involved in various abnormalities of plasma sodium concentration. The next stage is application or problem solving - where the emphasis is on remembering and using appropriate principles to solve a particular problem as illustrated by patient management problems or in an actual clinical situation. The higher ranks include analysis, synthesis and evaluation which are largely self-explanatory. In our experience, tape-slide programmes can achieve the first three levels but not the higher ranks. Other hierachical systems have also been described such as those by Krathwohl et al (1964) and Gagné (1965). It is not proposed to discuss these further here; they and other systems have been considered in a recent article by Davies (1973).

Some of the most valuable work on objectives has been done by Mager. He concludes his parable of the sea-horse (Mager 1962): "If you're not sure where you're going you are liable to end up some place else and not even know it". Students (and staff) stand in the same danger if they are unaware of the aims and objectives of their courses. Mager (1962) discusses the formulation of meaningful objectives in depth.

In medicine there is no general agreement as to the objectives of the undergraduate course. Dudley (1970) has devised a taxonomy of general objectives involved in clinical problem solving which is of some theoretical but little practical use. Attempts have been made to define objectives in internal medicine (Bacchus 1972), surgery (Rosenberg et al 1972), dermatology (Caplan and Solomon 1971) and neuroanatomy (Andersen and Bojsen-Møller 1970) and physiology (Naeraa 1970). It is claimed that if students are made aware of the objectives of a course then learning will be increased and this theory was supported by a controlled trial in cardiology (Varagunam 1971).

However, although the objectives of a course may be definable it may not be possible to teach all of these formally. However, this may be unnecessary. One study by Erskine and O'Morchoe (1961) compared two groups learning anatomy. One course emphasised the principles only but omitted the details whereas fuller information was given in the other. Later, in a test of factual recall, the former group performed better. Mosel (1964) considers that the problem is to optimise learning by proper organisation.

However, the studies quoted in this section are isolated examples of a particular approach in medicine. In general, most medical schools have not defined specifically the objectives of their courses but simply try and cover as much material as possible during the course. This may well become impossible with the vast increase in scientific knowledge. In addition, as Peterson (1964) points out, much of medical education is purely academic and ignores the outcome of a practising doctor.

6.3.2 OBJECTIVES AND THE EXAMINATION

It is to some extent true that "he who controls the examination controls the education" (see G.E. Miller 1964). Because a primary aim of the student is to pass his examination the objectives of the undergraduate course tend to be designed with the examiners rather than a subsequent career in mind. Examining bodies thus have an important influence on the form of the medical curriculum. Where the designers of the curriculum are also the examiners (the university M.B.) there need be no major problem.

6.3.3 ASSESSMENT

The other important stage in a course is the form of assessment of students. Stones (1969) has outlined some of the problems associated with this and has pointed out that most examinations are designed to discriminate between students and place them in rank order.

He suggests that this is unimportant and that tests should determine whether or not the aims of the course have been met. In this type of examination, if the course is successful, all students may score high marks or conversely all may fail. The standard of success (pass) should be determined in advance based on the objectives of the course and not decided afterwards in the light of the students marks. However, acceptable standards vary. Pilots, for instance, must be 100% accurate and the R.A.F. has a 90/90 specification that is 90% of students must score 90%. Seemingly lower standards are acceptable in a medical student. However, if students score low marks there are three possible explanations: the students were poor, the course was poor or the examination was inappropriate for the material taught. Generally, the last two factors are ignored; although examinations can provide valuable feedback to the staff.

Another variable is introduced by the students who possess different ability and background knowledge. Eraut (1967) considers that it is important to assess their capabilities before they start on a course or topic. Some may have insufficient background knowledge and may need revision first (e.g. the biochemistry of the Kreb's cycle before studying diabetic coma). Others could profitably by-pass some topics as they have already acquired the information; these students could either save time or perhaps spend it more profitably for example some of the brighter students could do a research project. Thus, students in the physiology course at Aarhus are examined during the first week: one of the aims of this test is to pick out the specially competent student so that he can have an opportunity of cutting off six months by arranging a special schedule for himself (Naeraa 1970).

Assessment of this type is especially useful in courses which are largely based on self-instruction as they are more flexible and can therefore be adapted to meet the needs of individual students: remedial work for the poorer or inexperienced students and additional stimulation for some of the better ones.

6.3.4 THE AUDIOVISUAL APPROACH

There is some evidence that the audiovisual approach is more efficient than either sound or vision alone (see Menne and Menne 1972) and Hsia (1968 and 1971) considers the combination may be superior provided that the total information presented does not exceed the capacity of the learner's central nervous system to absorb it. An interesting experiment in learning (Chan et al 1965) suggested that more was learnt from the visual than from the auditory channel when different information was presented simultaneously to both. It also showed that colour increased the amount learnt from the visual channel but this was at the expense of the auditory channel as the total amount learnt did not increase.

Nevertheless, the combined system may have its drawbacks. Although one channel can reinforce the other, they can also compete and interfere if they convey different information. An ideal situation might be thought to exist when both channels carry exactly identical messages. However, this is also probably untrue as demonstrated in a bad television news, when the screen displays an extract while the announcer reads the same extract verbatim. In practice this is irritating as most viewers read faster than the broadcaster. It is also distracting, as the viewer becomes uncertain whether to listen or to read.

Thus, although the combined audiovisual approach carries a number of potential advantages as indicated above and in the introduction (3.3.3) it is not free of problems. However, these can largely be overcome if the material is carefully designed so that the script and slides complement each other.

6.4 GROUP LEARNING

Group presentations would appear an economic method of presenting tape-slide programmes to students; fewer programmes and fewer sets of equipment being required. Unfortunately they are not always popular. When first tested in 1969/1970 group learning was particularly unpopular although there was no difference in examination scores between students working in groups or alone. Reasons for this have been discussed. Particularly students did not like the fact that the presentation was outside their control. The situation was not improved when headphones were introduced the following year in an attempt to make it more personal. It was objected that group presentations resembled a lecture without light relief.

Groups where discussion was allowed were more popular, being strongly favoured by some and strongly disliked by others. The former seemed to find it a good balance between the asocial individual tape-slide programmes and the lecture, the latter found the discussion, which inevitably lengthened the presentations, to be irrelevant and boring.

As described it is difficult to decide on an optimal pace for group presentations. Gropper and Kress (1965) have studied the problem in more detail and found, not unsurprisingly, that the number of errors rose as the pace of the presentation (i.e. the shorter the duration of the stimulus exposure and of the opportunity to respond) was increased. They also discovered that students did not always select the optimum pace for themselves when working individually.

These authors suggested that in order to maximise effectiveness and efficiency, it might be possible to suit the needs of groups of students who share pacing requirements by providing, say, two groups run at different tempos.

In 1971/1972 we analysed the behaviour of students in the group sessions in an attempt to see if it reflected their personality. Skovronsky et al (1971) have studied the interaction of physicians within a group, classifying their behaviour as outlined by Bales (1951). The majority of the contributions were concerned with either giving (42%) or asking for (24%) information. Antisocial behaviour was rare.

Groups which are pre-selected on various parameters may be more productive as Fleisher (1968) has suggested. He found that groups which were composed of people with certain behavioural characteristics were more productive than control groups.

Thus, although the group may appear attractive and economic there remains the mathematical impossibility of selecting a pace to suit all participants. Nevertheless it may be possible to make a group more or less productive by selecting its members. More work is needed in this field. On a purely practical level, group teaching imposes an inflexible timetable on the curriculum similar to that created by a conventional lecture course. However, groups may have a place during the testing stages of a programme as any deficiencies are quickly exposed.

6.5 PERSONALITY OF STUDENTS AND TAPE-SLIDE PRESENTATIONS

We are currently analysing data on this interesting question. Preliminary examination of our data by an M.Ed student from the University Department of Education (Wood 1972) suggests that introverts have a more favourable reaction to self-instruction than extroverts but that the student's personality is not clearly related to his choice of presentation technique, i.e. hand-operated, automatic or group.

6.6 ASSESSMENT OF EDUCATIONAL TECHNIQUES BY EXAMINATION OF STUDENTS

In the three years studied students who learnt endocrinology and renal disease (1969-1971) from tape-slide programmes scored higher in these sections of the examination than their colleagues who attended the conventional lectures. There are a number of possible explanations: tape-slide students could have been intrinsically superior, this is unlikely as they were randomly selected and the examination results in the control situation found them indistinguishable from their colleagues (excepting one group in 1969/1970). More likely, the novelty of using a new technique could have played a part in their improved performance. Against this is the 13 hour duration of the course in 1968/1969 and the fact that students did as well in a second tape-slide course as in the first in 1970/1971 which involved a total of about 24-25 hours. Students knew they were involved in an experiment and it is well recognised that this can affect performance, the so-called Hawthorne effect. Also as stressed earlier (3.4) the value of such comparative studies is questionable. Nevertheless, it would be reasonable to conclude that the students using tape-slide programmes are not handicapped in subsequent examinations. This has been the previous experience of programmed teaching material (usually in book form) which has generally shown benefit in terms of examination results (Green et al 1962; Cheris and Cheris 1965) or no significant difference from controls (Elder et al 1964, Allender et al 1965, Miller et al 1965, Owen et al 1965a and b, Moser et al 1967, Stretton et al 1967, Wilds and Zachert 1967a, Manning et al 1968).

Foreign students benefitted particularly from the tape-slide programmes and their academic performance improved strikingly (Harden et al 1969c). Language problems may handicap these students in lectures and ability to replay tapes would then be a major advantage. The fact that foreign students took longer than the rest of the group supports this. Owen et al (1965b) made similar observations: in their study the performance of foreign students in the experimental (branching programme presented by teaching machine) group was equal to that of their U.K. colleagues although it was inferior in the lecture group. The authors suggested these students may be more fluent in written than inspoken English.

One advantage of programmed material is that it allows all students to reach a similar standard. In our study in 1968/1969 all the experimental students moved into the upper third of the class. Thus, a minimum level of achievement is more likely to be attained in this way,even if previous standards varied. Green et al (1962) showed that poorer students using a programmed text were able to reach a level equal to those who normally performed well with or without programmed instruction. Similar results were obtained by Owen (1965a and b).

All the evidence suggests therefore that students using programmed material do as well or better in examinations than students attending a conventional lecture. Clearly, performance in examinations is not the only or even a major object of medical education; but it is often argued (sometimes by students) that the lecture, unpopular though it be, is an effective means of covering a medical syllabus completely in preparation for examinations. The tape-slide presentation seems superior.

6.7 ASSESSMENT BY DISCUSSION AND QUESTIONNAIRE

The reaction of students to the tape-slide courses was assessed by discussion with them and by questionnaire. Measurement of attitudes is difficult and open to misinterpretation. It has been used previously with students as a source of information on a course in occupational health (Gauvain 1968). However, as Merrill et al (1969) have demonstrated, students' enjoyment of a course need not necessarily correspond with what they have learnt. Nevertheless as Parlett and Hamilton (1972) stress, this type of assessment may provide more valuable insight into the actual operation of a system than can be obtained from examination results.

Like Lloyd (1967), we have also used the questionnaires in a more practical way to determine whether to use automatic or hand-operated equipment and whether the group is preferred to individual instruction. Decision was needed on these points and we have depended as much on the students' attitudes as on their examination results in making decisions.

In general, the students' attitude to the programmes has been favourable and many have expressed appreciation at efforts to improve the course. In our experience, students are tolerant of experiments in education provided that they have been adequately briefed.

The most commonly cited advantages were that it was easier to concentrate and to learn using tape-slide presentations. Similar reactions to programmed material were found at Newcastle (Anderson et al 1967). Criticisms of our course in Glasgow were of two broad types: those which related to the principle of tape-slide presentations (its antisocial nature etc. see 5.3.4) and those which concerned the technique of presentation (a badly designed programme, poorly fitting headphones, hard chairs in the group etc.). Generally the latter were curable. The former were not (although they could be lessened for example by a good tutorial system). As is apparent from the methods section improvements in the style of programming were considered important.

One interesting finding emerged in the session 1971/1972. Medical students are probably by nature conservative and they need to be exposed to new techniques before volunteering to do them spontaneously. This was exemplified by the students who elected to do the renal course as an optional extra: more students who had previous experient of the technique, having done the endocrinology course by tape-slide presentations, returned to do the renal programmes than their colleagues who had only experienced the lecture.

In summary, the attitude of the students to the programmed tape-slide presentations was generally favourable and it is important, in my view, that only a few students objected in principle to learning in this way.

6.8 TIME TAKEN TO COMPLETE PROGRAMMED MATERIAL

Our experience in 1968/1969 and in 1969/1970 showed that students took longer to complete the tape-slide programmes (mean 13 hours 20 mins and 12 hours 6 mins respectively) than to attend the conventional lecture course (9 hours). The extra time was spent in answering questions and replaying tape. However, lecture students may spend more time in additional work during the course and later for revision. Unfortunately, this information was not collected and no conclusions can be drawn from the differences observed. However, Owen et al (1965) found that the total time spent (allowing for extra work) by the machine-taught and lecture groups was almost identical although, as in our study, the programmes took longer to complete. In Georgia, the programmed group was able to demonstrate a saving in time over the course as a whole even though again the programmes took longer. Similar results have also been found in other studies (Green et al 1962, Miller et al 1965, Daufi and Fernandez-Cruz 1967, Howard 1967).

In my view, despite these relatively consistent results, time spent on education is difficult to quantify. If there is a difference between tape-slide presentations and formal lectures it is probably small and had it been longer, it would probably not be of paramount importance except that allowance would need to be made for it in the curriculum.

6.9 COSTS OF TAPE-SLIDE PRESENTATIONS

The initial costs of producing tape-slide presentations are certainly high but it is difficult to provide an accurate cost per presentation because of the assumptions made. For similar reasons, it is difficult to cost the running of a tape-slide course for a large number of students. Comparisons with a conventional lecture are even more difficult; we attempted one (Dunn et al 1969) and concluded that the costs per student of a lecture and a tape-slide presentation were approximately similar when the latter is used by more than 275 students. Like the text book, but unlike the lecture, tape-slide presentations can be repeated, for example by students who miss the lecture. In addition, with 'lending libraries' such as the Medical Recording Service Foundation and possibly in the future with publication, multiple copies of tape-slide programmes can be widely distributed and the cost of a programme (per student) would fall as the size of the audience increases.

However as indicated, these costs are very difficult to assess. There are two ways of approaching the problem - firstly to try and estimate the amount of time spent during production. This is the figure that would be required if a publishing company commissioned a series of programmes and was the method we used in our calculations in 1969. However in some ways, in the university setting, this is fallacious. A lecturer, for example, is employed for a fixed sum but much time is spent in administration, meetings and other related problems. Therefore, an alternative method would be divide his salary (time spent on clinical work would be deducted) by the number of programmes produced. This would markedly increase the cost of a single programme and it is difficult to say which is the truer figure.

Inflation too has had its effects on a lecturer's salary which raises the production costs, although this is offset to some extent as the time spent is probably decreased with experience.

In contrast, with the advent of cheap cassette-recorders and mass production of slide viewers etc. the equipment involved is probably cheaper now than in 1960. An economical argument deriving from this is that it would be better to have only a few centres in the United Kingdom producing a large number of widely distributed programmes.

Another fallacy which exists in the study of comparative costs is that one system is simply to replace another. The argument for replacing lectures with tape-slide presentations is not that it will be cheaper because lecturers will stop lecturing and will no longer be needed. As likely as not they would be more profitably (educationally) employed as tutors and clinical teachers.

6.10 LECTURES OR SELF-INSTRUCTION

6.10.1 A PERSONAL VIEW

In the early stages of clinical training it is probably desirable that students are taught systematically to take histories and examine patients. Though ideal initially, the systematic approach ceases to be practical later and may be actually harmful.

In Glasgow, because of the integrated lecture course, clinical work is restricted to two hours daily. This is necessarily related to patients available in the wards at the time and is therefore usually unrelated to the theme of the lecture. Theoretical and practical aspects therefore fail to integrate; this is undesirable but inevitable and demonstration of a single patient to large groups of students during a lecture is no substitute in my view.

The difficulty of linking practical work with lectures centres on the number of patients available at any one time with a particular disease and the number of students needing to examine these patients. Ideally, not more than 8-10 students should or could be taught on one patient. If, within a formal course, 100 students are to be shown, say, peptic ulcer in a systematic, and thus simultaneous way, at least 13 patients with peptic ulcer would be needed. Not only is the organisation of this daunting but it would be wasteful of interesting patients with other diseases available in wards and outpatient departments at the same time.

The alternative is opportunism: students concentrate on available patients but this is not possible with an inflexible lecture syllabus. In my view, one of the most stimulating aspects of tape-slide presentations (and other forms of self instruction) is that they may make it possible to break this deadlock. In a year of theoretical and practical studies (replacing the so-called integrated year) it would be possible for one small group of about 8 students to be studying, say, patients with peptic ulcers in the wards, and learning the theoretical aspects of the disease by self instruction using tape-slide presentations, books and other aids. Because these were on the epidemiological, physiological, pathological and clinical aspects of the disease the sense of integration would remain. Meanwhile, and at the same time, the remaining students, also divided into small groups would each be studying different topics. Interchange and guidance by a tutor would ensure that most subjects were covered. Such a system also allows students to stagger the times they spend clerking patients, attending outpatients, reading and doing the audio-visual presentations. Another disadvantage of a formal course is that the lecture itself has major shortcomings as discussed earlier (3.2.2). It is often unpopular and, according to some, ineffective. The question at issue is therefore whether the more attractive solution offered by self instruction, outlined above, could replace part or all of the lecture course. To do this, self instruction should be as effective and as popular as the lecture.

For reasons already discussed (3.4) the comparison of any two regimes for effectiveness, popularity and cost is difficult and open to misinterpretations. With these reservations, in our experience, it is apparent that on no point is the lecture clearly superior to tape-slide presentations. On the contrary, attitude questionnaires suggest that students prefer tape-slide programmes, and, generally they do better in multiple-choice examinations. While there is no doubt that initial costs are high for a first (i.e. a master) copy of a tape-slide presentation, if the programme is used by a large number of students costs become comparable to that of a lecture and would be further reduced if the programme was widely distributed.

Macaulay (1969) criticised our use of programmed tape-slide presentations. He considered that the best teacher was experience and the second best, personal contact with an experienced man. I agree with this but I do not agree that use of tape-slide presentations diminishes either experience or personal contact. Properly organised both should be increased.

Contact, between students and staff, is generally considered important in education. Skinner (1958) talks of the 'productive interchange' which occurs in tutorials. This is unlikely to be achieved in lectures and furthermore, as Thorndike said over 50 years ago: 'A human being should not be wasted in doing what 40 sheets of paper or 2 phonograph records can do. Just because personal teaching is so precious and can do what books and apparatus cannot, it should be saved for its peculiar work'.

If lecturers were not used to give lectures they could concentrate instead on tutorials and on clinical teaching (both more popular with students than lectures) which would make better use of both their time and their talents.

6.10.2 OTHER EVIDENCE

Other studies also support the value of self instruction. Graves et al (1969) investigated two types of courses in anatomy: a traditional lecture course (lectures, assigned reading and dissection) and one which relied more on self instruction. Although an objective examination revealed no difference between the two groups, the self instructional group was found to be superior in problem-solving.

A post-graduate course in surgical anatomy for dentists was held in Denmark (Birn and Christophersen 1973). The material was presented in a number of ways some self instructional (tape-slide presentations, audiotape guide to pathology museum) and others conventional (seminars, group discussion). In the tests held on completion of the course and six months later, it was found that higher marks were scored in those sections taught by self instruction.

Students vary both in the rate at which they learn and the way in which they learn best e.g. reading, lectures, teaching machines (Kopta 1972). Self instruction may allow them to exploit those methods from which they obtain most benefit.

In addition, if lectures are replaced by self instruction, teaching staff can be used in a more meaningful way as exemplified in a number of multimedia courses (Postlethwait 1965, Chez and Hutchison 1969, Chez and Kubiak 1970, Rolston and Kochhar 1971). The introduction of self instruction is probably easier in a new university. An interesting and novel curriculum has been developed at McMaster University (there are no conventional preclinical years). Here the emphasis is on self instruction (mainly tape-slide presentations, although some videotapes are used) with the help of tutors (for details see Spaulding 1969, Campbell 1970).

Teachers have the capacity to be a strong motivating force (Canad. Med. Ass. J. 1969) and this is more likely to occur where there is close contact between students and staff; the teaching of skills and how to use information is also possible with small groups of students (Beckel 1968). Tutorials can be useful in helping individual students and can also act as a stimulus. G. Miller (1967) has suggested that learning is faster if students are actively involved or if they see its relevance. Self instruction can actively involve students and both tutorials and bedside teaching can demonstrate its relevance. A further advantage of programmed tape-slide presentationsis that students come to the teaching staff prepared (Buckley-Sharp and Harris 1969). In a self instructional setting, staff act as 'managers' of the learning process rather than simply as a source of material (Stritter and Bowles 1972).

Inevitably a great deal of effort is needed 'behind the scenes' in course analysis and in the design of material (Foster 1970, Stritter and Bowles 1972). However, this problem could be minimised if a few centralised units undertook the majority of this work.

6.11 THE FUTURE

There are two central problems created by the use of self instructional techniques: preparation of material and its use. A possible answer to both these lies in centralisation.

6.11.1 CENTRAL DEPARTMENTS OF MEDICAL EDUCATION

There is a case for establishing in a medical school or university a single production unit so that the effort is not dispersed among a number of enthusiasts working in different departments. This is not a new idea. In 1963, Greenhill stressed the importance of a learning centre and later described an organisation which would involve instructional research, course development, production of material, implementation, evaluation and also in-training services for staff (Greenhill 1964).

In this country Cull (1963) suggested that a department of "communication" (for production, collection, dissemination, storage and retrieval of instructional material) should be established within a university with a full time director who should have experience of both teaching methods and of educational psychology.

There have been so-called "resource or communication" centres in North America for some time. In 1962 Atlanta established the National Audio Visual Aids Centre with a staff of 80 (Liebermann 1963). The work of the University of Kansas (Ruhe 1963) and that of the Rochester Clearing House (Jason and Lysaught 1966) have been described. Kolvoord (1965) has outlined the use of such a centre for both clinical records and as a consultation service for physicians.

There are many advantages of a centralised unit as both equipment and expertise can be shared and the service offered can be more efficient. A higher standard of production is also possible which is important to achieve because students are accustomed to this from the entertainment media. The role of the producer is important: to interprate ideas, to act as organiser and to direct the technical staff (Gilder 1972a). A large unit can span a wide range of activities including graphic design, film and television. A lecturer can therefore receive advice as to how best to solve a teaching problem and which medium, e.g. booklet, tape-slide presentation, film,is indicated. He is not, therefore, forced to adopt the only method that is available in his department which may be inappropriate to his own needs.

Medical centres should have facilities for evaluation of the material as well as for their production (Gilder 1972b). In 1961, Greenhill suggested that there should be a core of trained specialists to organise research into education. The number of education research units in the U.S.A. has increased from 3, ten years ago, to over 17 in 1970 (Miller 1970). Miller (1969) suggested that research units should study the process of teaching rather than its products. He also emphasised that efforts should be institutional and interdisciplinary and not departmental.

In this country such a unit could be a university department of medical education. Its aims should go far beyond the preparation and accumulation of material. It should also be involved with planning the curriculum, with the assessment of both the traditional and newer methods of instruction and with other research into teaching. In addition it could play an important part in the training of medical staff as teachers. Staff of a department of this kind could include educationists, educational psychologists, statisticians, medical illustrators, technical and secretarial staff as well as doctors. However, recognition, in respect to promotion and salary, is needed for staff working in education (J. Med. Educ. 1973).

From the production side there should be a few centres actively engaged in preparing new material. Stead (1972) suggested that the format adopted should be standard in order that it is interchangeable, the quality should be reviewed and acceptable material sent to a central network for cataloguing and rapid distribution.

The responsibility of training doctors as teachers could well be undertaken by a department of medical education. As Illingworth (1968) points out few teachers are selected for their teaching ability and fewer still are taught to teach.
However, already a number of institutions have offered short training courses (Rosinki and Miller 1962, Arsham 1971, Reerink 1972, Anderson et al 1972, Perlberg et al 1972). One survey, by opinion questionnaire, of such a course revealed a generally favourable reaction (Cantrell 1972). A longer course (46 hours spread over 2-3 months) has been held in Denmark, although here the participants were not confined to medicine (Nerup et al 1972) and Miller (1969) has reported that at Illinois they offer a one week workshop, a broader and deeper six week course and finally they have created a

Fellowship programme for an extended period of training.

6.11.2 USE OF MATERIAL

Use of self instructional materials, within an institution, should be centralised to allow maximum use of equipment and consequent saving in costs. Ideally this area would form part of the medical library so that the important tasks of cataloguing, storage and retrieval of the audio-visual presentations could be handled centrally by a staff who are skilled in these matters. The facilities of a library must expand and should include both books and audiovisual presentation (Green and Millard 1965) and co-operation between libraries and "media men" is essential (Levin 1972). J.G. Miller (1967) has proposed a design for an idealised information centre.

Self instruction material can be used either for reference or to replace a systematised lecture course. If the material is used intermittently purely for interest then the demand for any one programme will be staggered; fewer copies of each will be needed and the system can be run by a smaller number of staff. If, on the other hand, the programmes replace a lecture course more copies of the programmes and sets of equipment are required. But, as described earlier it is possible to arrange that large numbers of students do not descend simultaneously.

In order to justify high production costs, audiovisual presentations should have a wide distribution. A steering committee in obstetrics and gynaecology have demonstrated that this is possible (Stenchever and Brown 1972). A number of studies have shown that programmes prepared in one institution can be used effectively in another (Wilds and Zachert 1967b, Engel et al 1972, Kent et al 1972).

One of the problems that interferes with free interchange of audiovisual material is the compatibility of equipment. Fletcher (1972) has discussed this in relation to audiotape. However, if the N.C.E.T. 1973 recommendations for impulses are accepted these difficulties, for tape-slide presentation, will largely be resolved. The copyright of the material may also present difficulties. It has been discussed in the U.S.A. recently (J. Med. Educ. 1973) and Joy (1964) looked at the problem from the artist's point of view. If programmes are to be widely distributed consideration may be necessary on this point.

6.12 FINAL SUMMARY

Medical education, particularly in Scotland, is based on the formal lecture. There is plenty of evidence to suggest that the lecture is an educational technique of very limited value; when over-used or used in inappropriate routine ways it results in either poor student learning, or fossilisation of the curriculum or both.

Improvements in medical education require commitment to a variety of methods selected for their appropriateness in achieving given objectives and for their acceptability to students. In any such curriculum audiovisual aids and self instruction will be central components. However, if quality, effectiveness and acceptable cost are to be features of the medical education scene then adequate attention has to be given to: the formulation and definition of aims, goals and objectives, the process of preparation of materials and a feasible distribution system. Such attention seems to the author to require a central body (possibly the examining bodies) to define generally, acceptable objectives of the undergraduate course. This would also help to ensure that the materials were interchangeable between different centres. Preparation of material of a high standard is time-consuming and relatively expensive. It would therefore seem logical for a few centres, with adequate staff and facilities, to produce the majority of such material and to distribute it widely. Who should act as distributors remains a problem: one attractive solution would be an organisation such as the Medical Recording Service Foundation. However, there will probably soon be a wide range of material: tape-slide presentation, 8mm film and videocassette and it is possible that it might be easier to use a commercial publishing company although it is likely that this would escalate the costs.

To summarise I have been concerned in the work described in this thesis to identify a problem in medical education, to describe a technique, tape-slide presentations, which might deal with part of the problem and to test the technique by attitude questionnaires and multiple choice examinations. Although I have doubts about the validity of such tests I have graver doubts about the wisdom of continuing the formal lecture without seriously challenging its value and without, at the same time, testing alternative solutions. In my view, tape-slide presentations should be made and tested on a large scale in a few universities. The aim being to compare the effect of substituting self instruction for the formal lecture.

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9. APPENDICES

APPENDIX A

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The references are classified by subject and listed chronologically.

AUDIOTAPE

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J. Med. Educ., 34, 121-126

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The General Clerkship: A Course designed to teach the Clinical approach to the patient
J. Med. Educ., 47, 556-563

Mai, F., 1972
Teaching and Learning the Clinical Interview
Med. J. Aust., i, 1314-1318

Tapia, F., 1972
Teaching Medical Interviewing: A Practical Technique
Brit. J. Med. Educ., 6, 133-136

As an aid in the supervision of Psychotherapy:

Beiser, H.R., 1966
Self-listening during supervision of Psychotherapy
Arch. Gen. Psychiat., 15, 135-139

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Sound and visual teaching aids in Obstetrics and Gynaecology
Med. biol. Ill., 16, 218-222

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Amer. J. Clin. Path., 42, 509-512

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J. Med. Educ., 43, 83-85

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Med. biol. Ill., 22, 100-102

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Radiology, 97, 657-659

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J. Med. Educ., 41, 275-280

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A correlative approach to examinations in microscopic anatomy
J. Med. Educ., 42, 78-80

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Blackboard Drawing in Medical Teaching
Brit. med. J. (i) 782-784

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Golden, J.P., Fitzgerald, M.J.T., 1973
Use of the Overlay Technique in Illustrating Human Anatomy
Med. biol. Ill., 23, 109-111

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Improving the teaching of radiological anatomy through demonstrations with transparent diazo overlays
J. Med. Educ., 35, 832-834

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The fold-over human heart
Med. biol. Ill., 6, 224-226

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J. Med. Educ., 33, 591-594

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J. Med. Educ., 36, 892-898

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J. Med. Educ., 38, 315-318

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Med. biol. Ill., 18, 249-252

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A working paper model of the human larynx
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An overview of motion pictures in medical education
J. Med. Educ., 46, 592-598

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J. Med. Educ., 38, 307-314

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The art and science of medical film making
Med. biol. Ill., 15, 90-93

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Canad. Med. Ass. J., 98, 1081-1084

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Med. biol. Ill., 19, S23-S31

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Brit. J. Med. Educ., 4, 312-315

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J. Nerv. Ment. Dis., <u>144</u>, 207-223

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Med. biol. Ill., 7, 33-38

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Surgery, 66, 233-236

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J. Nerv. Ment. Dis., 144, 207-223

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Amer. J. Psychiat., 128, 1219-1223

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J. Nerv. Ment. Dis., 141, 29-41

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Closed-circuit television in teaching diagnostic radiology
Brit. J. Med. Educ., 4, 23-28

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Med. biol. Ill., 13, 49-57

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APPENDIX B

Nature of Diabetes

'Objectives' of programme: written in the form of items (positive) for a multiple-choice examination

NATURE OF DIABETES

PRE-KNOWLEDGE (ASSUMED)

(Kreb's cycle)
Abnormal glucose tolerance
Pancreas - site of production of insulin
Glycogen - storage form of glucose

TERMS:

Ketones/Ketosis
Glycosuria
Lipolysis
Gluconeogenesis
Catecholamines and names of hormones
Haemochromatosis

DEFINITIONS | NO DISTRACTORS

(1) Abnormal glucose tolerance as shown by an elevated blood sugar is the essence of the clinical diagnosis of diabetes mellitus

(2) In severe cases of diabetes increased excretion of nitrogen and ketone bodies occurs in addition to glycosuria

(3) The cause of the metabolic defects is unknown

PRE-KNOWLEDGE | NO DISTRACTORS

(A revision sequence should be included in the programme to cover these)

INSULIN

(1) Both carbohydrate and protein stimulate the pancreas to release insulin

(2) Insulin facilitates the entry of glucose into striated muscle and adipose tissue by increasing their permeability

(3) Insulin increases the storage of glucose in striated muscle by stimulating the formation of glycogen

(4) Insulin stimulates the formation of fatty acids and triglycerides from glucose in adipose tissue

(5) During periods of starvation fat is released from adipose tissue by lipolysis

(6) Insulin's action on carbohydrate release from adipose tissue is antilipolytic

NO DISTRACTORS

Which of the following factors is/are antagonistic to insulin?

(1) Growth hormone

(2) Cortisone

(3) Catecholamines

(4) A.C.T.H.

(5) T.S.H.

(6) Glucagon

(7) Secretin

(8) Thyroxine

(9) Gastrin

CLASSIFICATION

NO DISTRACTORS

(1) Diabetes may be secondary to a number of metabolic conditions

(2) The cause of primary diabetes is unknown but a hereditary component may be present

(3) Secondary diabetes is less common that the essential (primary) type

NO DISTRACTORS

Which of the following definitions is/are correct?

(1) A potential diabetic is a person who has a high risk of developing diabetes although at the time he has neither biochemical nor clinical evidence of diabetes

(2) A latent diabetic is a person who only has an abnormal glucose tolerance test at times of stress, e.g. during pregnancy

(3) An asymptomatic diabetic has a diabetic glucose tolerance test but clinically is normal

(4) A juvenile diabetic is insulin dependent and is prone to develop keto-acidosis

(5) Adult or maturity onset diabetics are relatively stable and are resistant to the development of ketosis

NO DISTRACTORS

Which of the following is/are potential diabetics?

(1) The identical twin of a diabetic

(2) A person with both parents diabetic

(3) A person with one parent diabetic and the other parent with a first degree relative with diabetes

(4) A woman with a live or stillborn baby weighing over 10lbs

CLASSIFICATION NO DISTRACTORS

Which of the following pancreatic conditions may result in diabetes?

(1) Pancreatitis

(2) Haemochromatosis

(3) Neoplasia

(4) Pancreatectomy

CLASSIFICATION NO DISTRACTORS

Which of the following endocrinopathies may give rise to secondary diabetes?

(1) Hyperpituitarism

(2) Primary Aldosteronism

(3) Cushing syndrome (Hypercorticism)

(4) Phaechromocytoma

(5) Hyperthyroidism

CLASSIFICATION NO DISTRACTORS

Which of the following drugs may give rise to secondary diabetes?

(1) Thiazides

(2) Steroids

(3) The contraceptive pill

PREVALENCE (This varies with the definition of the disease and the means of detection) NO DISTRACTORS

(1) 0.6% of the population in the U.K. are diabetics

(2) 0.6% of the population in the U.K. are asymptomatic diabetics

(3) Diabetes is common in later life and is maximal in the 7th and 8th decades

APPENDIX C

Sample Answer Sheet: Hyperglycaemic Coma I
(pages 4 - 10 inclusive)

The S numbers on the left-hand side of the page refer to the slide numbers.

Lack of insulin in hyperglycaemic coma

S8 * ∴ lack of insulin causes i)

ii)

This results in :-

S9 * Glucose in hyperglycaemia is unavailable as an energy source.

∴ the energy is provided by :

This metabolic pathway is favoured by –

S10 * The by-products produced are :-

S11 * These products are usually disposed of by :-

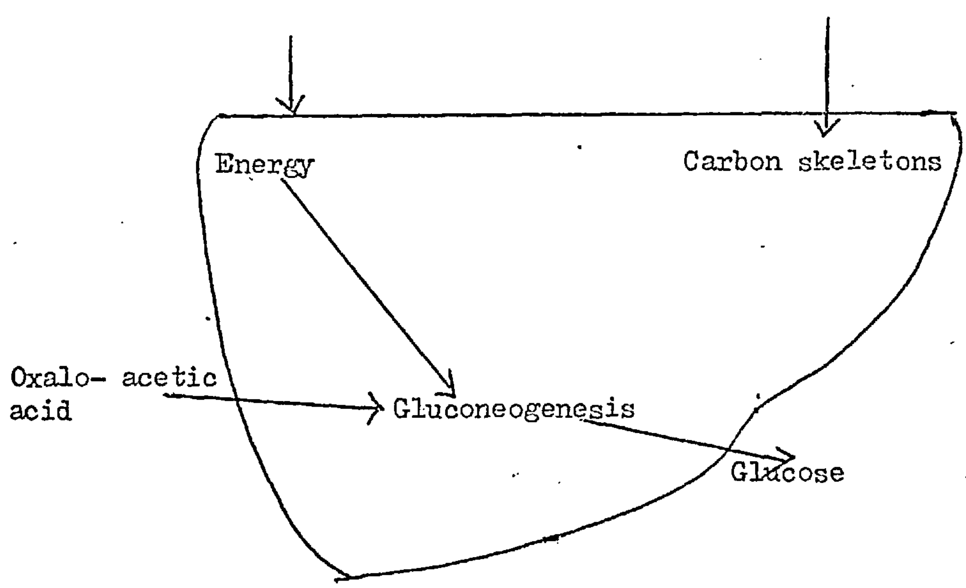
S12 Oxalo-acetic acid is required both for

1) gluconeogenesis
2) disposal of by-products (acetyl CoA)

Effect of lack of insulin on liver

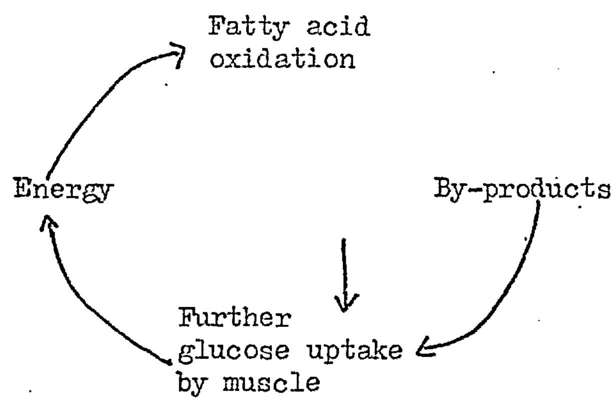
Increases gluconeogenesis

*



S13 In hyperglycaemic coma oxalo-acetic acid is required
* predominately for :-

S14 * In hyperglycaemic coma :



S15 * Accumulation of by-products

Metabolic effect :-

This is recognised in the side-room by :-

S17 *

Effect of hyperglycaemia on kidney :

Clinical features :

1)

2)

Sodium

S19 Sodium is lost :

1) hyperglycaemia - osmotic diuresis

* 2)

S21 3) vomiting - a) precipitating cause of coma, e.g. abdominal emergency

b) ketosis

Sodium deficiency - 450 meq

Water depletion up to 6L (or more)

S21 * Sodium depletion

Effect on G.F.R. -

Blood urea -

S22 Blood urea

* Real - 1) (as in answer S21)

- 2)

Apparent - 3)

Potassium

Potassium loss by kidneys is increased because

a) hyperglycaemia - osmotic diuresis

b) metabolic acidosis - to excrete aceto-acetate ion

c) stress

Untreated hyperglycaemic coma - potassium passes from the intracellular fluid (I.C.F.) into the extra-cellular fluid (E.C.F.)

This passage of potassium is accelerated by the following factors :

a) acidosis

b) anoxia

c) increased protein breakdown

d) increased hepatic glycogenolysis

e) interruption of carbohydrate metabolism

Untreated hyperglycaemic coma

S24 * Serum potassium:-

Total body potassium:-

S25 * Treated hyperglycaemic coma

Serum potassium:-

Total body potassium:-

Keto-acidotic coma

Hyperglycaemia

Metabolic acidosis

Water depletion

Sodium depletion

Potassium - total body K - low

Serum K - untreated - high

treated - low

S28 Non-ketotic hyperglycaemic coma

Rare

Maturity-onset diabetes - elderly patients

Hyperglycaemia - (very high levels)

Dehydration - severe

Ketosis - absent

A possible explanation of the dissociation of hyperglycaemia and the keto-acidosis which occurs is that insulin production is suppressed but :

a) it is adequate to prevent excess fatty acid release from adipose tissue - ∴ there is a reduced tendency to acidosis

b) it is inadequate - to promote transfer of glucose across cell membrane ∴ hyperglycaemia develops

APPENDIX D

1968/1969 Attitude Questionnaire

I. S. I. T. M. E.

We would like you to help us assess this experiment.

In most of the following items you are asked to record your agreement or disagreement by putting a tick in the column of your choice:

SA	Strongly agree
A	Agree
U	Uncertain
D	Disagree
SD	Strongly disagree

For some items you have to tick one of the following:

VF	Very frequently
F	Frequently
O	Occasionally
VO	Very occasionally
N	Never

Do not spend time pondering over any item - we want your initial reaction to each statement. If you find this difficult for any item leave it and discuss it with one of us.

The detailed answers to this questionnaire will be treated as confidential - please be completely honest!

Thank you for your co-operation

Name   Date

General

	SA	A	U	D	SD
1. I am glad I took part in the experiment					
2. I would <u>not</u> advise next year's students to take part in a similar experiment					
3. I would like to see this type of teaching replace some other lectures in the integrated year course					
4. I learned more going through these programmes than I would have done at the lectures					
5. Although I spent longer going through the programmes than I would have done at the lectures, it was worth it					
6. This type of teaching requires more supplementing in tutorial discussion groups than lectures do					
7. I shall have just as much work to do at home as I would have had if I had gone to the lectures					
8. The pace of teaching in the tapes on <u>diabetes</u> was about right, on the whole					
9. The pace of teaching in the tapes on <u>thyroid</u> was about right, on the whole					
10. The diabetes tapes covered the material too quickly					
11 The thyroid tapes covered the material too quickly					
12 I was usually clear what type of answer was expected in the diabetes tapes					
13 I was usually clear what type of answer was expected in the thyroid tapes					
14 The correct answer always became clear to me in the diabetes tapes					
15 The correct answer always became clear to me in the thyroid tapes					
16 There was too much overlap of content in different diabetes tapes					
17 There was too much overlap of content in different thyroid tapes					

		SA	A	U	D	SD
18	I "lost the thread" more often in the diabetes tapes than in lectures					
19	I "lost the thread" more often in the thyroid tapes than in lectures					
20	If the equipment were readily available I should make use of it for private study and revision					
21	I would be willing to use the equipment at times outside normal lecture hours (i.e. at weekends or in evenings)					
22	I am more likely to attend an auto-instructional session than I am to go to a lecture on the same topic					
23	I preferred working in the booths to the general 'open' room					
24	There was insufficient room in the booths. (For note-taking, storage etc.)					
25	The lighting in the booths was satisfactory					
26	I think each booth should have its own light					
27	When I was working in a booth the noise from other people disturbed me					
28	When I was in the 'open' room the noise from others was disturbing					
29	The chairs were comfortable					
30	Professional speakers should make the tapes - rather than subject specialists					
31	Dr. Harrison (Diabetic Coma, Complications etc.) should continue as the <u>speaker</u> in some subsequent tapes					
32	Dr. Allan (Treatment of Diabetes etc.) should continue as the <u>speaker</u> in some subsequent tapes					
33	Professor Foulds (Ocular Complications of Diabetes) should continue as the <u>speaker</u> in some subsequent tapes					
34	Dr. Harden (Thyroid ....) should continue as the <u>speaker</u> in some subsequent tapes					

	SA	A	U	D	SD
35 A supervisor with medical knowledge of the content of the tapes is <u>unnecessary</u> during these sessions					
36 A technical supervisor is <u>necessary</u>					
37 The earphones become uncomfortable					
<u>Kindermann Machine</u>					
Assume in items 38 to 42 that we can guarantee trouble-free running of the machines in future					
38 I prefer this to the manually operated equipment					
39 It is easier to concentrate with this machine than with the hand-operated equipment					
40 It is easier to concentrate with this than at a lecture					
41 The manipulation of the apparatus interfered with my learning					
42 This machine costs about 5 times more than the hand-operated equipment but it is worth it					
43 I was familiar with the operation of the machine by the end of my first programme					
44 I was familiar with the operation of the machine by the end of my second programme					
45 Loading the tape on to the machine is a bit difficult - I would prefer cassette loading					
46 I wished it was easier to go back to earlier material					

	VF	F	O	VO	N
47 I had trouble with slide changes					
48 The machine failed to stop when a response was to be made					
49 The machine did not re-start after an automatic stop					
50 The slides and the commentary got out of phase					
51 The slides were in the wrong order					
52 The slides were upside-down or back to front					
Other comments -					

<u>Manually Operated Equipment</u>

	SA	A	U	D	SD
53 I prefer this to the Kindermann machine					
54 It is easier to concentrate with this than with the Kindermann					
55 It is easier to concentrate with this equipment than at a lecture					
56 The manipulation of the slides and viewer interfered with my learning					
57 The operation of the tape-recorder interfered with my learning					
58 I found the stop/start switch too stiff					
59 I was familiar with the operation of the equipment by the end of my first programme					
60 I was familiar with the operation of the equipment by the end of my second programme					
61 I wished it was easier to go back to earlier material					

	VF	F	O	VO	N
62 I had difficulty loading/unloading slides					
63 Some words were lost when re-starting after a response					
64 The slides and the commentary got out of phase					
65 The slides were in the wrong order					
66 The slides were upside down or back to front					
Other comments -					

	SA	A	U	D	SD
<u>Viewers and Slides</u>					
67 I prefer the Photax viewer (the one with metal holder) to the Panavue (plastic)					
68 The Photax gave a picture of acceptable size					
69 The Panavue gave a picture of acceptable size					
70 The Photax viewer made my eyes tired					
71 The Panavue viewer made my eyes tired					
72 It was easy to see all neccessary detail with Photax					
73 It was easy to see all necessary detail with Panavue					
74 There was considerable distortion using the Photax					
75 There was considerable distortion using the Panavue					
76 It was easier to operate the Panavue than the Photax					
77 A simple "one-slide-at-a-time" hand viewer would be perfectly acceptable					

		SA	A	U	D	SD
78	The slides made a very helpful contribution to my learning					
79	The quality of the slides with <u>words only</u> was good					
80	The quality of the slides with clinical pictures was good					
81	The quality of the slides with diagrams was good					
82	The quality of the slides showing X-ray photographs was good					
83	The quality of the slides with ECGs was good					

		VF	F	O	VO	N
84	The colour differences for results of clinical tests were unclear					
85	There were too many words on the slides					

		SA	A	U	D	SD
86	There were too many slides					
87	Where possible I prefer 'real' pictures to diagrammatic representations					
88	I like to see words saved by pictures and diagrams					
89	There were too many 'trivial' slides with little on them					
90	The answer sheets were well constructed					
91	The answer sheets will not be very useful					
92	The answer sheets are more useful than handouts					

	SA	A	U	D	SD
93 There was not enough space on the answer sheets for additional notes					
94 The answer sheets are better than my usual lecture notes					
95 I would have preferred to make more responses during the diabetes tapes					
96 I would have preferred to make more responses during the thyroid tapes					
97 Things were omitted from the answer sheets which should have been included					

98 I thought the best tape was:

Can you suggest why?

99 I thought the worst tape was:

Can you suggest why?

100 I think it would be best if each unit took about

30 / 45 / 60 / 75 / 90 minutes

(underline answer of your choice)

101 I could work efficiently for a session lasting

30 / 60/ 90 / 120 / more than 120 minutes

102 What is the maximum time you think you could work satisfactorily on these tapes in any one day?

__________ hours

103 What other areas in your course would you suggest might be taught in this way?

104 The three main advantages of this method of teaching are:

1)

2)

3)

105 The three main <u>disadvantages</u> are:

1)

2)

3)

106 Can you suggest anything you would like us to consider in future research?

Thank you again.

Sorry - just three more items

		SA	A	U	D	SD
107	Background noise on the Kindermann tapes was distracting					
108	Background noise on the cassettes (for portable tape-recorders) was distracting					
109	This teaching method seemed more effective to me at the end of the experiment than it did at the beginning					

APPENDIX E

1969/1970 Specimen Timetable

(Renal Disease December 1969)

GROUP A

MONDAY 1ST DECEMBER (Group-paced

*11.15 a.m. Renal Structure - Lecture Room I

*Noon Renal Function I - Lecture Room I

1.00 p.m. BREAK - SANDWICH LUNCH - Lecture Room I

*1.30 p.m. Renal Function II - Lecture Room I

2.45 p.m. L/S Investigation of Renal Disease, I.Y.R.

TUESDAY 2ND DECEMBER (Group-paced)

*11.15 a.m. Acute Glomerulonephritis I - Lecture Room II

*12.15 p.m. Acute Glomerulonephritis II - Lecture Room II

2.00 p.m. Clinical Renal Disease, I.Y.R.

WEDNESDAY 3RD DECEMBER (Group-paced)

*11.00 a.m. Nephrotic Syndrome - Lecture Room I

Noon Biochemistry Lecture

p.m. Private Study

THURSDAY 4TH DECEMBER

Morning (Group-paced)

*11.15 a.m. Urinary Tract Infection I - Lecture Room I

*12.15 p.m. Urinary Tract Infection II - Lecture Room I

Afternoon (Self-paced)

2.15 p.m. *Chronic Renal Failure I - Kindermann

*Chronic Renal Failure II - Kindermann

FRIDAY 5TH DECEMBER (Self-paced)

*11.15 a.m.	Chronic Pyelonephritis - Kindermann
2.00 p.m.	Seminar, Pyelonephritis (I.Y.R.)

MONDAY 8TH DECEMBER (Self-paced)

*11.15 a.m.	Acute Renal Failure IV - Kindermann (Dialysis)
*	Chronic Renal Failure III (Haemodialysis) - Kindermann
2.00 p.m.	Seminar, Renal Transplantation, I.Y.R.
*3.30 p.m.	T.V., short 13mm film, I.Y.R.

TUESDAY 9TH DECEMBER (Self-paced)

*11.00 a.m.	Acute Renal Failure I - hand equipment
*	Acute Renal Failure II - hand equipment
*12.45 p.m.	SANDWICH LUNCH - LECTURE ROOM II
* 1.15 p.m.	Acute Renal Failure III - hand equipment
2.30 p.m.	Renal Biopsy, I.Y.R.

WEDNESDAY 10TH DECEMBER)
THURSDAY 11TH DECEMBER) - as I.Y.R. timetable

* Topics covered by self-instructional tape-slide programmes

APPENDIX F

1969/1970 Attitude Questionnaire

PROJECT ISITME

You helped us in December and January to assess the tape/slide materials on Renal Disease, Thyroid and Diabetes. Now that you have had time to reflect, would you please help us again by completing this brief questionnaire?

A. In each of the following you are offered a straight choice of two methods of instruction. For each pair circle the method you would prefer.

1. Conventional lecture	OR	Tape/slides on Kindermann
2. Tape/slides on simple equipment	OR	Tape/slides - group presentation
3. Conventional lecture	OR	Tape/slides - simple equipment
4. Tape/slides on Kindermann	OR	Tape/slides - group presentation
5. Tape/slides - group presentation	OR	Conventional lecture
6. Tape/slides - simple equipment	OR	Tape/slides - Kindermann

B. For each method of presentation of the tape/slides note down the principal features you liked and disliked

1. Kindermann machine in booths

2. Simple hand-operated equipment

3. Group presentation

Thank you.

APPENDIX G

1970/1971 Attitude Questionnaire

TAPE/SLIDE PROGRAMMES MARCH 1971

This should be the last form we ask you to fill in!

You have now had experience of four methods of presentation:

Automatic	-	the Kindermann machine in a booth
Portable	-	hand-operated equipment, portable
Group A	-	upstairs in 22 Bute Gardens - earphones
Group B	-	ground floor in Bute Gardens - no earphones

It will be helpful to us to have your considered reactions to these methods and the contents of the programmes.

1. In each of the following pairs of methods write the method you would prefer if offered the straight choice:

(a)	Automatic	v.	Portable
(b)	Group A	v.	Group B
(c)	Group B	v.	Automatic
(d)	Portable	v.	Group B
(e)	Automatic	v.	Group A
(f)	Group A	v.	Portable

2. Which of the four methods did you like most?

   Give two reasons:

3. Which of the four methods did you like least?

   Give two reasons:

4. If for a section of the course all 4 methods were offered, note opposite each method the % of the time you would choose to use each method:

   1. Automatic ---%
   2. Portable ---%
   3. Group A (with earphones) ---%
   4. Group B ---%

5. Thinking about the simple hand-operated equipment:

   i) If you were using this regularly at home

   A) would you prefer a larger picture size?

   YES NO DON'T KNOW

   B) would you prefer Battery or Mains operated equipment?

   ii) If you made use of this material outside instead of during normal lecture hours did you during the lecture hours:

   (a) engage in leisure pursuits

   (b) study privately

   (c) attend the lectures

   iii) Did anyone else use your programmes?

6. Any other comments about any of the <u>methods</u>?

7. How much of the present integrated year lecture course would you like to see replaced by tape/slide programmes presented by the method you favour most? (circle one)

100% 75% 50% 25% 0

8. Looking back over all the programmes can you recall any programme (or group of programmes) you thought particularly good?

Can you suggest why?

9. Do you recall any programme (or group of programmes) you thought particularly bad?

Can you suggest why?

10. Anything further you wish to draw our attention to?

Again very sincere thanks for your co-operation.

APPENDIX H

1971/1972 Specimen 'briefing' hand-out

INTEGRATED YEAR

Thank you for helping us over the next week or so. We are confident from our experience over the last three years that your learning will not suffer by taking part in this course; you will learn at least as effectively with these programmes as you would with the conventional lecture. The material in the tape/slide presentations is the same as that covered in the lectures. This investigation requires some data and we ask you to provide this on the orange and green data sheets on the folder we provide as part of the course.

The programmes are perhaps less than perfect and we need your assistance in evaluating them so that they can be improved for future users.

There are eight programmes covering diabetes mellitus (and a ninth - "The eyes in diabetes" - as an optional extra) and five on the thyroid.

All the programmes are presented by audio tape and slides; the tape stops regularly to allow you to answer questions on the sheets provided; the completed sheets form a summary of the programme which is yours to use as you would your lecture notes. This forms an adequate resume of the programme but you are free to take additional notes if you want to.

During this period you can use the programmes in different ways.

1) Individual equipment

The equipment is of two types -

a) Automatic equipment

Booths are located on the first floor of the Gardiner Institute. This equipment has synchronised slide change and an automatic stop. It is not portable and you have to work in a booth in the Gardiner Institute. You can work on your own or perhaps you may choose to work in pairs. Some people prefer working on their own but others may prefer to work through the programme with a colleague. The booths will be open for use from 11 a.m. - 4 p.m. Each programme takes on average something less than one hour, but of course you are working at your own pace and some will take longer than others.

Booths may be booked for periods of one hour. Bookings are made through Mrs. Shirley Holl, Room 104, 1st Floor, G.I.

b) <u>Simple equipment</u>

This consists of a simple play-back tape recorder and a hand viewer for slides. You stop and start the tape and change the slides yourself at given signals on the tape. You use this on your own.

During the day, this equipment may be used in the Gardiner Institute from 11 a.m. - 4 p.m. It can also be used at home and a case to carry the equipment and the programmes is available. If you wish to use the programmes at home, the equipment can be collected between 4 p.m. and 5 p.m. from Mrs. Holl and must be returned no later than 11 a.m. the following morning.

Simple equipment for use in the G.I. or at home may be booked through Mrs. Holl.

Simple equipment booked on a Friday evening should be returned by 11 a.m. on Monday morning.

You are allocated a certain number of tape/slide presentations to complete on the individual equipment during a specific period, e.g. from Friday 4th - Tuesday 8th or Tuesday 8th - Friday 11th. You are not forced to do them at any specific hour within that period - you can please yourself.

2. Groups

The tape/slide presentations will also be used with groups of about 10 students.

The group will sit informally round a table and discussion between the members is encouraged. The slides are changed and the tape stopped by a technician present.

The place and time for the groups is scheduled. Group presentations will take place in the Gardiner Institute (Seminar Room) or in Lecture Room I (near D.3/4).

The timetables for each group are on the following pages.

Data Sheets

In your folder containing the answer sheets we have included two data sheets and we shall probably ask you to co-operate in filling up a questionnaire at the end of the course. This will cover your more general reactions and opinions.

Please feel free to ask questions and give us your comments informally at any time. These are the people whom you will meet in the next few weeks:

Dr. Rosemary Lever

Dr. Mary Stevenson

Mr. William Dunn - Department of Education

Mrs. Shirley Holl - Secretary/Technician

Mr. Paul Bonatti - Medical Illustrator

Dr. R.McG. Harden

Prof. Renschler - visiting from Germany

Again, thanks for your help and co-operation.

TIMETABLE FOR STUDENTS IN

GROUP A

During Section ONE

from Friday 4th - Tuesday 8th at lunchtime you will use the individual equipment. Booking commences on Wednesday 2nd at 9 a.m. in Room 104 (1st Floor G.I.) with Mrs. Holl. Booths or simple equipment may be booked for one-hour periods. You should complete all the tape/slide presentations in Section ONE by Tuesday 8th at lunchtime.

During Section TWO

from Tuesday 8th (lunchtime) - Friday 11th you will use the tape/slide presentations in small groups. Report initially to Lecture Room I (near D.3/4) at 2 p.m. on Tuesday 8th February. Thereafter you will be in Lecture Room I or the Seminar Room in the G.I. Groups must attend at the times stated in the programme.

During Section THREE

on Monday 14th February - for the following presentations you may choose whichever method you prefer - lecture, or tape slide presentation using booths, simple equipment or groups. The presentations are:

1) Clinical Features of Thyrotoxicosis
2) Treatment of Thyrotoxicosis

Booths and simple equipment may be booked as before. Groups will be in Lecture Room I and Seminar Room (G.I.) at the scheduled times.