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DESIGN AND EVALUATION OF A TEACHING TOPIC — ORTHODONTIC ANCHORAGE

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A Thesis submitted in partial fulfilment of the requirements for the degree of Master of Dental Science

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INTRODUCTION

Audio-visual presentations have been gaining increasing acceptance in dental and medical education. Is it justified to replace more conventional forms of teaching with video-tape and tape-slide programmes? Or should they be used in combination with lectures and tutorials, and made available to students to supplement or reinforce more traditional instruction? Are audio-visual presenations as effective as other methods of instruction and are they accepted by students instead of lectures?

This project was planned in order to attempt to answer some of these questions. Instructional units were developed as described. Part 1 is concerned with the mechanical aspects of orthodontic anchorage and Part 2 with the biological aspects of orthodontic anchorage. Four different teaching presentations were prepared and evaluated: a tape-slide, a video-tape, hand-outs and a lecture.

In the first part of this thesis the design strategy for the development of an undergraduate orthodontic course is formulated. The design relationship of the instructional unit (the project of this thesis) to the total under-graduate orthodontic course is also described.

PART 1

PRINCIPLES OF LEARNING SYSTEM DESIGN

INTRODUCTION

Undergraduate orthodontics is part of the total curriculum for the training of dental undergraduates.

A strategy using Mager and Beach's (1967) principles for the systematic development of instruction may be effectively used in planning, designing, implementing and evaluating a total course or any of its parts.

The design relationship between one part (the project of this thesis) and the total course will be outlined using the above strategy.

The first step in designing a course is deciding and describing what needs to be achieved (Mager and Beach, 1967). Undergraduate orthodontics aims at training graduates in dentistry to supply non-specialist orthodontic care; a general goal could be for the practitioner to be able to carry out the following:

(a) The diagnosis and assessment of orthodontic problems

(b) The planning and implementation of alternative therapies for non-specialist orthodontic problems.

An understanding of the mechanical and biologic aspects of orthodontic anchorage is one of the prerequisite skills necessary for goal (b). This topic required development as an instructional unit in the present course, and so was chosen for this project.

DESIGN STRATEGY

What will the new graduate have to know to carry out his non-specialist orthodontic responsibilities? What tasks will he have to perform? Answers to these questions will have to be sought when planning a course in orthodontics. Then the instruction needs to be designed and implemented to achieve this result; and it is necessary to check if the desired result has been achieved or not; last, the instruction may need to be improved to improve results. Mager and Beach (1967) describe these steps as follows:

(a) Deriving and describing objectives

(b) Developing instruction which is designed to meet these objectives and trying out the course

(c) Determining how well the objectives were achieved

(d) Improving the course to improve the results.

A. DERIVING AND DESCRIBING OBJECTIVES

Course goals and instructional goals and objectives will state what needs to be achieved; these may be determined by preparing a description of all the tasks which the dental practitioner usually carries out and then making an analysis of the separate tasks.

The task analysis includes task listing and detailing, also a description of learner characteristics and their prerequisite skills. The type of learning needed for carrying out each step of the task is also included in the task analysis.

The job description and task listing and detailing are based on records of observations and questioning of general practitioners about their extent of involvement in orthodontic care.

Instructional goals and objectives are derived partly from the task analysis and partly from other sources which will be described later.

B. DEVELOPING INSTRUCTION WHICH IS DESIGNED TO MEET THESE OBJECTIVES AND TRYING OUT THE COURSE

This phase is the instruction which is designed to achieve the objectives.

In the beginning of this phase the instructional units which are designed to enable the student to carry out each task are sequenced. Sequencing may be according to the type of learning needed to carry out each task. All this information can now be used for content selection and choosing instructional methods.

C. DETERMINING HOW WELL THE OBJECTIVES WERE ACHIEVED

This is evaluation. Evaluation will provide information whether the desired results have been reached or not.

D. IMPROVING THE COURSE TO IMPROVE THE RESULTS

Evaluation information enables decisions to be made about course improvement.

The above steps may be employed, as shown in Table 1.1, for the total process of designing, implementing and evaluating an instructional system, as adapted from Mager and Beach (1967).

Planning the instruction is a complex and continuous process. All the separate steps in the plan affect the development of other steps. All steps have to be re-evaluated from time to time. Changes are usually necessary. Changing one part of the system often necessitates changing some or many of the other parts.

TABLE 1.1 DESIGN STRATEGY

A. DERIVING AND DESCRIBING OBJECTIVES:	Job Description ↓ Task Analysis — Types of Learning Outcome; Learner Characteristics; Prerequisite Skills Task Listing Task Detailing ↓		
	Course Objectives	- General Course Goals ↓ Instructional Goals ↓ Behavioural Objectives	- General Course Goals and Instructional Goals for an Undergraduate Orthodontic Course Design Relationship of this Project to the Total Course
B. DEVELOPING INSTRUCTION and TRYING OUT the COURSE:	Sequencing of Units ↓ Content Selection ↓ Instructional Method		
C. DETERMINING HOW WELL the OBJECTIVES ARE ACHIEVED:	Evaluation		
D. IMPROVING the COURSE:	Course Improvement Possible Revision of: Objectives Instructional Procedures Evaluation		

A. DERIVING AND DESCRIBING OBJECTIVES

JOB DESCRIPTION

A job or vocation consists of all the tasks performed by the person carrying out the job. If only relevant activities and subject matter are to be included in a course, it is desirable to start with a job description. In this case, the job description should consists of all the activities which a general practitioner is to perform in supplying orthodontic care to his patients. Questioning and observing general practitioners regarding their orthodontic involvement will help in describing the job.

EXAMPLE

VOCATION: General practitioner performing orthodontic service.

A general practitioner is able to take the appropriate records (study casts, x-rays etc.) for orthodontic purposes. He diagnoses and assesses orthodontic problems. He discusses the needs of patient and parent and makes his recommendations. He refers patients to an orthodontist or orthodontic department when appropriate.

He plans and implements alternative therapies for non-specialist orthodontic problems. He carries out the

appropriate preventive measures (oral hygiene instruction, topical fluoride, etc.). He is able to design, fabricate and supervise the different orthodontic appliances for malocclusion problems which are suitable for non-specialists to treat.

It is obvious from the above example, that the job description is only a sketchy outline. In order for this to be of help in developing a course, a task analysis is needed.

TASK ANALYSIS

The job description only gave a brief outline of the job. The task analysis consists of listing all the tasks which make up the job. The analysis includes task detailing, identifying the types of learning which are needed to carry out each step, a description of learner characteristics and prerequisite skills.

TASK LISTING

Task listing consists of listing all the tasks included in a job. There are cognitive and action tasks. A cognitive one is performed in the head. Task listing is important, for steps which are easy to carry out may be overlooked by instructors (Mager and Beach, 1967).

A table showing the frequency of each task, the importance and learning difficulty is useful (Table 1.2).

TABLE 1.2 TASK LISTING

Task	Frequency	Importance	Learning Difficulty
1. Seats Patient	Continuous	2	Easy
2. Examines Patient	Frequent	1	Moderately Difficult

TASK DETAILING

Task detailing consists of describing each step or sub-task of a task. Tasks may be of fixed sequence or variable sequence. Fixed sequence ones have steps which have to be carried out in a definite sequence. There are cognitive or action tasks. Action ones have some cognitive sub-tasks.

A useful way of detailing tasks is to make a table which shows each step, the type of learning performance which is needed to carry out each step and the level of learning difficulty. An example of task detailing is shown in Table 1.3.

TYPES OF LEARNING OUTCOMES

In the task detailing, each task was broken down into steps. On examining these steps, it becomes obvious that different actions or performances are needed to carry out each step of the task.

Different types of learning enable the learner to carry out different performances. When learning has taken place, this can be shown by a visible or demonstrable action or performance. Gagné (1974) calls these performances the outcomes of learning. For example, a student who has learned to discriminate between different teeth, will be able to name the correct teeth when given examples of them.

TABLE 1.3 TASK DETAILING

Task: Designing an Appliance for Anterior Crossbite

Number of Steps in Performing Task	Types of Learning	Learning Difficulty
1. IDENTIFIES PROBLEM	DISCRIMINATION (identifies shape, size and position of different teeth)	EASY
	↓	
	CONCEPTS (identifies type of malocclusion)	MODERATELY DIFFICULT
	↓	
2. DECIDES on ANCHORAGE to be EMPLOYED	APPLIES PRINCIPLES (applies principle of orthodontic anchorage; identifies units best suited for anchorage)	MODERATELY DIFFICULT
3. DESIGNS APPLIANCE	PROBLEM SOLVING (applying above discriminations, concepts and principles, decides on design).	DIFFICULT

It needs usually more than one type of performance to carry out each step of the task. As part of the task analysis, the type of learning needed to carry out the principal performance should be identified. This will help in the selection of course content, instructional procedures, and the sequencing of units.

Gagné (1974) describes five major categories of learning outcomes:

(1) verbal information,

(2) intellectual skills,

(3) cognitive strategies,

(4) attitudes, and

(5) motor skills.

Each type of learning enables the learner to do something or perform something.

(1) *VERBAL INFORMATION*

This is the usual way man communicates. Speech, writing and recall are included in this area.

(2) *INTELLECTUAL SKILLS*

This category of learning outcomes consists of knowing how. Verbal information is having factual knowledge, and it consists of knowing that. It is using intellectual skills that enables the learner to interact with his environment through symbols.

The varieties of intellectual skills are shown in Table 1.4. These skills are hierarchical in nature and are arranged in order of decreasing complexity.

TABLE 1.4*

Varieties of intellectual skills, arranged (bottom to top) in order of increasing complexity (Gagné, 1970)

HIGHER-ORDER RULES

require as prerequisites

RULES

require as prerequisites

CONCEPTS

require as prerequisites

DISCRIMINATIONS

require as prerequisites

(simple types of learning)

* from Gagné, (1974), p. 56.

DISCRIMINATIONS

Learning discriminations enables the learner to respond differently to stimulus objects which are different but resemble each other in physical appearance.

Identifying different teeth by recognizing distinguishing characteristics is an example of this kind of learning.

CONCEPTS

A concept is an abstract idea generalized from a class of objects. Concepts enable us to classify diverse phenomena.

Concepts which are learned by identifying examples are called concrete concepts, e.g. a sphere, food, etc. Some concepts are too sophisticated or abstract to demonstrate (e.g. hate, gentleness). These are learned from definitions and are called defined concepts. Concrete concepts may be learned by definitions or explanations or by observing examples of the concept.

RULES OR PRINCIPLES

Principles or rules state relationships between two or more different concepts. Principles make it possible to predict and explain phenomena, infer causes, control situations and solve problems. Principles or rules may be formulated from personal observations of repeated events or phenomena.

HIGHER-ORDER RULES OR PROBLEM SOLVING

In this type of learning the learner will put together previously learned concepts or principles without being guided to the solution. It is the most advanced type of learning since it involves the process of discovery.

(3) COGNITIVE STRATEGIES

Cognitive strategies refer to the way the learner internally organizes his own learning and thinking.

(4) ATTITUDES

An attitude is a state of mind which may influence what action a person takes.

These attitudes are represented in two types of action: "approach" or "withdrawal" and expressed in terms like "interest", "disinterest","friendly", "belligerent", "empathy", "insensivity" etc. Attitude to learning is an important concern in designing instruction, to encourage and maintain student interest.

(5) MOTOR SKILLS OR MANIPULATION

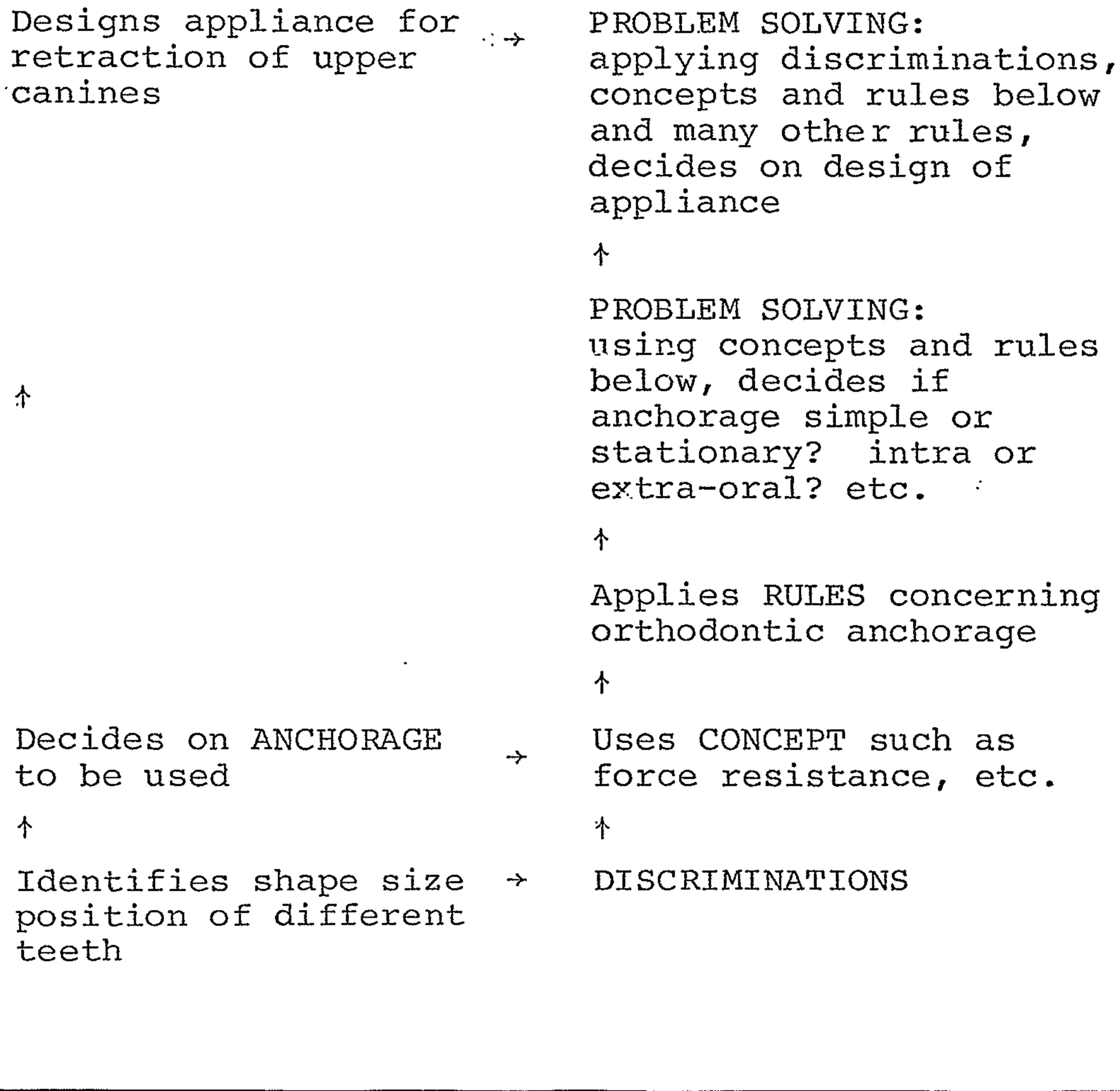
The major part of dentistry consists of these tasks. Most manipulation procedures are carried out as a series of steps. The order of sequence of these steps is important and must be learned at the same time as each skill item. Most, if not all skills require simultaneous cognitive processes, such as reproducing learning sequences, selecting tools and materials, etc.

LEARNING HIERARCHIES

It can be seen from the previous table (Table 1.4) that learning is hierarchical in nature: simpler types of learning are prerequisites for more complex ones. This is an important aspect in the designing of instruction. The lower order skills should be mastered before higher order skills can be learned. It is often desirable to plan sequencing of instruction according to the types of learning involved. If problem solving is to be done, the principles and concepts required for problem solution should be first learned, as shown in the following example:

EXAMPLE

TASK: Retract upper canines



LEARNER CHARACTERISTICS

When designing a course, it is necessary to know some of the characteristics of the group for which the course is designed. Mager and Beach (1967) suggest that the physical characteristics, education, motivation, interests and attitudes, biases and prejudices of students be described. Briggs (1970) is interested in academic ability, level of anxiety, motivation and dependence of students; students of different personalities possess different learning styles.

In a tertiary institution students are a relatively homogeneous group regarding their formal education. At any rate, very little information is available about learner characteristics other than academic ability.

PREREQUISITE SKILLS

Prerequisite skills of students entering a new course needs to be determined. The designer has to decide which skills the students have already, and which have to be learned.

Where students have passed previous examinations, it should be reasonable to make assumptions about many of their prerequisite skills.

Again, it is useful to draw up a list of the prerequisite skills which the instructor assumes students have (Mager and Beach, 1967). If it is assumed that a skill is not known it may be added to the list of objectives.

The designer may decide to test for the prerequisite skills which he is not certain that the students have.

COURSE OBJECTIVES

The next step is the most important one in the design process. At this stage the designer decides and describes what he expects the student to learn: what tasks he should be able to carry out at the end of the instruction. The designer develops goals and objectives.

There is a hierarchical structure involved in writing objectives:

General Course Goals
↓
Instructional Goals
↓
Behavioural Objectives —— *Terminal Objectives*
↓
Enabling Objectives

First, general course goals are stated. Next step is the development of instructional goals. The sources which are used for the development of these goals are discussed in the next section.

A LEARNER-CENTRED APPROACH TO DERIVING OBJECTIVES

Objectives to be of maximum use for planning instruction, for measuring student achievement, and for evaluating a teaching programme have to be written in terms of the learner's behaviour (Davis *et al.*, 1974; Mager, 1962; Briggs, 1970; Gronlund, 1970; Lynch and Holloway, 1973).

The reason for the learner-centred approach is that learning can only be gauged by observing the learner's behaviour. For example, we want students to understand the meaning of orthodontic anchorage. What can the student do to demonstrate that he understands this concept? Perhaps he could define orthodontic anchorage; he may be able to name the anchor elements when shown suitable appliances. At any rate, he must carry out an overt action to demonstrate his new skill or knowledge. An objective which describes what the learner does after the instruction, under what conditions and how well, is called a behavioural objective.

INSTRUCTIONAL GOALS

The first step in deriving objectives is stating instructional goals. These describe in general terms what the designer expects the students to know, what new skills and abilities he expects them to have at the end of the instruction. Instructional goals are broad and general. They may be differently interpreted by different

instructors. In order to precisely state the intent of an instructional goal, it needs to be broken down into behavioural objectives.

BEHAVIOURAL OBJECTIVES

Behavioural objectives have three components which, according to Briggs (1970), are:

(1) terminal behaviour

(2) conditions

(3) standards

or according to Mager (1962)

given what (conditions)

student does what (terminal behaviour)

how well (standards).

A satisfactory behavioural objective should describe the behaviour expected of the learner after instruction, under what conditions and how well.

(1) TERMINAL BEHAVIOUR

This part of the objective should contain a statement of overt behaviour. The statement includes an action verb which indicates what the student is expected to do in order to show that he achieved the objective.

(2) CONDITIONS

This part of the objective describes materials, aids, tools and environment, and any restrictions placed on the student's behaviour (e.g. time).

(3) STANDARDS

This part of the objective states the minimal level of performance accepted as evidence that the learner achieved the objective.

Behavioural objectives are terminal and enabling objectives.

Terminal objectives are general objectives. A terminal objective is a framework within which more specific objectives called enabling objectives are written. The enabling objective defines the activities of procedure by means of which he reaches the more general terminal objective (Lynch and Holloway, 1973).

EXAMPLE

TERMINAL OBJECTIVE

Shown 6 slides of appropriate appliances in 6 minutes

Without errors

Identifies anchor units supplying stationary and anchor units supplying simple anchorage.

ENABLING OBJECTIVES

(1) Defines orthodontic anchorage

(2) Defines simple and stationary anchorage

(3) Shown appropriate slides,

(a) points out anchor units

(b) selects anchor units which supply simple and stationary anchorage.

The student needs to be able to carry out the activities stated in the enabling objectives in order to achieve the terminal objective.

GENERAL COURSE GOALS AND INSTRUCTIONAL GOALS FOR AN UNDERGRADUATE ORTHODONTIC COURSE*

First a broad statement is made which describes the general course goals. More detailed instructional goals have to be derived based on information from different sources.

The task analysis was useful, but other information is also needed. The changing needs of society, and the changing pattern of health care will have to be predicted.

The following sources may be used for the development of instructional goals:

---

* The development of task analysis, instructional goals and course objectives were previously described.

(1) Task analysis

(2) Analysis of existing models of instructional programmes

(3) Survey of community needs and demands for anticipating needs for orthodontics performed by the general practitioner.

1. The task analysis is based on records of observations and questioning of practitioners about the extent of their involvement in orthodontic care and their abilities to answer needs and demands of their patients in this direction.

2. The origin of this analysis is as stated.

3. This analysis is based on records of observations and questioning of public health authorities, general practitioners, academics and specialists, i.e. orthodontists.

General course goals for an undergraduate orthodontic course may be the following:

(1) The diagnosis and assessment of orthodontic problems

(2) The planning and implementation of alternative therapies for non-specialist orthodontic problems.

THE DESIGN RELATIONSHIP OF A UNIT ON ORTHODONTIC ANCHORAGE (THE PROJECT OF THIS THESIS) TO THE TOTAL COURSE

The diagnosis and assessment of malocclusions and the treatment of non-specialist orthodontic problems are general course objectives (for an undergraduate orthodontic course) as stated previously.

An understanding of orthodontic anchorage is required to reach the above objectives. The project of this thesis consists of the development and evaluation of an instructional unit concerned with the mechanical and biological aspects of orthodontic anchorage.

B. DEVELOPING INSTRUCTION AND TRYING OUT THE COURSE

SEQUENCING OF INSTRUCTION

Consideration has to be given for the sequencing of instruction. Units of a course, terminal objectives for each unit and enabling objectives for each terminal objective have all to be sequenced.

SEQUENCING ACCORDING TO HIERARCHICAL STRUCTURE

Most sequencing has to be done according to the hierarchical nature of learning. As has been pointed out before, concepts which make up a rule have to be first learned; rules needed have to be mastered before problem solving can be accomplished successfully.

For example, knowledge of many concepts such as crossbite, Class II and Class III malocclusion etc., is needed as prerequisite skills for the learning units of this project. The units of this project in turn include concepts of anchorage which have to be learned as prerequisites for selecting appropriate orthodontic therapies and designing orthodontic appliances.

The sequencing below shows this kind of logical sequencing:

Unit for Individual Malposition of Teeth

Extrusion, Tilting, etc.

↓

Unit for Angle's Classification of Malocclusion

↓

Units for Anchorage

↓

Units for Designing of Appliances for

Different Malocclusion Problems

OTHER TYPES OF SEQUENCING

Not all sequencing needs to be done in a hierarchical structure. When there is a choice and one unit does not have to be taught before another, then sequencing may be done according to students' interests. If units of instruction are presented at a time when they are most relevant to students needs, they will tend to be more motivated to learn. Or sequencing may be done according to frequency: skills which are used most are taught first (Mager and Beach, 1967).

SUBJECT CONTENT

Behavioural objectives and subject content should be closely related. Content also should be chosen putting emphasis on attainments of learners. To include all the content required and to avoid unnecessary material, the designer should ask the following question: what content is needed in order that the learners will achieve the objectives which have been stated? Well-formulated behavioural objectives make excellent guides for choosing content for their achievement.

Examining enabling objectives (see example on p. 24) gives an indication for the content needed for the unit of instruction to be presented to achieve the enabling objectives.

INSTRUCTIONAL METHOD

A systematic approach may be applied to the selection of instructional methods. First the terminal objectives and enabling objectives of a unit of instruction are examined. Next, types of learning needed for reading each enabling objective are identified. Appropriate media are next selected for each instructional event. Mager and Beach (1967) suggest choosing a technique which most closely approximates the performance conditions called for by the objective.

This approach is demonstrated in Table 1.5 for the TERMINAL OBJECTIVE: Designs a cervical extra-oral appliance for a suitable molocclusion problem.

Enabling objectives can be seen in the first column.

INSTRUCTIONAL PROCEDURES AND MASTERY LEARNING

In order to judge if a student has obtained mastery of a particular skill, a standard is set for that skill. This standard should be the sole criterion for judging student performance. It has been found (Block, 1971) that almost all students, given enough time and suitable instruction are able to attain mastery of the skills which they are taught (Block, 1971).

TABLE 1.5 A SYSTEMATIC APPROACH TO THE SELECTION OF INSTRUCTIONAL METHODS

TERMINAL OBJECTIVE: Designs a cervical extra-oral appliance for a suitable malocclusion problem ENABLING OBJECTIVES	TYPES OF LEARNING INVOLVED	LEARNING SITUATION	SUITABLE INSTRUCTIONAL METHOD
Lists treatment objectives Indicates if force is orthodontic Indicates orthodontic or orthopedic anchorage employed Names amount of force employed Describes prerequisite conditions and restraints Names timing and period of use	Recall Concept learning Principal learning Problem solving	An opportunity for Identifying Concepts Applying Principles	1. Tutorial-Discussion 2. Individualised Instruction. e.g. each student works out case histories and treatment plans - tutor available for help 3. 1 and 2 combined
Lists parts of the appliance Describes parts of the appliance Lists auxiliaries Describes auxiliaries	Discrimination Learning	Opportunity for Observation To see, handle the appliance and auxiliaries and to have the appliance and auxiliaries described	1. Tutorial-Discussion with demonstration 2. Tape slide followed by discussion 3. Video-Tape 4. Text-book (e.g. Moyers, 1972)

Research does indicate that students differ in their aptitudes; that is, they differ in the rate at which they learn a given subject. Aptitudes vary from subject to subject and from task to task (Block, 1971).

The above findings make it clear that the use of a single mode of instruction hampers the learning of students who are weak in the aptitudes required to learn using that mode: e.g. a student with high spatial and low verbal aptitude would not learn well from textbooks and hand-outs. He would benefit from concrete demonstrations using models (Block, 1971).

ADVANTAGES AND DISADVANTAGES OF DIFFERENT INSTRUCTIONAL METHODS

In the following section some of the advantages and disadvantages of different instructional methods are shown:

	ADVANTAGES	DISADVANTAGES
TAPE-SLIDE	Visual and auditory input, including colour (Mager and Beach, 1967)	Not suitable for motion or animation*
	Suitable for small groups and for individualized instruction (Block, 1971, Krathwohl, et al., 1964, Elwood and Haley, 1974, N.F.F.R. 1968-1971)*	Less visual stimuli than video-tape*
	More suitable for a format which requires responses than video-tape	
	Good substitute for live demonstration and lectures (Emling and Gellin, 1976B, Emling and Gellin, 1975, Stanley and Reich, 1974, N.F.F.R., 1968-1971, Harden et al., 1969)*	Preparation takes a long time, cost high (Briggs, 1970)
	Preparation less time, lower cost, simpler equipment than video-tape*	
	Implementation: simple equipment required, can be operated by students,N.F.F.R., 1968-1971), can be programmed Harden, et al., 1969)*	
	Can be edited*	
	Can be stopped when convenient*	
	Can be used any time, any place N.F.F.R., 1968-1971)*	

*Also applied to AUDIO-TAPES

	ADVANTAGES	DISADVANTAGES
VIDEO-TAPE	Many visual and auditory stimuli can be used, including colour (Ward, et al., 1975, Mager and Beach, 1967)	Not particularly suitable for format which requires responses
	Suitable for motion and animation (Gagne, 1974, Wittich and Schuller, 1973)	
	Implementation takes less time than conventional procedures (Katz et al., 1977, Chu and Schram, 1967)	Preparation and implementation costly, requires expensive equipment and personnel (Katz, et al., 1977, Briggs, 1970)
	A close-up view of details of a practical procedure is available to each student (Katz, et al., 1977, Kasle, 1973)	
	Can be used as a substitute for conventional teaching (Katz, et al., 1977, Ward, et al., 1975)	
	The actuality of an important event demonstration can be replayed (Mager and Beach, 1967)	
	Can be edited, so maximum material can be covered in a minimum of time	
	Tends to be better prepared than demonstrations (Katz, et al., 1977)	
	Flexible, used any time or place	
	Less room, fewer instructors needed (Katz, et al., 1977)	

	ADVANTAGES	DISADVANTAGES
LECTURE	Easy to convey information (Gagne, 1974, Bligh, 1974)	Passive listening, no active participation (Gagne, 1974, Briggs, 1970)
	Many students can be instructed at the same time (Briggs, 1970)	Not good medium for discussion, mostly one-way communication (Bligh, 1974, Briggs, 1970)
		Boring for many students difficult to repeat
TUTORIAL DEMONSTRATION	Suitable for demonstrating actual appliance	Only small number of students at one time (Briggs, 1970)
	Appliances can be handled, assembled, etc.	Students must prepare in advance (Briggs, 1970)
	Suitable for discussions, questions	
	Provides feedback to teacher (Briggs, 1970)	
HAND-OUTS	May be used at any time when convenient (N.F.F.R., 1968-1971)	No active participation
	May be used as substitute for lectures (Gallagher, 1970)	Solitary activity
	Low cost and time involved	
	Good for reinforcing other forms of presentation	
	Can combine visuals and written word - visuals usually in form of diagrams, graphs and tables	

	ADVANTAGES	DISADVANTAGES
TEXTBOOK READING	Necessitates using library	Long time needed for study, note making
	Provides opportunity for wider reading than hand-outs	Not easily available to borrow
	Students are presented with different points of view, encourages critical thinking	Expensive for students to buy
		Students not always know which information is relevant to their needs
ASSIGNMENT WORK	Provides opportunity for:	Long time involved
	Problem solving	
	Using cognitive strategies	Solitary activity
	Discovery	
	Organised material	
	Using written language	

C. DETERMINING HOW WELL OBJECTIVES WERE ACHIEVED

EVALUATION

Evaluation refers to measuring student achievement, evaluating the instruction and evaluating the tests or assessment tool itself. Testing and students' and instructors' opinions provide information for evaluation.

Planning early for evaluation, soon after objectives have been formulated, is desirable (Davis, *et al.*, 1974; Mager and Beach, 1967). The designer, when writing tests, can check and revise the objectives.

Early planning for evaluation allows for gathering student opinions early and using the information for course improvement. Prerequisite skills may need to be tested on students entering the course.

FORMATIVE EVALUATION

Formative evaluation (Kemp, 1977) is used to test the new system while it is being designed (during try-outs).

Answers are needed to questions like these:

Are enabling and terminal objectives achieved?

Which are the deficiencies of the course?

Are instructional methods suitable for meeting objectives?

What are students' and instructors' opinions of the course?

SUMMATIVE EVALUATION

Summative evaluation (Kemp, 1977) is carried out at the conclusion of the instructional and learning processes. It should provide information for the following questions:

Which objectives were achieved?

How many students achieved the objectives?

Were instructional methods suitable to meet objectives?

Was implementation smooth?

Were equipment and materials satisfactory?

What were students' attitudes?

Both formative and summative evaluation consist of testing achievement of objectives and evaluating the instruction.

TESTING ACHIEVEMENT OF OBJECTIVES

It is usually not possible to test all the tasks which the learner is expected to perform at the end of the instruction. Therefore a sample of tasks has to be selected to represent the larger domain of behaviours. The sample of tasks chosen must be a truly representative sample of the required student behaviour, since we are going to generalize from the test results that the learner has reached the objectives.

PRETESTING

Davis *et al.*, (1974) advised testing before and after each unit of instruction in order to evaluate a learning system properly.

Results of pretests provide information regarding what part of the planned instruction students already know. Results of pretests may also be used to provide students with feedback. Preassessment may arouse students' interest in the planned unit of instruction. Berlyne found that prior familiarity with future response terms may contribute to motivation (Glaser, 1973a). The learning gained from the instruction can be measured using actual evaluation tests for both pretesting and for posttesting. In this case the amount of student learning is determined from the gain in scores from pretests to posttests.

EVALUATING THE INSTRUCTION

The instructional effectiveness may be evaluated by interpreting the information obtained from the results of testing and by collecting student opinions.

An effective way to evaluate instructional procedures is to draw up a table showing the objectives which were tested, the importance factor of each objective, the number of students and the percentage of students who achieved each (Table 1.6).

TABLE 1.6*

PROCEDURE FOR EVALUATING INSTRUCTIONAL EFFECTIVENESS

Objectives	Importance Factor	Students S-1	S-2	S-3	S-4	S-5	S-6	S-7	Number of Students Achieving	Percent of Students Achieving
O-1	3	3	3	3	3	3	3	3	7	100
O-2	3	3	3	0	0	0	0	3	3	42
O-3	3	2	0	2	2	0	2	2	5	70
O-4	1	1	1	1	1	1	1	1	7	100
O-5	3	3	3	3	3	3	3	3	7	100

*from Davis (1974, p. 112).

It is easy to see from such a table which objectives have not been achieved by many students. Instructional procedures or test items for these objectives will have to be reviewed.

Students opinions are usually obtained regarding instructional procedures by using questionnaires. Davis, *et al.*, (1974) suggest that questions be chosen in such a way that the answers can be used for improving the instruction (also Oppenheim, 1966).

EVALUATING DIFFERENT METHODS OF INSTRUCTION

Studies have been carried out evaluating different methods of instruction (Katz, *et al.*, 1977; Emling and Gellin, 1975; Ward, 1975; Elwood and Haley, 1974; N.F.F.R., 1968-1971; Harden, *et al.*, 1969, Chu and Schramm, 1967).

The project of this thesis consists of such an experiment. These studies have sought to find out whether:

- one form of presentation is more effective than another (Emling and Gellin, 1975; Harden, *et al.*, 1969, Chu and Schramm, 1967)
- audio-tapes, video-tapes or tape-slides may be satisfactory substitutes for conventional type presentations (Katz, *et al.*, 1977; Harden, *et al.*, 1969, Chu and Schramm, 1967)
- students of different abilities learn more from different presentations (Emling and Gellin, 1976a)
- the form of presentation has an effect on the time spent on learning (Emling and Gellin, 1976b)
- student performance in relation to cost of producing the unit of instruction (Katz, *et al.*, 1977)

Units of instruction which have the same learning objectives and the same content presented with different methods may

be compared with each other. For the results of such a comparison to be valid it is necessary to:

(1) use groups of students of similar abilities and prerequisite skills

(2) use evaluation tests for pretesting and post-testing each group to make it possible to measure learning gained from each method of instruction

(3) use questionnaires to obtain students attitudes regarding the different types of presentation

(4) compare instructor and student time involved and cost for operating each system (Davis, *et al.*, 1974).

It is usually long-term memory which is of interest to us when evaluating the learning which took place or when comparing different methods of instruction. There does not seem to be a sharp line dividing short-term from long-term memory; short-term memory often refers to memory lasting for seconds up to one minute (Bligh, 1974). Retention test results are more valid than post-presentation test results in measuring long-term memory.

Between the presentation of instruction and the retention test, forgetting of the original learning takes place. New learning may also occur if students revise the material (Stammers and Patrick, 1975).

Unfortunately, the retention tests carried out for the present project can hardly be regarded as supplying valid and reliable information about students long-term memory as it relates to the particular learning packages about orthodontic anchorage.

TESTING

There are two basic approaches to the construction of tests and interpretation of test results: norm-referenced and criterion-referenced approaches.

NORM-REFERENCED APPROACH

Norm-referenced measures are used to ascertain a student's performance compared to the performance of other students on the same measuring device. It is an expression of relative standing of a student and does not tell anything of his performance. Norm-referenced measures are designed to distinguish between individuals: they are an advantage when grading is required (Gronlund, 1976).

CRITERION-REFERENCED APPROACH

Criterion-referenced measures depend on the concept of mastery learning. These measures convey information about an individuals performance compared with some established criterion. It is an absolute measure. One student's score is not dependent on scores of other

students. Criterion-referenced measures are suited to evaluating the instruction as well as evaluating the students. Although any test results can be interpreted this way, Gronlund (1973) recommends that to obtain the most meaningful results, the tests should be especially designed to be criterion-referenced.

VARIABILITY

In norm-referenced measures, variability of scores is essential, since students have to be distinguished from each other.

In criterion-referenced testing variability is irrelevant. It is a compliment to the students and to the teaching if all students have perfect scores.

Statistical methods to measure reliability and validity depend on variability of scores and mostly apply to norm-referenced testing.

RELIABILITY

Reliability refers to the internal consistency of a measurement. If the students were re-tested another day, or if different samples of the same items were used to test them, how similar would the scores be?

Indices of internal consistency are only meaningful if they show a high degree of consistency. If the index of internal consistency is low, the criterion-referenced test may still be highly reliable (Popham, 1973b).

VALIDITY

Validity is subdivided into content validity, predictive validity (criterion-related) and construct validity. Mathematical treatment of validity refers mainly to predictive validity (Fleming, *et al.*, 1976).

CONTENT VALIDITY

Content validity describes the extent to which an examination samples the candidate's knowledge, psychomotor skills or attitudes over the whole range of the subject being tested. The construction of an examination of high content validity demands careful matching of the content of the examination with the objectives. A decision has to be made regarding how much weight various behavioural changes will carry (Davis, *et al.*, 1974). This is a subjective decision. It is useful to draw up a table of specifications which shows how much weight or relative emphasis may be given to each topic and each type of behavioural change. The test items then may be compared to this table (Table 1.7).

TABLE 1.7*

Table of Specifications for a 40-Item Test on Addition of Fractions

Instructional Objectives / *Content Area*	*Adds Fractions*	*Adds Fractions and Mixed Numbers*	*Adds Mixed Numbers*	*Total Items*
Denominators are alike	5	4	4	13
Denominators are unlike (with common factor)	5	4	4	13
Denominators are unlike (without common factor)	6	4	4	14
Total items	16	12	12	40

* from Gronlund, (1973, p. 14)

Content validity approaches are particularly suited to criterion-referenced tests. In a test of high content validity, the performance and the conditions of the test items should match those of the objectives.

PREDICTIVE VALIDITY

Predictive validity is concerned with the extent to which an examination predicts future performance or yields results similar to those of another test of the same attributes.

Statistical assessment of predictive validity is suited to norm-referenced testing. Again, as with reliability, criterion-referenced tests may have predictive validity even if no positive correlation can be shown between tests (Popham, 1973b).

CONSTRUCT VALIDITY

Construct validity refers to the type of intellectual activity required to pass the examination. This measurement is appropriate to both type of testing.

ITEM CONSTRUCTION

There is a difference in writing items for criterion-referenced and for norm-referenced tests. In norm-referenced testing items are chosen to get a wide spread of scores; the writer tries to write items which increase variability of test results.

In criterion-referenced items variability is not necessary; the item should be an accurate reflection of the criterion, or in other words it should match the objective.

ITEM ANALYSIS

The function of item analysis is to test the validity and reliability of the assessment tool and in turn the learning objectives and the instruction.

In norm-referenced tests, items which do not differentiate between individuals are unsatisfactory; they are either too easy, too difficult or ambiguous.

A non-discriminating item need not be discarded in criterion-referenced testing: it may discriminate between students taking the instruction and those not taking the instruction. A positively discriminating item may point to flaws in the instruction. A negatively discriminating item (one which is answered correctly by more of the low ability students than the high ability ones) is usually an item with a flaw in both norm-referenced and criterion-referenced tests (Popham, 1973b).

REPORTING AND INTERPRETATION

In norm-referenced testing the conventional reporting is done by interpreting an individual's performance with respect to the performance of other individuals (the results are reported as percentile rankings or standard scores).

In criterion-referenced testing it is usual to report if a student has reached the set criterion or not. It may be useful to state how far the student was from reaching the criterion.

If the report is used to assess a programme, then it is useful to report the number of students who reached the

pre-established criterion. The traditional statistics such as means and standard deviation gives extra information about the programme (Popham, 1973b).

MULTIPLE CHOICE QUESTIONS

Multiple choice questions form an objective type test. Each question or "item" consists of a "stem" which is a question or incomplete statement and usually four or five alternative answers called "responses". The right answer is the "correct response" and the wrong answers are called "distractors" (Hall with Cannon, 1975).

This type of test is well suited to measuring cognitive abilities (Hall with Cannon, 1975; Ebel, 1972). It can be scored rapidly and reliably either manually or by a computer (Ebel, 1972). It is suited to an educational experiment where objectivity is important: test results can be analysed and item difficulties and discriminations may be calculated.

Setting a multiple-choice test is time-consuming and difficult if ambiguity and irrevelance are to be avoided. Rules such as the following need to be observed (Hall with Cannon, 1975): distractors should be equally plausible; all responses should be as short as possible and of similar length; all responses should fit the stem grammatically; the correct responses should be randomly distributed through the test.

EXAMINING SEQUENCING AND INSTRUCTIONAL PROCEDURES

Answers are required to the following questions:

- Were units appropriately sequenced?

If units are not sequenced according to an hierarchical learning structure, learning takes longer (Gagne, 1965).

- Were instructional methods appropriately selected for the types of learning involved?
- Were alternative methods of instruction provided where possible, to fulfill individual needs?
- Were low ability students given enough time to reach objectives according to the principles of mastery learning?

Achieving mastery is essential in a course in dentistry. It is highly undesirable to have dentists who are almost able rather than capable to diagnose malocclusion problems.

Finding answers to the above questions and making appropriate changes are needed to improve the course.

D. COURSE IMPROVEMENT

COURSE IMPROVEMENT

Designing a course in a learning system is a continuous process: it consists of continually evaluating the course and improving some of its parts (Davis, *et al.*, 1974). Since all parts interact, changing one part will involve changing other parts as well.

In order to arrive at decisions concerning course improvement, it is necessary to study results of the evaluation or assessment of the following aspects involving course design: appropriateness and achievement of instructional goals and terminal objectives and efficiency of the course (Mager and Beach, 1967).

INSTRUCTIONAL GOALS AND TERMINAL OBJECTIVES

Answers need to be sought to the following questions:

- were instructional goals appropriate?
- do they set realistic requirements for a graduate to carry out non-specialist orthodontic tasks?
- Are there now new techniques, new information to be mastered?

Questioning new graduates, examining treatment procedures by general practitioners in other countries will help in re-assessing goals and objectives.

Information regarding achievement of terminal objectives is also needed for course improvement:

- What percentage of students reached each terminal objective?
- Were enabling objectives appropriate for students to achieve terminal objectives? In other words, were they taught the right things to reach terminal objectives?
- Were they taught well enough?

EFFICIENCY OF THE COURSE

Efficiency refers to the time taken for students to reach objectives and to the cost of instruction. Both these need to be taken into account when improvements are made.

PART 2 COMPARISONS OF MODES OF TEACHING IN MEDICAL AND DENTAL EDUCATION

There are many questions which instructors would like to have answered regarding different teaching presentations. Is one method more effective than another? Would high ability students perhaps do better using one form of presentation, and low ability students do better using another? Or perhaps there is just a personal preference. Some students may enjoy studying in a group and may need the interaction with other students and may therefore like viewing a tape-slide programme with a group. Others may prefer a solitary activity like reading. What are the advantages and disadvantages of the different forms of presentation, from the instructor's and from the students' point of view? The literature review answers some of these questions.

EFFECTIVENESS OF DIFFERENT TEACHING PRESENTATIONS

The different teaching presentations are similar in effectiveness in most studies reviewed. There tends to be no significant difference between test results of groups exposed to different instructional methods (Katz, *et al.*, 1977; Bogner, *et al.*, 1975; Emling and Gellin, 1975; Ward *et al.*, 1975; Gallagher, 1970; N.F.F.R., 1968-1971).

There is a trend that the tape-slide, audio-tape or video-tape techniques are more effective than the more conventional teaching methods (Bogner, *et al.*, 1975, Ward, *et al.*, 1975; Elwood and Haley, 1974, Harden, *et al.*, 1969; N.F.F.R., 1968-1971).

The differences tend to be more pronounced at post-presentation examinations than at retention examinations (Gallagher, 1970; Emling and Gellin, 1975).

It is necessary to use caution when interpreting these results. There may be the novelty aspect involved when students are using audio-visual programmes. There may be other reasons why one group does better than another group. In one study (Harden, *et al.*, 1969), for example, it was found that the tape-slide group did significantly better than the lecture group. However, the tape-slide demonstration was programmed. The students used their structured response sheets for subsequent revision, for

which these sheets were especially designed. It seems that in this study the tape-slide group had two distinct advantages: they had questions to answer while viewing the programme, and they had the structured response sheets for revision. Their notes may have been therefore superior to those taken by the lecture-group.

Ward, *et al.*, (1975) compared three groups who were given instruction in practical periodontic procedures. The control group C was given unconventional chairside demonstration, Group A received television demonstration, and Group B was given a self-instructional video-tape programme. There was no significant difference between mean scores of the control group and the television group. Group B did have significantly higher mean scores than the other two groups. Ward, *et al.* (1975) suggest that the self-instructional method is a more effective way of using the medium. This assertion does not seem valid, for the groups were not given the instruction under identical circumstances. Group B was allowed to view the programme more than once. The students in Group A only had one viewing and probably could not assimilate the information.

Emling and Gellin (1975) found a programmed text, slide-tape and lectures of similar effectiveness.

Katz, *et al.*, (1977) used a video-tape package teaching oral biology experiments on plaque to a large number of students. The results obtained by the students were not

statistically different from those obtained by experienced laboratory workers.

Stanley and Reich (1974) found no difference in the amount learned between two groups. One group was exposed to conventional methods, using microscopic slides explained by a written test with an instructor present. The other group was given a slide tape programme including self-testing questions.

Gallagher (1970) found that a group of students who received hand-outs instead of attending lectures did just as well as a group who attended lectures in a preclinical course in denture prosthodontics.

Ward, *et al.*, (1975) quote Stickel, who, in an unpublished doctoral dissertation, examined 250 studies. From the ones which met his requirements for adequate experimental design, he concluded that there was no significant difference between televised teaching and conventional teaching.

A study consisting of several projects was published as a final report to the Nuffield Foundation (N.F.F.R., 1968-1971). It consisted of the development and evaluation of audio-tapes with illustrative material for individual learning in medical education. In this study it was found that audio-tapes together with illustrative material are at least as effective and often superior to lectures.

Audio-tapes with illustrative material are as effective as written scripts also (N.F.F.R., 1968-1971).

Bogner, *et al.*, (1975) found a very small increase in cognitive achievement in the group taking slide-tape programmes instead of lectures in medical biochemistry.

Elwood and Haley (1974) offered four different teaching methods to students in a course in microanatomy. These four were lectures, laboratory sessions, laboratory exercises and slide-guides. The slide-guides were a self-contained instructional series consisting of slides with companion guides. As part of a flexible individualized curriculum a choice of different methods are considered desirable by the authors (Elwood and Haley, 1974). A direct correlation was found between students' performance and the number of slide-guide units completed. There was no such correlation found between student's performance and the other three methods.

EFFECT OF STUDENT ACADEMIC ABILITY ON LEARNING FROM DIFFERENT TEACHING PRESENTATIONS

It would be useful to know if students of different academic ability would benefit from different types of presentations. Most studies only use a "blanket application" (Emling and Gellin, 1976a). That is students, whatever their ability, are given the one type of programme.

From the studies which considered student academic ability, it appears that different types of presentations do not differ in their effectiveness for different ability levels (Emling and Gellin, 1976a, Elwood and Haley, 1974). There is some vidence that students of high ability benefited most and students of low ability benefited least using audio-tapes and illustrative materials instead of lectures (N.F.F.R, 1968-1971).

Emling and Gellin (1976a) found that programmed text, slide-tape and lecture do not differ greatly in their effectiveness for different ability levels. Elwood and Haley (1974) also found that both low ability and high ability students benefited equally from the slide guide method.

Interestingly, Emling and Gellin (1976b) did find that students of low ability needed less time to prepare for an examination using programmed texts than the slide-tape or the lecture group. In another study students of low

ability tended to prefer written scripts to audio-tapes (N.F.F.R., 1968-1971).

EVALUATION OF TIME SPENT IN LEARNING USING DIFFERENT TEACHING PRFSENTATIONS

In many studies time spent in learning is not taken into account.

When students are allowed to view a programme several times, they have a statistically higher mean score than students who are not given this opportunity (Ward, *et al.*, 1975).

Most students have a busy schedule and time is important to them. Also they have pressures on them by many teaching departments, from many different directions. Students are often not able or not willing to spend a great deal of time on studying; if specific teaching presentations can reduce their learning time, this is a great advantage to both students and faculty.

In studies where time was considered, the slide-tape group needed less time preparing for examinations than groups which had conventional instruction (Baggott, *et al* ., 1977; Katz, *et al*., 1977; Emling and Gellin, 1976a, Stanley and Reich, 1974).

Emling and Gellin (1976a) found that the slide-tape group took the least time and the lecture group took the longest time in studying for examinations.

In another study, students were presented with a video-taped package to carry out experiments on plaque (Katz, *et al.*, 1977). The procedures were performed satisfactorily and reports were completed in 40% less time than was required for students in the non-televised laboratory with an instructor.

Baggott, *et al.*, (1977) found that in medical biochemistry the group of students who were given a tape-slide programme and the group which was given the tape-slide programme together with lectures spent far less time studying than the control group (lectures only).

Stanley and Reich (1974) also found that a group learning blood morphology from a tape-slide programme including self-testing questions, needed less time than the group using conventional microscopic slides with written instruction and instructors. The authors comment that the self-testing may have contributed to the reduction of learning time.

The previous studies have shown that the slide-tape and video-tape groups needed less time for studying or completing reports than the groups given lectures or conventional laboratory instruction (Baggott, *et al.*, 1977; Katz, *et al.*, 1977; Bogner, *et al.*, 1975; Stanley and Reich, 1974). More time and effort and money is usually put into preparing slide-tape or video-tape programmes than into preparing lectures or conventional laboratory instruction

(Baggott, *et al.*, 1977; Katz, *et al.*, 1977). The better prepared presentations with less non-essential detail may account for students needing less time for organizing and learning material.

ADVANTAGES OF DIFFERENT TEACHING FORMATS

Different presentations have their own advantages and disadvantages. One form may be preferred purely for convenience. Limitations are placed by lack of space, available instructors, large number of students and availability of funds (Ward, *et al.*, 1975). Decisions have to be made regarding the presentation according to circumstances. Knowing some of the limitations and good points claimed for each form of presentation may help make these decisions (Bogner, *et al.*, 1975).

Advantages and disadvantages of different presentations are shown in detail in Part 1 of this thesis.

TAPE-SLIDES AND AUDIO-TAPES

Audio-tapes with illustrative material could be successfully transferred to institutions other than at which they were produced (N.F.F.R., 1968-1971).

Audio-tapes with illustrative material appeared a very flexible form of instruction. They are easy to take into students homes and are ideal for revision. When these were

made available for revision, students did significantly better in their exams than students in the previous years who did not have the material available (N.F.F.R., 1968-1971).

Audio-tapes with illustrative material have also been used to fill in a gap where instruction was not otherwise available. In this case the learning objectives included observation, deduction and decision making to prepare junior hospital officers for clinical practice. A highly significant improvement was found between pre and post-tests (N.F.F.R., 1968-1971).

One of the main advantages of this format compared to hand-outs and lectures is that the tape-slide has both an audio and visual input. It is possible to review any part of the material, but this involves some difficulty. The audio-visual synchronization may be lost (Emling and Gellin, 1975). This depends upon the type of instructional hardware and software available.

Tape-slide presentations may be programmed (Harden, *et al.*, 1969), although this is not often done.

TELEVISION INSTRUCTION

AND VIDEO-TAPES

Television instruction, video-tapes and movies have the added advantage of movement. They are essentially suitable for dentistry where the teaching of psychomotor skills is visually orientated (Ward, *et al.*, 1975).

Video-tape programmes (Katz, *et al.*, 1977) using the discovery approach have been successfully prepared and used in an oral biology course on dental plaque. The programme was divided into 2x5 minute segments. Time was allowed between segments for students to perform the procedures which were demonstrated on the preceding segment. Independent observers found that these experiments proceeded smoothly and efficiently (Katz, *et al.*, 1977). It was possible to pace these programmes so the students could carry out these experiments without undue pressure (Katz, *et al.*, 1977).

Katz, *et al.* (1977) point out that instructors are able to rehearse beforehand, so they can perform smoothly during taping. Preparation for any demonstration is necessary, but instructors possibly rehearse more thoroughly for going on television. This may partly account for the audio-visual programmes' success.

HAND-OUTS

Hand-outs were a satisfactory substitute for audio-tapes with illustrative material (N.F.F.R., 1968-1971).

DISADVANTAGES OF DIFFERENT TEACHING FORMATS

VIDEO-TAPE

This form of presentation is difficult to prepare well. The amateurish video-tape which may result from the lack of suitable equipment or inexperienced audio-visual personnel may spoil an otherwise well designed teaching programme.

The time and cost in preparing a video-tape programme is very high. Katz, *et al.*, (1977) say that preparation time was at least twice that of the traditional laboratory exercise. Cost benefit justification will require use of the video-tape packages for several years without major revision (ibid, p. 97).

Television instruction does not provide a very acute visual image, although this can be improved with the use of good equipment (Katz, *et al.*, 1977).

Disadvantages of different teaching presentations are identified and discussed in Part 3 of this thesis.

STUDENTS ATTITUDES TO DIFFERENT TEACHING PRESENTATIONS

Do students prefer one teaching format to another? There is some evidence that, when given a choice, students prefer audio-tapes to written scripts. (N.F.F.R., 1968-1971).

Students attitudes were generally favourable to audio-tapes with illustrative material (N.F.F.R., 1968-1971).

Audio-tapes with illustrative material were more acceptable to students when they could be used in their own homes (N.F.F.R., 1968-1971).

In another study (Elwood and Haley, 1974) it was found that when lectures, laboratory sessions, laboratory exercises and slide-guides were offered to students, they utilized all four methods.

In a televised pilot laboratory course in biochemistry (Katz, *et al.*, 1975), experiments stressed the relationship between basic sciences and clinical dentistry. When this course was offered to ten randomly selected students, these students preferred it to the traditional biochemistry laboratory. They expressed the opinion that the programme should be included on the regular dental curriculum. The students felt that they avoided repetition taking the dentally orientated course, and that it was more interesting than "pure" biochemical subjects. The

authors had the opinion that the success of this course may have been due to the "relaxed yet intellectually stimulating" (ibid, p. 97) atmosphere of the research centre where the pilot course was offered. The same package was then presented to 180 students in the dental school. The students opinions were favourable to this form of presentation: they felt the teaching was uniform and depended less on the instructors' organizational ability.

In Baggott, *et al.*'s (1977) study, two tape-slide programmes were made. One was professionally prepared using a lot of time and care with many visuals prepared by an artist. The other programme took much less time to make. It was prepared by the lecturer himself who only used simple drawings which were included in his lecture. Yet students opinions of these two presentations were virtually undistinguishable. This raises the question whether it is worth while to spend a lot of time, effort and money on preparing visuals - maybe simple drawings would be just as effective.

CHANGES OF ATTITUDE BY
DIFFERENT TEACHING PRESENTATIONS

Zaki and Bandt (1971) found that the tape-slide method was equally effective in improving students' oral hygiene techniques as conventional type teaching.

THE INSTRUCTOR'S VIEW

Audio-visual teaching is here to stay. The question is not whether to use it, but how to use it to its best advantage. Different presentations are similar in their effectiveness, they all have their advantages and limitations. To quote Elwood and Haley (1974): "For an individualized approach to be optimally effective it was felt that a choice of learning methods should remain available to students" (ibid, p. 161). This may be a worthy aim, even if it is not always practical or possible.

From a personal point of view, a successful audio-visual programme provides a lot of satisfaction. It does not provide, however, the personal interaction between students and instructor (Kasle, 1973). One of the most frequent complaints about video-tapes and tape-slides is that the personal contact is lost and that no questions can be asked.

Another thought comes to mind in defence of short lectures and tutorials. How effective might lectures and tutorials be if the same effort and preparation were put into them as is put into preparing audio-visual material?

SOME OTHER FACTORS REGARDING DIFFERENT TEACHING FORMATS

Results which favour one type of presentation may be due to many factors, some of these not at all obvious.

Emling and Gellin (1975) evaluated a programmed text, slide-tape and lecture at six dental schools. School number 2 outperformed the other five schools. This was unexpected. Academic ability and other obvious factors were investigated. The only explanation found was that the study originated from school 2. The students, although similarly treated as in the other schools, were unintentionally influenced. This data shows how differences in the environment may effect students (Emling and Gellin, 1975).

There may be other factors which effect students. A new approach may have a positive effect on learning, student to student interaction may be encouraged by the use of audio-visual equipment, also contributing to motivation (Stanley and Reich, 1974).

PART 3 ORIGINAL WORK

INTRODUCTION

The project of this thesis consists of the development of an instructional unit; four teaching presentations (tape-slide, video-tape, hand-outs and lecture) were prepared, evaluated and compared to each other.

The instructional unit is concerned with orthodontic anchorage. Part I is on the mechanical aspects and Part II on the biological aspects of orthodontic anchorage.

Evaluation of the teaching presentations entailed the testing of student achievement, obtaining and evaluating student attitudes and the instructor's attitude to the different presentations.

Pre-presentation tests, post-presentation tests and retention tests were administered to measure student achievement and to make comparisons between groups.

Student attitudes were obtained with the use of questionnaires. Questionnaires were administered pre-presentation, post-presentation and post-retention test.

The instructor's attitude to different presentations is also discussed.

METHOD

METHOD

Objectives were stated for Part I - the mechanical aspects and Part II - the biological aspects of orthodontic anchorage. Scripts were written for a two-part video-tape presentation using the following sources: Stoner (1975), Reitan (1975), Graber (1972), White *et al.* (1967), Salzmann (1966), Schwarz and Gratzinger (1966) and Anderson (196?).

The presentations were designed to enable students to achieve the stated objectives. Video-tapes, tape-slides, hand-outs and lectures were prepared and presented using the same scripts.

The writer was responsible for all aspects of design and presentation of each of the instructional modes. In the production of the audio-visual programmes the members of the Audio-Visual Department assisted.

PREPARATION OF THE VIDEO-TAPES

In the video-tape presentation a cartoon was used to introduce the subject. The idea of animation seemed suitable to the topic orthodontic anchorage, where appreciation of different tooth movements is required of students: video-techniques may be adapted for purposes of animation of visual sequences.

Teeth, bands, brackets, buccal tubes, cartoon figures and parts of the backdrop for the cartoon were prepared from thin sheets of polyvinyl chloride. Cartoon figures, parts of the backdrop and brackets were painted with enamel paint. A coat of clear varnish was used to obtain a matt finish. Rectangular arch wires were shaped out of strips of aluminium. Heavy wire was used for round wires.

The cartoon and tooth movements were semi-animated. Ceramic magnets were glued to the backs of cartoon figures and teeth.

For each sequence the appropriate teeth with magnets were placed on the magnetic board. The teeth were slightly moved towards each other for each frame. This technique resulted in semi-animated tooth movement.

It was found that elastics were not suitable, for they moved teeth on the board from their desired positions. String was used to represent elastics.

Slides of patients were used as stills to demonstrate orthodontic appliances. Slides with wording, containing definitions, captions and summary information were also included on the video-tapes.

PREPARATION OF THE TAPE-SLIDES

The tape slide presentation was prepared to be similar to the video-tape using the same visual component minus the animation. The cartoon was omitted. Identical scripts were used. Students also received similar pictorial information, without the advantage of movement. One slide was used to represent teeth before and another slide to represent teeth after tooth movement. The same polyvinyl chloride teeth with bands and brackets were used on the magnetic board. In each sequence showing tooth movement, one slide was prepared before the teeth had moved. The teeth were then rearranged on the magnetic board and the second slide prepared, showing the new position of the teeth. The stills used in the video-tape were all used in the tape-slide sequence.

PREPARATION OF THE HAND-OUTS

Part I of the hand-outs was prepared from textbooks (Moyers, 1972; Anderson, 1960). For Part II the typed script was modified to be photocopied and used as hand-outs. Modification of the script consisted of drawing simple diagrams; a felt-tipped pen was used for this purpose. Broken lines represented teeth after tooth movement; solid lines represented teeth before tooth movement.

PREPARATION OF THE LECTURES

The lecture was also prepared to follow the scripts closely. During the lecture similar diagrams to those in the script were drawn on a blackboard. Coloured chalks were used wherever applicable. Similar colour coding was employed as in the video-tape and the tape-slide in Part II of the lecture.

1977 PILOT RUN

In September 1977 the tape-slide, video-tape, hand-outs and lectures were presented to fourth year undergraduates.

It was decided to consider this a pilot run for the following reasons:

(1) The tests required short answer responses. These could not be marked subjectively and the results could not be considered valid.

(2) Students were allowed to sit wherever they liked in the lecture theatre. They chose to sit next to each other and some appeared to have copied each other's answers.

(3) The hand-outs for Part I were not satisfactory. They differed considerably from the video-tape and the tape-slide. Some facts were omitted, others not clearly presented.

(4) Many students complained about the background music to the video-tape in Part I. This was

found from questionnaires and from verbal complaints. They especially did not like music while slides containing wording were showing.

(5) The questionnaires also showed that students found the tape-slide programmes too fast.

(6) Due to some technical difficulties, the 1977 video-programme could not be presented as planned in the beginning of second term. This time was chosen to present the programme on anchorage: the students at this stage have the necessary prerequisite skills (e.g. knowledge of classification of malocclusions, etc.). They also needed an understanding of anchorage for their subsequent studies.

Unfortunately the programme had to be presented early in the third term. This is just after completion of annual examinations in orthodontics. Attendance was low and motivation did not appear good.

1978 PRESENTATION

Before the programmes were presented in 1978, certain changes were made in the tape-slide and video-tape presentations:

The Tape-Slide

Both Part I and Part I were re-pulsed for a slower automatic slide change.

The Video-Tape

The background music was retained only during the credits and the cartoon sequence.

Part I of the programme was presented at the beginning of the second term, Part II was presented two weeks later to fourth year undergraduate students. An announcement was made before the presentation that questions on anchorage would be included at the annual examination at the end of term. All four presentations were made in the same lecture theatre. Students were asked to sit with one empty chair between students. The tape-slide, video-tape and hand-out groups had their presentation at 2.00 p.m. The lecture was delivered at 10.00a.m.

In this school, fourth year is usually assigned to eight groups. The usual procedure in orthodontics is for two groups to attend tutorials and classes together. The academic staff has requested to have the groups as homogenous as possible.

Following this request students were assigned to groups on an alphabetical basis: the first name starting with A is placed in the first group, the second name starting with A is placed into the second group, etc. This way, each group contains a selection of students with names starting with different letters of the alphabet. This procedure seemed equivalent to a random selection of students and was adhered to. This way groups attended their usual classes, which was an advantage.

Group 1 and 2 are named Group 1; Group 3 and 4 are Group 3; Group 5 and 6 Group 5; and Group 7 and 8 are named Group 7.

GROUP 1 - The Tape-Slide Group

Part I was presented in 12 minutes. It was considered too fast by students to take notes. Part II was repulsed for a second time. The presentation of Part II took 14 minutes. The students were allowed 10 minutes to ask questions and look at notes but they only used five minutes.

GROUP 3 - The Video-Tape Group

Presentation lasted 12 minutes for Part I and 10 minutes for Part II. Students were allowed 10 minutes to ask questions and to look at notes, but they only used five minutes.

GROUP 5 - The Hand-Out Group

Hand-outs which were used for Part II in 1977 were used again in 1978. Part I hand-outs were prepared by modifying the script as previously described. Twenty minutes was allowed for studying hand-outs. An additional 5 minutes were allocated for questions or revision.

GROUP 7 - The Lecture Group

The preparation of the lecture was previously outlined. The 1977 lecture presentation was similar to the other

presentations. There were no interruptions and the lecture lasted approximately 20 minutes for Part I and 15 minutes for Part II. Very few questions were asked at the end of each lecture.

In 1978 students interrupted both lectures many times to ask questions. As a result of this, the lecture concerned with Part I lasted 30 minutes. Five more minutes were used for further questions. The lecture concerned with Part II lasted 35 minutes. No further time was used for asking questions.

QUESTIONNAIRES

Three sets of questionnaires were administered to collect student opinions. Pre-presentation questionnaires were distributed and collected four weeks before presentation of Part I of the programme; post-presentation questionnaires after the Part II post-test; post-retention test questionnaires after the retention test.

TESTS

A multiple-choice test was used to evaluate both the learning which took place and the instruction. The test was constructed to match the objectives. Test for Part I consisted of 16 questions and for Part II 12 questions. Pre-tests were administered just prior to the presentations. Post-tests were administered immediately after the presentations and question time. Retention tests were given for both Part I and Part II two weeks after the presentation of Part II.

The students made their responses on prepared test sheets which enabled machine processing. This processing and the associated scoring and statistical analysis was carried out by the Tertiary Education Research Centre of the University of New South Wales.

RESULTS

TEST RESULTS

PRE-TESTS - PART I (Results shown in Table 3.1)

It can be seen that the hand-out group had the highest mean score and the lecture group had the lowest. A student t test* according to the small sampling theory (Speigel, 1972) was used to determine whether there was a statistically significant difference between scores of pre-tests.

No statistically significant difference at $p=0.05$ was found between means of test results of the four groups.

PRE-TESTS - PART II (Results shown in Table 3.2)

In Part II the tape-slide group had the highest mean score and the hand-out group had the lowest. There were no statistically significant differences found at $p=0.05$ between means of scores of the four groups.

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* $$t = \frac{\bar{x}_1 - \bar{x}_2}{\sigma\sqrt{1/N_1 - 1/N_2}} \qquad \text{where } \sigma = \sqrt{\frac{N_1 S_1^{\,2} + N_2 S_2^{\,2}}{N_1 + N_2 - 2}}$$

TABLE 3.1 PART I. COMPARISON OF GROUPS IN PRE-TEST RESULTS

GROUP				TAPE-SLIDE (1)	VIDEO-TAPE (3)	HAND-OUT (5)	LECTURE (7)
	$\bar{x}$			4.36	4.54	4.78	4.17
		S.D.		0.86	1.84	1.93	1.20
			N	24	26	23	23
Tape-Slide (1)	4.36	0.86	24				
Video-Tape (3)	4.54	1.84	26	t = 0.21* d.f = 48			
Hand-Out (5)	4.78	1.93	23	t = 0.34* d.f = 45	t = 0.44* d.f = 47		
Lecture (7)	4.17	1.20	23	t = 1.48* d.f = 45	t = 0.81* d.f = 47	t = 1.26* d.f = 44	

$\bar{x}$ = Mean
S.D = Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* No significant difference at p = 0.05

TABLE 3.2 PART II. COMPARISON OF GROUPS IN PRE-TEST RESULTS

GROUP				TAPE-SLIDE (1)	VIDEO-TAPE (3)	HAND-OUT (5)	LECTURE (7)
	$\bar{x}$			5.30	4.75	4.72	5.25
		S.D		1.49	1.94	1.66	1.23
			N	23	28	25	24
Tape-Slide (1)	5.30	1.49	23				
Video-Tape (3)	4.75	1.94	28	t = 1.09* d.f =			
Hand-Out (5)	4.72	1.66	25	t = 1.24* d.f = 45	t = 0.06* d.f = 51		
Lecture (7)	5.25	1.23	24	t = 0.12* d.f = 45	t = 1.07* d.f = 50	t = 1.24* d.f = 47	

$\bar{x}$ = Mean
S.D = Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* No significant difference at p = 0.05

POST-TESTS - PART I

Comparison between pre-test and post-test results within groups are shown in Table 3.3. In every group the post-test has a significantly higher mean score than the pre-test of the corresponding group (e.g. the tape-slide group has a significantly higher mean score in the post-test than in the pre-test).

In Table 3.5 post-tests of the four groups are compared. The lecture group had the highest mean score followed by the hand-out group, then the tape-slide group and the video-tape group had the lowest mean score.

It was found that the lecture group had a significantly higher mean score than the hand-out group. The hand-out group had a significantly higher mean score than the tape-slide group. No significant difference was found between means of scores of the tape-slide group and the video-tape group.

POST-TESTS - PART II

Comparison between pre-test and post-test results within groups are shown in Table 3.4. The post-test of every group had a significantly higher mean score than the pre-test of the corresponding group.

Comparison of post-test results is seen in Table 3.6. The lecture group had the highest mean score followed by the

TABLE 3.3 PART I. COMPARISON OF PRE-TEST AND POST-TEST RESULTS WITHIN GROUPS

GROUP				TAPE-SLIDE PRE-TEST	VIDEO-TAPE PRE-TEST	HAND-OUT PRE-TEST	LECTURE PRE-TEST
	$\bar{x}$			4.63	4.54	4.78	4.17
		S.D		0.86	1.84	1.93	1.20
			N	24	26	23	23
Tape-Slide Post-Test	9.17	2.09	24	t = 9.63* d.f = 46			
Video-Tape Post-Test	8.68	2.13	25		t = 7.29* d.f = 49		
Hand-Out Post-Test	11.39	2.37	23			t = 10.14* d.f = 44	
Lecture Post-Test	14.22	1.89	23				t = 21.06* d.f = 44

$\bar{x}$ = Mean
S.D = Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* Significant difference at p = 0.05

TABLE 3.4 PART II. COMPARISON OF PRE-TEST AND POST-TEST RESULTS WITHIN GROUPS

GROUP				TAPE-SLIDE PRE-TEST	VIDEO-TAPE PRE-TEST	HAND-OUT PRE-TEST	LECTURE PRE-TEST
	$\bar{x}$			5.30	4.75	4.72	5.25
		S.D		1.49	1.94	1.66	1.23
			N	23	28	25	24
Tape-Slide Post-Test	9.48	1.89	23	t = 8.15* d.f = 44			
Video-Tape Post-Test	8.71	2.17	28		t = 7.07* d.f = 54		
Hand-Out Post-Test	10.12	1.34	25			t = 12.40* d.f = 48	
Lecture Post-Test	11.00	2.06	25				t = 11.56* d.f = 47

$\bar{x}$ = Mean
S.D.= Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* Significant Difference at p = 0.05

TABLE 3.5 PART I. COMPARISON OF GROUPS IN POST-TEST RESULTS

GROUP				TAPE-SLIDE (1)	VIDEO-TAPE (3)	HAND-OUT (5)	LECTURE (7)
	$\bar{x}$			9.17	8.68	11.39	14.22
		S.D		2.09	2.13	2.37	1.89
			N	24	25	23	23
Tape-Slide (1)	9.17	2.09	24				
Video-Tape (3)	8.68	2.13	25	t = 0.80 d.f = 47			
Hand-Out (5)	11.39	2.37	23	t = 3.34* d.f = 45	t = 4.08* d.f = 46		
Lecture (7)	14.22	1.89	23	t = 8.49* d.f = 45	t = 9.30* d.f = 46	t = 4.38* d.f = 44	

$\bar{x}$ = Mean
S.D = Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* Significant difference at p = 0.05

TABLE 3.6 PART II. COMPARISON OF GROUPS IN POST-TEST RESULTS

GROUP				TAPE-SLIDE (1)	VIDEO-TAPE (3)	HAND-OUT (5)	LECTURE (7)
	$\bar{x}$			9.48	8.71	10.12	11.00
		S.D		1.89	2.17	1.34	2.06
			N	23	28	25	25
Tape-Slide (1)	9.48	1.89	23				
Video-Tape (3)	8.71	2.17	28	t = 1.31 d.f = 49			
Hand-Out (5)	10.12	1.34	25	t = 1.33 d.f = 46	t = 2.75* d.f = 51		
Lecture (7)	11.00	2.06	25	t = 2.60* d.f = 46	t = 3.85* d.f = 51	t = 1.75* d.f = 48	

$\bar{x}$ = Mean
S.D.= Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* Significant difference at p = 0.05

hand-out group, then the tape-slide group and the video-tape group. The lecture group had a significantly higher mean score than the hand-out group; there was no significant difference found between means of scores of the hand-out group and the tape-slide group, or between means of scores of the tape-slide group and the video-tape group.

The hand-out group had a significantly higher mean score than the video-tape group.

RETENTION TESTS - PART I

Comparison between retention test results is shown in Table 3.7.

It can be seen that the lecture group had the highest mean score, followed by the hand-out group, the video-tape group and the tape-slide group. The lecture group had a significantly higher mean score than the hand-out group. The hand-out group had a significantly higher mean than the tape-slide group. No significant differences were found between the means of scores of the hand-out group and the video-tape group or between the mean of the video-tape group and the tape-slide group.

TABLE 3.7 PART I. COMPARISON OF GROUPS IN RETENTION TEST RESULTS

GROUP				TAPE-SLIDE (1)	VIDEO-TAPE (3)	HAND-OUT (5)	LECTURE (7)
	$\bar{x}$			8.74	8.81	10.08	12.15
		S.D		2.05	3.20	3.17	2.25
			N	23	26	24	26
Tape-Slide (1)	8.74	2.05	23				
Video-Tape (3)	8.81	3.20	26	t = 0.09 d.f = 47			
Hand-Out (5)	10.08	3.17	24	t = 1.68* d.f = 45	t = 1.38 d.f = 48		
Lecture (7)	12.15	2.25	26	t = 5.41* d.f = 47	t = 4.27* d.f = 50	t = 2.62* d.f = 48	

$\bar{x}$ = Mean
S.D.= Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* Significant difference at p = 0.05

RETENTION TESTS - PART II (Results are shown in Table 3.8)

In the retention test Part II the lecture group again had the highest mean score, followed by the hand-out group, then the tape-slide group and the video-tape group had the lowest mean score. However, the only significant difference was between mean of scores of the lecture group and the video-tape group; the mean score of the lecture group was significantly higher.

RESULTS OF ITEM ANALYSIS

Results of the item analysis of Part I are shown in Table 3.9 and of Part II in Table 3.10. Distractors which may need revising can be seen on the right hand side of the tables.

ITEM ANALYSIS - PART I

Results are shown in Table 3.9.

Students were "less familiar" at the pre-test and did not improve for the post and retention test in these questions:

Question 7.

Students performed poorly at the post and/or retention tests in these questions:

TABLE 3.8 PART II. COMPARISON OF GROUPS IN RETIENTION TEST

GROUP				TAPE-SLIDE (1)	VIDEO-TAPE (3)	HAND-OUT (5)	LECTURE (7)
	$\bar{x}$			8.57	7.96	8.63	9.54
		S.D		2.36	2.83	1.93	2.36
			N	23	26	24	26
Tape-Slide (1)	8.57	2.36	23				
Video-Tape (3)	7.96	2.83	26	t = 0.80 d.f = 47			
Hand-Out (5)	8.63	1.93	24	t = 0.09 d.f = 45	t = 0.95 d.f = 48		
Lecture (7)	9.54	2.36	26	t = 1.41 d.f = 47	t = 2.14* d.f = 50	t = 1.46 d.f = 48	

$\bar{x}$ = Mean
S.D = Standard Deviation
N = Number of Students
t = t value
d.f = degrees of freedom

* Significant difference at p = 0.05

TABLE 3.9 PART I. RESULTS OF ITEM ANALYSIS (X INDICATES RELEVANT FINDING)

		Learned Topic well				Less Familiar with Topic				Performed poorly, maybe Misinformed				Outside Range of 20 - 80% Correct in Difficulty: Too Easy				Outside Range of 20 - 80% Correct in Difficulty: Too Difficult				Poor Students performed as well as Good Students				Discrimination Index (R Biserial) at 5% significance Level*				Distractors which may need revising
	GROUP	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7	1	3	5	7	
QUESTION	TEST																													
1	Pre									X	X	X	X					X	X	X	X	X	X		X			0.81		
	Post				X			X		X	X												X			0.68		0.68	0.37	B
	Retention					X	X		X			X										X		X			1.06	0.62	0.64	
2	Pre						X	X	X	X												X		X	X					
	Post	X	X	X	X									X	X	X	X					X		X	X		0.80			C
	Retention	X		X	X		X										X		X		X					0.55		0.72		
3	Pre									X	X	X	X					X	X		X	X	X		X			0.54		
	Post			X	X	X					X						X					X	X					0.64	0.80	B
	Retention			X		X	X		X													X					0.47	0.74	0.55	
4	Pre									X	X	X	X					X	X	X	X	X	X		X		0.56			
	Post			X	X					X	X						X		X			X	X	X	X					B
	Retention			X	X	X	X										X					X			X		0.64	0.76		
5	Pre		X			X		X	X													X					0.49	0.47		
	Post			X	X	X	X										X									0.42	0.60	0.64	0.80	B
	Retention							X	X	X	X						X									0.59	0.93	0.56	0.47	
6	Pre					X	X	X	X													X		X	X		0.43			
	Post	X	X	X	X									X		X						X					0.60	0.67	0.87	D
	Retention					X	X	X	X																	0.48	0.71	0.99	0.45	
7	Pre					X	X	X	X													X	X	X	X					
	Post				X	X	X	X									X					X	X	X	X					C
	Retention				X	X	X	X														X	X	X	X					
8	Pre					X						X	X									X	X		X					
	Post	X	X	X	X									X	X	X	X						X			0.77		0.75	0.81	D,A
	Retention	X	X	X	X									X		X											0.79	0.80	1.05	
9	Pre									X	X	X	X					X	X	X	X		X	X	X					
	Post					X	X	X					X										X			0.48	0.49		0.70	
	Retention					X	X		X			X										X		X			0.45		0.64	
10	Pre									X	X	X	X					X	X	X	X	X	X		X			0.63		
	Post				X	X	X	X									X		X		X					0.76		0.61		
	Retention					X	X	X	X																X	0.90	0.46	0.65		
11	Pre					X	X	X	X															X	X	0.67	0.52			
	Post	X	X	X	X									X		X	X					X		X	X		0.56			A,B,C
	Retention	X	X	X	X										X	X	X					X	X	X	X					
12	Pre									X	X	X	X					X	X	X	X	X	X	X	X					
	Post				X		X	X		X							X	X								0.98	0.54	0.74	0.61	A
	Retention						X	X	X	X								X								0.83	0.74	0.60	0.59	
13	Pre					X		X			X		X									X					0.63	0.86		
	Post	X			X		X	X									X		X			X	X						0.68	0.98	
	Retention			X		X	X		X													X	X	X						0.53	
14	Pre					X	X		X			X												X	X	0.65	0.63			
	Post	X	X	X	X									X	X	X	X					X					0.57	0.78	1.08	A,D
	Retention	X	X					X	X						X							X	X					0.49	0.59	
15	Pre									X	X	X	X										X	X	X	0.88				
	Post			X	X	X	X									X	X									0.44	0.70	0.71	0.64	B,C
	Retention			X	X	X	X										X									0.75	0.85	0.93		
16	Pre					X		X			X		X									X			X		0.74	0.47		
	Post				X		X	X		X							X								X	0.68	0.44	0.61		D
	Retention			X		X	X		X													X	X					0.56	0.69	

*All Discrimination Indices recorded in this column represent significant values

Question 1 - The tape-slide and video-tape group at post-test; the hand-out group at retention test

Question 3 - The video-tape group at the post-test

Question 4 - The tape-slide and the video-tape group at the post-test

Question 5 - The tape-slide and the video-tape group at the retention test

Question 9 - The lecture group at the post-test; the hand-out group at the retention test

Question 12- The tape-slide group at both post- and retention tests.

Question 16- The tape-slide group at the post-test.

Poor students performed as well as good students in most groups in the post- and retention tests in these questions: (discrimination low)

Question 4

Question 7

Question 11

All groups found these questions too easy at the post-tests:

Question 2

Question 8

Question 14

ITEM ANALYSIS - PART II

Results are shown in Table 3.10.

Students knew these questions at the pre-test:

Question 4 - All groups

Question 1 - Tape-slide, video-tape and lecture group

Question 6 - Tape-slide and lecture group.

Students performed poorly at the post and/or retention tests in these questions:

Question 1 - Hand-out group at retention test

Question 10- Video-tape group at post-test, tape-slide and hand-out group at retention test.

Poor students performed as well as good students in most groups in the post- and retention tests in these questions: (discrimination low)

Question 4

All groups found these questions too easy at the post-test:

Question 4

Question 6

Question 7.

TABLE 3.10 PART II. RESULTS OF ITEM ANALYSIS (X INDICATES RELEVANT FINDING)

		Learned Topic well	Less Familiar with Topic	Performed poorly, maybe Misinformed	Outside Range of 20 - 80% Correct in Difficulty		Poor Students performed as well as Good Students	Discrimination Index (R Biserial) at 5% significance Level*				Distractors which may need revising
					Too Easy	Too Difficult						
	GROUP	1 3 5 7	1 3 5 7	1 3 5 7	1 3 5 7	1 3 5 7	1 3 5 7	1	3	5	7	
QUESTION												
	TEST											
1	Pre	X X X	X		X X X		X	0.71	0.72	0.51		C,D
	Post	X	X X X					0.66	0.58	0.45	0.81	
	Retention		X X X	X			X	0.59	0.55	0.56		
2	Pre		X X X X						0.85	0.76		B,C
	Post	X X X X			X X X X		X X	0.92	0.62			
	Retention	X X	X X					0.84	0.73	0.93	0.92	
3	Pre		X X				X X	0.76	0.70		2.03	B
	Post	X X X X		X X	X X		X X		0.78			
	Retention	X X	X X		X X			0.63	1.02	0.65	0.97	
4	Pre	X X X X			X X X X		X		0.73	0.68	0.54	A,B,C
	Post	X X X X			X X X X		X X X				2.03	
	Retention	X X X X			X X X X		X X X			0.74		
5	Pre		X X X X				X X		0.58	0.83		
	Post	X X X X			X X X		X X	0.58	1.04		2.03	
	Retention	X X X X			X X X		X X		0.75	0.56		
6	Pre	X X	X X		X X X X		X X		0.67	0.72		B,D
	Post	X X X X			X X X X		X		0.72	0.80	1.30	
	Retention	X X X X			X X		X	0.67	1.06	0.76	0.84	
7	Pre		X X	X X	X X X X		X X	0.56			0.59	A,C
	Post	X X X X			X X X X		X X	0.78			2.03	
	Retention	X X X X			X X X			0.94	0.93		0.91	
8	Pre			X X X			X X	0.78		0.59		A
	Post	X X X	X		X X		X X			0.80	2.03	
	Retention	X	X X X				X X	0.[illegible]		0.83	0.87	
9	Pre			X X X X		X X		0.89	0.46	0.60		C
	Post	X X X X						0.82	0.91		0.99	
	Retention	X X	X									
10	Pre			X X X X		X X X	X X	0.70	0.77			
	Post	X	X	X			X	0.70	0.72	0.81	1.07	
	Retention	X	X	X			X	0.72			0.73	
11	Pre		X X X	X	X X X		X		0.54		0.51	A,B
	Post	X X X X			X X X			1.36	1.03		0.65	
	Retention	X X X	X		X X X		X	0.81	0.77	0.93		
12	Pre			X X X X		X X X X	X X X	0.56				
	Post	X X X X					X	0.66	0.68		1.51	
	Retention	X X	X				X	0.70	0.85		0.76	

*All Discrimination Indices recorded in this column represent significant values.

QUESTIONNAIRE RESULTS

PRE-PRESENTATION QUESTIONNAIRE RESULTS

Results are shown in Table 3.11.

QUESTION 1 and 2

Fourth Year indicated fairly strongly that they would prefer lectures and that they could learn more successfully from lectures than from any other method. Their next preference were hand-outs and tutorials and/or demonstrations, which were liked by an approximately equal number of students. Video-tapes were chosen by a much smaller number and text-books and tape-slides by very few students as their first choice or as the method from which they could learn most successfully.

QUESTION 3

Fourth Year thought that hand-outs would make what they were expected to learn most obvious, followed by lecture, tutorial and/or demonstration, video-tape and tape-slide.

Responses to all three questions for tape-slide presentations were very few. In other words, very few students thought that they would select tape-slide presentations if given a choice.

TABLE 3.11 PRE-PRESENTATION QUESTIONNAIRE RESULTS

METHOD	Video-Tape				*	Tape-Slide				*	Lecture				*	Hand-out				*	Textbook				*	Tutorial and/or Demonstration				*
GROUP	1	3	5	7		1	3	5	7		1	3	5	7		1	3	5	7		1	3	5	7		1	3	5	7	
Q.1 Would you prefer to learn from:	2	2	5	6	15	3			1	4	9	13	6	15	43	13	4	6	4	27	2			1	3	4	7	8	10		29
Q.2 Indicate method from which you learn most successfully:	1	2	4	3	10	2			1	3	8	12	6	12	38	9	2	7	1	[illegible]	1	1	4		6	3	7	6	6		22
Q.3 Indicate method which would make what you are expected to learn most obvious:	2	3	5	3	13	2	1	2	1	6	6	7	4	5	22	9	10	9	8	36	1				1	3	3	5	6		17
Q.4 Briefly indicate good and bad points of each:																														
METHOD	Video-Tape				*	Tape-Slide				*	Lecture				*	Hand-out				*	Textbook				*	Tutorial and/or Demonstration				*
GROUP	1	3	5	7		1	3	5	7		1	3	5	7		1	3	5	7		1	3	5	7		1	3	5	7	
GOOD POINTS:																														
Visual	4	8	6	6	24	2	4	3	4	13																				
Audio			1		1	1		1	1	3																				
Can Replay	2	3			5	2	3	4	5	14																				
Good with Clinical Demonstration				7	7																									
Movement			2	1	3																									
Questions and Discussion											6	7	6	4	23															
Good Supplement																1	7	3	5	16	2	2	4	2	10					
Information what to Learn		1		1	2				3	3	3	7	7	5	22	4	12	9	12	37	3	2	2	1	8					
Personal													2	4	6															
Good Summary			2		2		2		2	4						3	7	2	3	15		3			3					
Good Reference																					1	3	2		6					
Clear, Good			1		1		2	1		3		9	2	3	14	3			3	6		5			5					
Tutorial or Demonstration or Tutorial and Discussion - Good																										6	14	11	19	40
Good																											4			4
Can Take Notes											2	4	1		7															
Total Number of Favourable Comments	6	12	12	15	45	5	11	9	15	40	11	27	18	16	72	11	26	14	23	74	6	15	8	3	32	6	18	11	19	54
BAD POINTS:																														
Boring	6	7	5	3	21	2	9	7	8	26	1	1		1	3							2	1		3					
No Question or Discussion	5	12	4	10	31	5	4	1	3	13		1	1		2		2			2		2			2					
Cannot Stop to Replay	1	4	4	1	10									2	2															
Impersonal/no personal Involvement	2	4	1	5	12	2	4	1	4	11																				
Too Fast		1			1						3	1	2		6															
Expensive/Hard to get																					3	3	3	2	11					
Not Clear						1		1		2						1	2			3	2	7	3		12					
Too Brief			1	1												3				3										
Slow/Long	1				1			2	1	3											3	4		5	12					
Too Detailed																					3	3	3	4	13					
Not Covers all Topics																					3				3					
Visually Bad		4			4		4			4		1	1		2															
Bad/Cannot Concentrate				4	4	4	5	1		10				3	3			3	3	6										
Too Busy Writing to Listen												3	3		6															
Cannot take Notes		3	2	1	6				1	1																				
Total Number of Unfavourable Comments	15	35	16	25	91	14	26	13	17	70	4	8	8	6	26	4	5	4	3	16	14	21	10	11	56					
No Answer	3	1	1		5	3				3	1			1	2	1			1	2	2				2	10	4	6		20

*Total number of responses

QUESTION 4

In this question students supply their own answers. The lecture and hand-outs received many favourable comments and the video-tapes had the largest number of unfavourable ones. Tutorials and demonstrations were liked by many.

Hand-outs received the largest number of favourable comments and the least number of unfavourable ones. They were mostly liked because they provide information about what to learn and because they are a good summary and a good supplement.

Lectures were mainly popular because they provide an opportunity for asking questions and because they provide information to students about what to learn. Criticism of the lecture were few: "too busy writing to listen" or "too fast" was made by some students.

Tutorials and demonstrations were simply called "good". The "good points" or "bad points" were supplied. Many students did not respond to this part of the question.

Both video-tapes and tape-slides were rather criticized than praised. They were found "boring" by many. Students complained that they do not provide the opportunity for questions and discussion. Students also found that the video-tapes and tape-slides are impersonal and they lack student-lecturer interaction. Few students did mention some good points of the video-tapes and tape-slides:

the visual component and the fact that the tape-slide can be replaced were praised. Surprisingly, animation of the video-tape attracted only very few comments.

COMPARISON BETWEEN GROUPS

GROUP 1 - (The Tape-Slide Group)

This group preferred hand-outs to lectures. It also showed less liking for tape-slides/video-tapes than Group 5 or Group 7. Generally less responses were made (especially favourable ones) than by the other groups.

GROUP 3 (The Video-Tape Group)

The largest number of responses to video-tapes and tape-slides were made in this group. Lectures were strongly preferred.

GROUP 5 (The Hand-out Group)

This group did not show a strong preference for one form of presentation. A similar number of students preferred to learn from and could learn most successfully from tutorials and/or demonstrations, hand-outs and lectures; only a few less chose video-tapes.

In questions where students provided answers, lectures and hand-outs seemed to be preferred to other forms of presentation.

GROUP 7 (The Lecture Group)

Many students in this group showed a preference for lectures and chose lectures as the method from which they could learn most successfully. They also showed a liking for the video-tape and tape-slide presentations by responding with the largest number of "good points".

POST-PRESENTATION QUESTIONNAIRE RESULTS

Results are shown in Table 3.12.

GROUP 1 (The Tape-Slide Group)

This presentation was better liked than the video-tape, but not as well liked as the hand-outs or lectures. Many students showed that they would prefer different presentations, or a combination of a tape-slide with another method.

GROUP 3 (The Video-Tape Group)

This was the most unpopular presentation. This group had the largest number of students who would have preferred the topic presented differently and who did not enjoy the presentation. It was the only group where a considerable number of students said that they did not find it obvious what they were expected to learn.

Many students asked for a slower presentation.

TABLE 3.12 POST-PRESENTATION QUESTIONNAIRE RESULTS

		GROUP:	T.S.** (1)	V.T. (3)	H.O. (5)	L (7)
Q.1	Was it obvious what you were expected to learn?	Extremely	9	8	14	14
		Moderately	10	10	9	8
		Slightly	4	5	0	1
		Not		6	1	
Q.2	Do you think this topic relevant to your present or future need?	Extremely	5	9	5	11
		Moderately	15	17	14	10
		Slightly	3	8	4	2
		Not		1	1	
Q.3	How stimulated are you now to learn about this topic?	Extremely	2	6	3	4
		Moderately	14	12	13	13
		Slightly	5	8	7	3
		Not	2	2	1	1
Q.4	How successful are you in learning the subject matter presented?	Extremely	1	1	5	13
		Moderately	17	12	17	8
		Slightly	5	11		2
		Not		2	2	
Q.5	Would you have preferred to have this topic presented in a different way?	Yes	13	16	7	4
		No	10	12	18	19
Q.6	How enjoyable did you find this presentation?	Extremely	3	1	6	9
		Moderately	8	7	12	11
		Slightly	8	9	3	3
		Not	4	11	3	
Q.7	In which way would you have preferred this topic presented?	As a Lecture or Lecture with other method	10	9	5	2
		As Tutorial or Tutorial with discussion	7	4	1	
		With slides			2	
		With handouts	2	3		
		As is	4	1	5	9
		Slower		8		
		Shown twice		3		
		No answer	2	3	7	9
Q.8	How might this instructional experience be improved?	Slower	6	15		
		No pre-tests	1	8		5
		With tape-slide			3	2
		With Tutorial or Demonstration	5	9	4	4
		As Lecture or Handouts	3	3		
		Answers given straight after	3			1
		Shown twice		3		
		Louder or better sound		3		
		Stating objectives		4		
		As is			3	
		Other favourable comments				2
		Other unfavourable comments		2	5	2
		Total number of responses	18	47	15	16
		No answer	5	1	1	7

** T.S. = Tape-Slide H.O. = Hand-out
V.T. = Video-Tape L = Lecture

GROUP 5 (The Hand-Out Group)

Reactions to the hand-outs were good, although it was less popular than the lecture. A few students would prefer a lecture or a lecture and demonstration.

GROUP 7 (The Lecture Group)

This presentation was well liked by the majority of students. Most students ask for the presentation "as is". In this group and the hand-out group the majority of students responded with "extremely" to the question: "Was it obvious what you were expected to learn?"

POST-RETENTION TEST QUESTIONNAIRE RESULTS

Results are shown in Table 3.13.

QUESTION 1 - Different Methods for Revision

The largest number of students studied from their own notes. Approximately half the number of students used hand-outs, a smaller number studied from text-books and a very few used tape-slides. Only one student played the video-tape. Many students employed more than one method for revision.

GROUP 1 (The Tape-Slide Group)

This group had the second largest number of students studying; mean time for studying was the shortest. Approximately equal numbers of students used hand-outs,

TABLE 3.13 POST-RETENTION QUESTIONNAIRE RESULTS

Q.1 INDICATE TIME IN MINUTES SPENT REVISING THE RESPECTIVE SUBJECT MATTER - ALSO INDICATE METHOD OF REVISION

METHOD									
	GROUP	1 (T.S.)		3 (V.T.)		5 (H.O.)		7 (L)	
	PART	I	II	I	II	I	II	I	II
TAPE-SLIDE	TIME	85	75						
	RANGE	5-45	5-30						
	NUMBER	4	5						
VIDEO-TAPE	TIME	10							
	RANGE	10*							
	NUMBER	1							
HAND-OUT	TIME	95	115	40	35	178	146	30	30
	RANGE	10-20	10-20	10-15	5-15	3-60	1-60	30*	30*
	NUMBER	8	8	3	3	9	9	1	1
OWN NOTES	TIME	75	60	385	355	12	34	258	171
	RANGE	5-20	5-15	5-60	5-60	2-10	2-20	5-55	3-30
	NUMBER	7	6	20	9	2	4	15	12
OTHER (TEXT-BOOK)	TIME	20	10	170	140	30	10	60	
	RANGE	20*	10*	10-60	10-60	10*	10*	60*	
	NUMBER	1	1	6	5	3	1	1	
TOTAL TIME SPENT		285	260	595	530	220	190	348	201
TOTAL MEAN TIME		15.0	15.3	25.9	24.1	22.0	15.8	21.7	16.7
TOTAL NUMBER		19	17	23	22	10	12	16	12

Time: Time spent in minutes by group
Range: In minutes
Number: Number of students revising
* Constant

	GROUP	1 (T.S.)	3 (V.T.)	5 (H.O.)	7 (L)
Q.2 How familiar were you with this topic before presentation?	Extremely				
	Moderately	1		2	
	Slightly	4	6	4	
	Not	18	20	18	24
Q.3 Would you like other topics in Orthodontics presented in this way?	Yes	7	5	11	20
	No	10	12	3	
	Not sure	6	8	10	4
Q.3 Do you believe you need to revise material on anchorage again before your examination?	Yes	23	26	23	23
	No				
	Not sure				
Q.5 Do you prefer objective type (M.C.Q.) Tests instead of easy questions?	Yes	6	11	10	10
	No	7	6	5	3
	Not sure	9	8	9	12

and their own notes; a smaller group used the tape-slides.

GROUP 3 (The Video-Tape Group)

The largest number of students who studied was in this group. The mean time for studying is considerably higher than in the other groups. Most of these students used their own notes. There was also the largest number of students in this group who used text-books.

GROUP 5 (The Hand-Out Group)

This group had the smallest number of students spending time on revision: hand-outs were used by most students.

GROUP 7 (The Lecture Group)

The mean time was similar for the hand-out group and the lecture group. It was somewhat less for Part I and considerably less for Part II than the mean time of the video-tape group.

QUESTION 2

All students in the lecture group replied "not" when asked if they were familiar with this presentation. Most students in the other groups responded with "not" and in a few with "slightly".

QUESTION 3

The lecture group fairly unanimously showed that they would like other topics presented as lectures.

In the hand-out group approximately equal numbers of students responded with "yes" or "not sure" whether they would like hand-outs for other topics.

In the tape-slide group the largest number of students said "no" to this question.

The video-tape group had the largest number of students who did not want video-tapes for other topics.

QUESTION 4

All Fourth Year believes that they need to revise this material again.

QUESTION 5

An approximately equal number of students responded with "yes" and "don't mind" and a smaller group said "no" to this question. There does not seem to be much difference between groups.

DISCUSSION

DISCUSSION

In most studies reviewed different teaching presentations are similar in effectiveness as far as the amount learned is concerned (Katz *et al.*, 1977; Emling and Gelin, 1975; Ward *et al.*, 1975; Bogner *et al.*, 1975; Gallagher, 1970; N.F.F.R., 1968-1971). There seems to be a slight trend that audio-visual techniques are more effective than more conventional methods (Bogner *et al.*, 1975; Ward *et al.*, 1975; Elwood and Haley, 1974; F.R.N.F., 1968-1971, Gallagher, 1970).

In the studies which considered time for learning, the slide-tape or video-tape groups used less time for preparing for examinations than the groups receiving conventional instruction (Katz *et al.*, 1977; Baggott *et al.*, 1977; Emling and Gellin, 1976b; Stanley and Reich, 1974).

In the studies which considered student attitudes, there was some evidence that students preferred audio-visual presentations to more conventional methods (Katz *et al.*, 1975; N.F.F.R., 1968-1971).

In this project four different presentations were compared and evaluated. Results differ from the results of the

studies which were reviewed. The lecture was found to be more effective and better liked by students than the other presentations. The hand-outs were also slightly more effective and more popular than the video-tapes.

The video-tapes were the least effective and the least liked presentations. More students studied and the longest mean time for studying was spent in the video-tape group than in any other group. Some of the possible reasons for these results will be discussed later.

In such educational projects which involve evaluation, it is necessary to consider a variety of factors such as student abilities, students' and teachers' attitudes which may have a modifying effect on the intended educational outcomes. Some of these factors will be discussed later.

TEST RESULTS

(Tables 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8).

At the pre-test no differences between groups were found.

In the retention tests less significant differences between groups were found than at the post-tests. The general trend however did not change: the lecture group was still the best and the video-tape group still the worst group. The possible effect of students' and teacher's attitude on these results will be discussed later.

RESULTS OF ITEM ANALYSIS

(Tables 3.9 and 3.10)

Distractors which need to be revised can be seen at the right-hand side of the tables. An example of a question, an analysis of its faulty distractors and the revised question will be given later.

Interpretation of the item analysis provides information about the teaching and about the test items. This information may be used to improve the programme and the test in the following manner:

PART I

QUESTIONS AT WHICH STUDENTS PERFORMED POORLY

Simple and Stationary Anchorage

(Q. 1, 3, 12, 4)

Only the video-tape and tape-slide groups performed poorly in these questions. During the lectures and after the hand-out presentations, questions were asked to clarify these concepts. They will similarly have to be clarified when the video-tapes and tape-slides are revised.

Various Direction of Pull Employed by Extra-Oral Appliances (Q. 4)

The video-tape and the tape-slide group need to improve in this area. A caption added to each slide, indicating the type of pull will probably solve this problem.

Definition of Orthodontic Anchorage (Q. 9)

This needs to be emphasised in the hand-outs and future lectures.

QUESTIONS WHICH DISCRIMINATED POORLY BETWEEN STUDENTS (Q. 4, 7, 11)

Cervical Anchorage (Q. 4, 7)

Question 7 was the only question which was not answered better at the post-presentation test than at the pre-test by any of the groups. It seems that students did not know the word "cervical". This word will have to be defined in future programmes.

Description of Extra-Oral Anchorage

This topic was learned well. It discriminated poorly between students because distractors were poor. The question needs to be revised.

PART II

QUESTIONS WHICH STUDENTS KNEW WELL AT THE PRE-TEST (Q. 4, 1, 6)

Tissue Change Associated with Pressure (Q. 1)

Students were less familiar with this topic at the post and retention test than at the pre-test. The item needs to be discarded, it is confusing.

Areas of Bone Resorption During Lingual Tipping (Q. 4)

All groups knew this topic well at all the tests including the pre-tests. The item may be superfluous.

Tissue Changes Associated with Bodily Movement (Q. 6)

Two groups knew this topic well at the pre-tests. The item is good and discriminates well between students. Two of the distractors may need to be improved.

QUESTIONS AT WHICH STUDENTS PERFORMED POORLY AT THE POST AND RETENTION TESTS (Q. 10, 7)

Tissue Changes During the Second Period of Lingual Tipping (Q. 10)

The video-tape group at the post-test, the hand-out group and the tape-slide group at the retention test performed poorly at this topic.

In the lecture students asked questions showing that they were confused about this subject. It was discussed and clarified during the lecture. This area needs to be clarified in the other presentations also.

Definition of Hyalinization (Q. 7)

Groups found this question too easy in the post-test. It discriminated well between good and bad students. Two distractors need to be revised.

ANALYSING AND RE-WRITING DISTRACTORS

Example

Q12/I In orthodontic tooth movement which situation best fits the requirements of stationary anchorage?

x(a) The anchor tooth or teeth remain stationary

(b) Any form of extra or intra-oral anchorage which remains stationary

(c) The anchor tooth or teeth remain stationary while the other tooth or teeth move bodily

*(d) The anchor tooth may move, and this is bodily movement.

x = distractor which needs revising

* = correct response.

Distractor (a) needs revising, for it did not attract any students. There is some guess-work involved in analysing why a distractor is unsatisfactory. In this case one basic rule was not followed: distractors should be of equal length (Hall with Cannon 1975). The revised distractor is as follows:

(a) The anchor tooth or teeth remain stationary, while the other tooth or teeth tip.

STUDENT ABILITIES

Any difference in test performances between the groups could also be related to differences in academic ability within and between groups. This possibility of such differences was realised but could not be taken into account in the design of this educational study. It was necessary to use the existing teaching groups which had been arranged on an alphabetical sorting according to student names.

In order to test for non-uniformity of academic attainment among the four student groups, students' examination marks at their previous annual examination were analysed.

The mean mark for the respective group can be ranked in descending order of magnitude from Group 7, then Group 5, Group 1 and lastly Group 3 (Table 3.14). Analysis of variance (Table 3.15) indicate no significant difference in academic scores between the four groups.

Nevertheless, there was other information about students' previous performances which suggested that the groups were not uniformly constituted and that they might be expected to perform differently in any new learning situation. This information concerned the number of students of each group with deferred examinations and also the total number of such examinations shared in each group (Table 3.16). The possible effects of this lack of uniformity between groups will be further discussed.

INTERPRETATION OF QUESTIONNAIRE RESULTS
(Tables 3.11, 3.12, 3.13)

STUDENTS' ATTITUDES

The results of the student questionnaires indicate a strong bias, even before the presentations, in favour of the lecture and to a lesser degree to the hand-outs, compared with the specially designed audio-visual programmes. This bias may be due to previous unfortunate experiences with audio-visual programmes, or it may be simply that lectures are more familiar to students. These student attitudes also serve to raise similar questions about possible teacher's bias which will be discussed later.

TABLE 3.14 ANALYSIS OF ACADEMIC PERFORMANCE OF STUDENTS OF PREVIOUS ANNUAL EXAMINATIONS BY GROUP

	GROUP 1	GROUP 3	GROUP 5	GROUP 7	ALL STUDENTS
Number of Students (n)	28	28	28	27	111
Mean Mark ($\bar{x}$)	286.61	285.11	292.75	297.37	289.40
Sums & Squares ($\Sigma x-\bar{x}$)	31966.7	18357.7	14951.2	18800.3	86734.6
Variance ($\frac{\Sigma (x-\bar{x})^2}{n-1}$)	1183.95	679.91	553.97	723.09	788.50
Standard Deviation	34.41	26.08	23.54	26.89	28.08

TABLE 3.15 ANALYSIS OF VARIANCE OF STUDENT GROUP ACADEMIC PERFORMANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	$\Sigma (x-\bar{x})^2$	ESTIMATE OF POPULATION VARIANCE
Total	110	86734.6	788.40
Group Means	3	2652.7	884.23
Individuals in Group	107	84081.9	785.81

$F = 884.23/785.81 = 1.13$ $F = 0.05 = 2.30$

TABLE 3.16 RECORD OF DEFERRED EXAMINATIONS FOR STUDENT GROUPS

	GROUP 1	GROUP 3	GROUP 5	GROUP 7
Total Number of Students in Group	28	28	28	27
Number with Deferred Exams	11	13	10	6
Number of Deferred Exams Taken	25	19	14	9

The video-tape group did not improve in the retention test in spite of the large number of students and long mean time spent studying. This group complained that they could not take good notes. Yet these unsatisfactory notes were used for studying and hand-outs which were available were not borrowed.

TEACHER'S ATTITUDE

Teachers also have preconceived ideas about different presentations: these biases may have an effect on the outcome of the presentation and on student attitudes. It was pointed out in the literature review that if the teacher is committed to one strategy, he may work harder to bring about its success. Similarly, his lack of enthusiasm for another strategy may bring about its failure.

In this project the instructor preferred the lecture to the other presentations. This attitude may have been transmitted to the students: the lecture group was certainly an unusually alert, interested group.

There were many doubts about the video-tape even before the preparation. The difficulties involved in the making of this programme are described later. When the presentations were finished the tape-slides were much preferred to the video-tapes. These attitudes of the teacher may have influenced student attitudes and indirectly, test results.

PREPARATION OF VIDEO-TAPES

The preparation of this presentation took three months longer than planned. This was partly due to difficulties with equipment and partly to teaching commitments which allowed little time for making this programme. After the considerable time, care and effort which was spent on the preparation of the video-tapes, the quality seemed particularly disappointing.

Much more expertise is needed to make a good video-tape than a tape-slide. The video-tape is an excellent medium for a clinical demonstration; the type of animated film which was made on anchorage is a different matter. A good director may have improved the quality of this programme. For example, in Part I, a few slides containing wording follow each other. On a video-tape, where movement is expected, this appears rather stilted. The video-tapes are not good visually. In Part II, where colour coding is important, this is a distinct disadvantage. These are some of the shortcomings which, even though the pictorial information and script were similar, made the video-tapes inferior to the tape-slides. Video-tapes tend to be compared with professionally made films. The tape-slide programmes on anchorage compare reasonably well with the quality of tape-slides seen by undergraduates. The slides were good and the colours clear.

PRESENTATIONS

The lecture group's behaviour during this presentation really helps to explain why they did better in the post and retention tests than the other groups. Students were extremely alert during this presentation; the lecture was frequently interrupted, so that it took much longer to deliver than in 1977. The item analysis shows that students in the lecture group answered some questions well, while the video-tape and the tape-slide group did not.

COMMENTS

The information regarding students' deferred examinations (Table 3.16) lends some support to the conjecture that the lecture group could be expected to perform better overall than the other groups with students of the tape-slide group and the video-tape group likely to perform least well.

The possible effect of examination, failure and extra time and effort required for taking deferred examinations may conceivably take their toll on affected students, adversely affecting their later performances. However it is beyond the scope of this project to consider such effects further.

It appears from the questionnaire results that students want and need the personal interaction with the lecturer.

They ask for an opportunity for questions and discussions. After the tape-slide and video-tape presentations such an opportunity was provided, yet students did not take it, the opportunity was not sufficient: students need to be motivated to ask questions, perhaps by a more stimulating programme.

Some of the following suggestions may make audio-visual presentations more acceptable to students:

(a) Good quality audio-visual presentations - these may overcome students' bias

(b) Opportunity for students to view audio-visual presentations in their own time on topics of their choice

(c) As students suggest, combining audio-visual presentations with tutorial discussions. In small groups (10-12), discussion may develop more easily than in the larger groups of this project.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

Two instructional units concerned with the mechanical and biological aspects of orthodontic anchorage were developed. The design relationship between an undergraduate orthodontic course and these instructional units called Part I and Part II was outlined.

Four teaching presentations were prepared from the instructional units. These presentations were tape-slides, video-tapes, hand-outs and lectures.

All four presentations were based on the same script. The same visual component minus animation was used for the tape-slides as for the video-tapes. In the hand-outs and the lecture, simple diagrams were substituted for slides of teeth and appliances. In the hand-out colour was omitted. Pre-tests were administered prior to the presentations. Post-tests were given immediately after the instruction presentations. Retention tests were administered for both Part I and Part II two weeks after the presentation of Part II. The same multiple-choice test was used for all three tests.

Questionnaires about student knowledge and attitudes to various instructional modes was administered before and after the instruction and after the retention tests.

In the pre-tests no differences of knowledge of orthodontic anchorage between groups was found.

Both post and retention test show the lecture to be the most effective presentation and the video-tape the least effective. The hand-out group did significantly better than the video-tape group in the post-tests and significantly better than the tape-slide group in the post-test Part I and retention test Part II. No significant differences were found between the tape-slide group and the video-tape group in any tests. Less significant differences between groups were found in the retention tests than in the post-tests.

Information from the item analysis of the tests was used to correct faulty question items and to make future improvements to the programmes.

Some factors, such as student abilities, students' and the teacher's attitude, which may have had a modifying effect on test results, were discussed.

Concerning student abilities, differences were found between the number of students with deferred examinations of different groups; this information would lead one to expect the lecture group to do the best and the tape-slide and video-tape groups the least well.

Students showed a strong bias even in the pre-presentation questionnaires in favour of lectures with hand-outs following and audio-visual presentations were least preferred.

The post-presentation questionnaires showed that student attitudes to presentations matched their test results. In other words, the lecture was liked best followed by the hand-outs then the tape-slide and the video-tape was liked the least of all.

The post-retention test questionnaires indicated that in Fourth Year, as a whole, the largest number of students used their own notes for studying. Hand-outs were used by the next largest group. A few students used textbook, and fewer still used tape-slides.

The video-tape group had the largest number of students spending time on revision. Mean time for studying was longest also in this group. Mostly their own notes were used.

All groups accepted multiple choice questions quite well. When test results, student opinions and time spent on studying are considered, then the lecture proved to be the most effective presentation and the video-tape the least effective in this project.

After the experience of this study, one cannot but be impressed with the importance of individual student and teacher attitudes and abilities which can modify the teaching and learning process on both favourable and unfavourable directions.

REFERENCES

ANDERSON, G.M. 1960 — Practical Orthodontics. C.V. Mosby Company, St. Louis.

AUSTRALIAN ARMY 1974 — The Systems Approach to Training. An Introduction to the Systems Approach to Training. Pamphlet No. 1.

BAGGOTT, J., LAWRENCE, D.M., SHAW, F., GALEY, M., DEVLIN, T.M. 1977 — Efficiency of Do-It-Yourself Slide-Tape Programs as an Alternative to the Lecture in Medical Biochemistry. J. Med. Educ., 52:157-159.

BLIGH, D.A. 1974 — What's the Use of Lectures? Penguin Education, Harmondsworth.

BLOCK, J.S. 1971. — Mastery Learning: Theory and Practice. Holt, Rinehart and Winston, New York.

BOGNER, Phyllis, SAJID, A.W., FORD, D.L. 1975. — Effectiveness of Audio-Based Instruction in Medical Pharmacology. J. Med. Educ., 55:677-682.

BRIGGS, L.J. 1970 — Handbook of Procedures for the Design of Instruction. American Institute for Research. Pittsburgh.

CHAMBERS, W.D. 1973. — CAP - Criterion Ability Prediction, Clinical Grading System. J. Dent. Educ., 37:13-18.

CHU, G.C. and SCHRAMM, W. 1967 — Learning from Television, What the Research Says. Institute for Communication Research, Stanford University.

COX, R.C. 1973. — Evaluative Aspects of Criterion-Referenced Measures, from Popham, 1973A, pp. 17-37.

DAVIS, R.H., ALEXANDER, L.T., YELON, S.L. 1974. — Learning System Design - An Approach to the Improvement of Instruction. McGraw Hill, New York.

EBEL, R.L. 1972 — Essentials of Educational Measurements. Prentice-Hall, Inc., New Jersey.

ELWOOD, W.K. and HALEY, T.V. 1974 — Effective Learning by Slide-Guide Method: Evaluation of a Course in Microanatomy. J. Dent. Educ., 38:161-167.

EMLING, R.C. and GELLIN, M.E. 1975 — An Evaluation of Programmed Text, Slide-Tape and Lecture at Six Dental Schools. J. Dent. Educ., 39:72-77.

EMLING, R.C. and GELLIN, M.E. 1976A — Effect of Student Academic Ability on Learning from a Programmed Text, a Slide-Tape and a Lecture at Six Dental Schools. J. Dent. Educ., 40:86-89.

EMLING, R.C. and GELLIN, M.E. 1976B — Evaluation of the Time Spent in Learning from a Programmed Text, a Slide-Tape and a Lecture at Six Dental Schools. J. Dent. Educ., 40:559-561.

FLEMING, P.R. SANDERSON, P.H. STOKES, J.F. WALTON, H.J. — Examinations in Medicine. Churchill Livingstone, Edinburgh

GAGNE, R.M. 1965 — The Conditions of Learning. Holt, Rinehart and Winston, New York.

GAGNE, R.M. 1974 — Essentials of Learning for Instruction. Dryden Press. Illinois.

GALLAGHER, J.B. 1970 — An Evaluation of the Transfer of Information by Printed Materials Without a formal Lecture. J. Dent. Educ., 50:373-380.

GARVIN, A.D. 1973 — The Applicability of Criterion-Referenced Measures, from Popham 1973A, pp. 55-63.

GLASER, R. 1973A — Instructional Technology and the Measurement of Learning Outcomes - Some Questions, from Popham 1973A, pp. 5-17.

GLASER, R. 1973B — A Criterion-Referenced Test, from Popham 1973A, pp. 41-51.

GODFREY, K. 1977 — Selection of Students for Dentistry, Faculty of Dentistry, University of Sydney Report.

GRABER, T.M. 1972 — Orthodontics, Principles and Practice W.B. Saunders Co., Philadelphia.

GRONLUND, N.E. 1970 — Stating Behavioral Objectives for Classroom Instruction. The Macmillan Co. New York.

GRONLUND, N.E. 1973 — Preparing Criterion Referenced Tests for Classroom Instruction. The Macmillan Co. New York.

GRONLUND, N.E. 1976
Measurement and Evaluation in Teaching. The Macmillan Co. New York.

GULLION, C. and GILPATRICK, E. 1973
The Design of Curriculum Guidelines for Educational Ladders, Using Task Data Working Paper No. 11. Health Services Mobility Study.

HALL, W.C. with CANNON, R. 1975
University Teaching. Advisory Centre for University Education, The University of Adelaide, South Australia.

HARDEN, R.M.G., DUNN, W.R. HOLROYD, C. LEVER, Rosemary LINDSAY, Anne WILSON, G.M.
An Experiment Involving Substitution of Tape/Slide Programmes with Lectures. The Lancet, 1:933-935.

JORDAN, I. 1976
Teaching the Begg Technique by Animated Film. An M.D.Sc. Thesis, Faculty of Dentistry, University of Sydney.

KASLE, M.J. 1973
One Instructor's Experience with Television in Dental Teaching. J. Dent. Educ., 37-43, 1973.

KATZ, S., OLSON, B.L., KOERBER, L.G. 1975.
An Experimental Laboratory Program in Oral Biology. J. Dent. Educ., 39:276-283.

KATZ, S. KOERBER, L.G. OLSON, B.L. 1977
Teaching Oral Biology Laboratories to Large Numbers of Students by Video Tape. J. Dent. Educ., 41:97-100.

KEMP, J.E. 1977
Instructional Design. A Plan for Unit and Course Development. Fearon Publishers, Belmont, California.

KRATHWOHL, D.R., BLOOM, B.S. MASIA, B.B. 1964
Taxonomy of Educational Objectives. The classification of Educational Goals Handbook II: Affective Domain. Longmans, London.

LYNCH, B.L. and HOLLOWAY, L.D. 1973
An Introduction to Preparing Objectives for Health Career Education. Learning Resources Centre, College of Medicine, University of Iowa, Iowa City.

McCREA, M.W. and SWANSON, E.A. 1969.
Are Formal Lectures Really Necessary? J. Dent. Educ., 33:424-430.

McKEACHIE, W.J. 1969
Teaching Tips: A Guidebook for the Beginning College Teacher. D.C. Heath and Co., Lexington, Mass.

MacKENZIE, N.I. ERAUT, M., JONES, H.C. 1970
Teaching and Learning. An Introduction to New Methods and Resources in Higher Education. UNESCO Press and the International Association of Universities, Paris.

MAGER, R.F. 1962
Preparing Instructional Objectives. Fearon, Belmont, California.

MAGER, R.F. and BEACH, K.M. 1967.
Developing Vocational Instruction. Fearon, Belmont, California.

MAGER, R.F. 1973
Measuring Instructional Intent, or Got a Match. Fearon, Belmont, California.

MEDICAL EDUCATIONAL COMMITTEE 1972
A Guide to Developing Educational Objectives. The University of Iowa, College of Medicine.

MOYERS, R.E. 1972
Handbook of Orthodontics for the Student and General Practitioner, Yearbook Medical Publishers, Chicago.

NUFFIELD FOUNDATION - FINAL REPORT (N.F.F.R.) 1968-1971
The Development and Evaluation of Audio-Tapes with Illustrative Material for Individual Learning in Medical Education, The Department of Audio-Visual Communication, British Medical Association and British Life Assurance Trust for Health Education.

OPPENHEIM, A.N. 1966
Questionnaire Design and Attitude Measurement. Heinemann, London.

POPHAM, W.J. 1973A
Criterion Referenced Measurements - An Introduction, Educational Technology Publications, New Jersey.

POPHAM, W.J. 1973B
Implications of Criterion Referenced Measurement, from Popham, 1973A, pp. 17-37.

POPHAM, W.J. 1973C
Indices of Adequacy for Criterion-Referenced Test Items, from Popham 1973A. pp. 79-98.

REITAN, K. 1975
Biomechanical Principles and Reactions from Graber, T.M. and Swain, B.F. Current Orthodontic Concepts and Techniques. Vol. 1, pp. 111-229, W.B. Saunders Co., Philadelphia.

SALZMANN, J.A. 1966 — Practice of Orthodontics, Vol. Two. J.P. Lippincott and Co., Philadelphia.

SCHRAMM, W. 1962 — Learning from Instructional Television. Rev. Educ. Res. XXXII: 156-167.

SCHWARZ, A.M. and GRATZINGER, M. 1966 — Removable Orthodontic Appliances. W.B. Saunders, Philadelphia, 1966.

SCIAKY, I. 1962 — Some Thoughts on the Dental Curriculum. W.H.O. Expert Committee on Dental Health.

SPEIGEL, M.R. 1972 — Schaum's Outline Series: Statistics McGraw-Hill, New York.

STAMMERS, R. and PATRICK, J. 1975. — The Psychology of Teaching, Essential Psychology, Methuen, Great Britain.

STANLEY, J. and REICH, P. 1974 — Teaching Blood Morphology: Audiovisual Method Compared to Microscopic Slides with Written Text and Instructors, Blood 44:445-448.

STONER, M.M. 1975 — Tooth Movement, from Graber, T.M. and Swain, B.F., Current Orthodontic Concepts and Techniques, Vol. 1, pp. 543-555, W.B. Saunders Co. Philadelphia.

WARD, V.J. 1975 — Effectiveness of Self-Instructional Materials in Teaching Practical Periodontal Procedures. J. Dent. Educ., 39:596-599.

WHITE, T.C. GARDINER, J.H. LEIGHTON, B.C. 1967 — Orthodontics for Dental Students, Staples Press, London.

WITTICH, W.A. and SCHULLER, C.F. 1973 — Instructional Technology - Its Nature and Use. Harper and Row.

ZAKI, H.A. and BANDT, C.L. 1971 — Effectiveness of Audio-Visual Machines in Teaching Oral Hygiene. J. Dent. Educ., 35:423-426.